GUIDING ENVIRONMENTAL LAW'S TRANSFORMATION

Guiding Environmental Law's Transformation into Earth System Law Through the Telecoupling Framework*

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Insights from Earth system science show us that we are crossing over into a new geological epoch, the Anthropocene. Yet, environmental law has failed to integrate these insights and adopt an Earth system perspective, with the result that environmental law has arguably become incapable of responding to the numerous complex, interconnected, and non-linear challenges of an erratic Earth system in the Anthropocene. Earth system law is proposed as a response and is intended to 'translate' Earth system science insights into the legal domain, thereby transforming Holocene environmental law and making it more fit for purpose in the Anthropocene. In order to practically explore how this transformation could take place, reliance is placed on the telecoupling framework, which analyses interconnected or coupled human and natural systems over distances. With reference to the mining activities conducted by Canadian companies in Mexico, the telecoupling framework is revealed as a valuable tool for thinking about environmental law in Earth system terms and enabling one to see a range of deeply intertwined telecoupled issues and considerations that must be taken account of by the law. In turn, this enables one to begin to imagine the types of considerations that should be incorporated into legal responses in order to adequately respond to the socio-ecological challenges of the Anthropocene.

Keywords: Anthropocene, Earth system, Earth system governance, Earth system law, Earth system science, Environmental law, Socio-ecological systems, Telecoupling

I. Introduction

Human activities have had major impacts on the Earth system – 'the suite of interacting physical, chemical, and … biogeochemical cycles … and energy fluxes which provide the conditions necessary for life on the planet'[1] – and have structurally modified those conditions that support all life on Earth. Humans have consequently become 'geological agents',[2] and are pushing Earth out of the Holocene epoch – 'the only state of the [Earth system] that we know for certain can support contemporary human societies'[3] – and into the Anthropocene, a new geological epoch.[4] Earth system science provides us with the evidence that we are crossing over into the Anthropocene.[5] While the insights we gain from Earth system science will presumably have numerous implications for many scientific domains, as lawyers, we need to ask ourselves: what do Earth system science insights collectively mean for law as a regulatory institution insofar as law steers human behaviour?[6] Are these insights useful to law and, more importantly for present purposes,

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[1] *Global Change and the Earth System: A Planet Under Pressure* 7 (Will Steffen et al. eds, Springer 2004).

[2] Naomi Oreskes, *The Scientific Consensus on Climate Change: How Do We Know We're Not Wrong?*, in *Climate Change: What it Means for Us, Our Children, and Our Grandchildren* 93 (Joseph F. C. Dimento & Pamela Doughman eds, MIT Press 2007).

[3] Will Steffen et al., *Planetary Boundaries: Guiding Human Development on a Changing Planet*, 347(6223) Sci. 1259855, 1259855-1 (2015).

[4] Paul J. Crutzen & Eugene F. Stoermer, *The 'Anthropocene'*, 41 IGBP Newsletter 17 (2000); Will Steffen, Paul J. Crutzen & John R. McNeill, *The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature*, 36(8) J. Human Env't 614 (2007); Johan Rockström et al., *A Safe Operating Space for Humanity,* 461 Nature 472 (2009). While the Anthropocene has not yet been formally accepted as a distinct geological unit within the geological time scale, metaphorically, the term is useful as an analytical lens: Jane Carruthers, *The Anthropocene*, 115(7/8) South African J. Sci. 6428 (2019); Louis J. Kotzé, *Rethinking Global Environmental Law and Governance in the Anthropocene*, 32(32) J. Energy & Nat. Res. L. 121, 126 (2014).

[5] For example, Steffen et al. eds, *supra* n. 1; *Earth System Analysis for Sustainability* (Hans Schellnhuber et al. eds, MIT Press 2004).

[6] This is a question that is increasingly being posed. *See* e.g.,: Eva Lövbrand, Johannes Stripple & Bo Wiman, *Earth System Governmentality Reflections on Science in the Anthropocene*, 19 Global Envtl. Change 7 (2009); Louis J. Kotzé, *Earth System Law for the Anthropocene: Rethinking Environmental Law Alongside the Earth System Metaphor*, 11(1–2) Transnat'l Legal Theory 75, 104 (2020).

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could these insights play a role in rethinking the role of law in (re)shaping human behaviour in the Anthropocene?

On the one hand, Earth system science describes the natural science-based phenomena that give rise to those governance challenges that law and other social regulatory institutions must address (climate change is one example). On the other hand, Earth system science could also offer solutions in response to the deficiencies of our legal institutions in order to better govern these challenges. So, while we agree with the view that '[t]he challenges to … legal institutions to deal with the complexities of Earth System management are formidable',[7] we also believe that Earth system science is useful for law, especially to the extent that it could inform law's ability to better understand and respond to the type of governance challenges that emanate from a complex Earth system.

Yet, while Earth system science has comprehensively been engaging with numerous aspects related to a changing Earth system for several years now, law does not yet seem to have embraced the insights that Earth system science offers in relation to what the Earth system is and how it functions, transforms, and is impacted. Overall, there is a clear dissonance between what Earth system science tells us should be the law's object of concern in the context of the Anthropocene (i.e., the Earth system), and what law is actually doing to embrace these insights. Interdisciplinary co-learning is therefore yet to occur.[8]

We clearly observe this dissonance within the domain of environmental law, the focus of our present analysis. Environmental law is the body of law that should presumably be most obviously concerned with governing Earth system issues. Yet, it seems that environmental law still continues to regulate and limit human activities in the context of an outdated set of Holocene-embedded assumptions about and understanding of Earth system functions, impacts and transformations.[9] Environmental law, for example, continues to follow a linear, path-dependent, one-dimensional and segmented approach to governing, what it incorrectly perceives as, discrete, unrelated, localized 'environmental' problems that only occur in specific and disconnected geographic locations.[10]

There are examples of environmental law integrating scientific knowledge in regard to environmental issues within 'defined spatial boundaries',[11] such as the international legal regime to address stratospheric ozone depletion and, to some extent, the international climate change regime. In the European context, it has been highlighted that the European Commission 'gives significant consideration to science', thereby contributing to the incorporation of scientific knowledge into environmental lawmaking.[12] However, recognizing that the Earth functions as a system, and that its interacting system dynamics, processes and components have social implications, leads one to the conclusion that the social regulatory institution of environmental law will have to discard its preoccupation with a singular 'environment', and instead will have to open itself up to, and more fully embrace, insights from Earth system science if it is to remain useful and relevant in the face of the Anthropocene's reality (a reality that is characterized by a deep socio-ecological crisis and unprecedented levels of planetary injustice). In other words, environmental law will have to become commensurate with Earth system dynamics, which could open up the possibility for environmental law to mimic 'in a mirror-like way, aspects of the Earth's complex adaptive system'.[13]

On the other hand, if there are no structural changes with respect to the legal institutions that regulate human activities at a planetary level and scale, it is highly likely that environmental law will be unable to regulate increasingly severe human impacts on the Earth system. This, in turn, might give rise to the risk of environmental law becoming irrelevant in the Anthropocene.[14]

As a response to this challenge, the notion of Earth system law has recently been proposed as a new epistemic framework relevant to the attempt to regulate socio-economic-ecological interactions in the Anthropocene alongside an Earth system perspective.[15] Earth system law is meant to serve, among other things, as an innovative legal imaginary that could 'translate' Earth system science insights into the legal domain, thereby transforming Holocene environmental law and making it more fit for purpose in the Anthropocene.[16] As a contribution to the evolving debate on Earth system law, and in an effort to bolster similar calls made elsewhere to capitalize on the

[7] Steffen et al. eds, *supra* n. 1, at 297.

[8] Louis J. Kotzé & Duncan French, *The Anthropocentric Ontology of International Environmental Law and the Sustainable Development Goals: Towards an Ecocentric Rule of Law in the Anthropocene*, 7(1) Global J. Comp. L. 5 (2018); Antonio Cardesa-Salzmann & Endrius Cocciolo, *Global Governance, Sustainability and the Earth System: Critical Reflections on the Role of Global Law*, 8(3) Transnat'l Envtl. L. 437 (2019); Tim Stephens, *What Is the Point of International Environmental Law Scholarship in the Anthropocene?*, in *Perspectives on Environmental Law Scholarship: Essays on Purpose, Shape and Direction* (Ole W. Pedersen ed., Cambridge University Press 2018).

[9] Clive Hamilton, *The Anthropocene as Rupture*, 3(2) Anthropocene Rev. 93 (2016).

[10] Jorge Viñuales, *The Organisation of the Anthropocene in Our Hands?*, 1(1) Int'l Legal Theory & Prac. 1 (2018); John Dryzek, *Institutions for the Anthropocene: Governance in a Changing Earth System*, 46(4) Brit. J. Pol. Sci. 937 (2016).

[11] Stephens, *supra* n. 8, at 124.

[12] Aleksandra Čavoški, *Science and Law in Environmental Law and Policy: The Case of the European Commission*, 9(2) Transnat'l Envtl. L. 263, 294 (2020).

[13] Louis J. Kotzé, *Earth System Law for the Anthropocene*, 11 (8–9) Sustainability 6796 (2019).

[14] Louis J. Kotzé & Rakhyun E. Kim, *Earth System Law: The Juridical Dimensions of Earth System Governance*, 1 Earth Sys. Governance 100003 (2019); Stephens, *supra* n. 8, at 124.

[15] Kotzé & Kim, *supra* n. 14; Kotzé, *supra* n. 13.

[16] Louis J. Kotzé & Rakhyun E. Kim, *Exploring the Analytical, Normative and Transformative Dimensions of Earth System Law*, Envtl. Pol'y & L. (2021, in press).

perceived epistemic and, ultimately, regulatory benefits of engaging an Earth system perspective,[17] this article explores the potential role of the Earth system perspective to guide the transformation of environmental law into an Earth system-centred body of law. Our hypothesis is that environmental law's continued legitimacy, use, and relevance in the context of the Anthropocene will significantly depend on its ability to align itself with the system dynamics of the Earth system, which it could accomplish by fully embracing the Earth system perspective inherent to Earth system science.

The discussion commences in Part 2 by briefly illuminating, within the context of Earth system science, what the Earth system perspective entails. Part 3 explores how environmental law is currently disconnected from such an Earth system orientation. As a counter-narrative, it then offers an alternative (ideal) vision of a juridical imaginary that actually does embrace, and is more aligned with, an Earth systems perspective, namely Earth system law. Part 4 discusses how the Earth system perspective could be employed to guide environmental law's transformation into Earth system law with reference to the notion of telecoupling. Telecoupling has been developed as a framework to analyse complex global socio-economic-ecological interactions among coupled human and natural systems over distances,[18] and could usefully offer a more concrete framework for environmental law to embrace an Earth system perspective. Part 5 concludes the discussion.

II. The Earth System Perspective

The Earth system is made up of several components, namely: the geosphere (the physical climate system), which is comprised of the atmosphere (the layer of air surrounding Earth), the hydrosphere (the Earth's water), the cryosphere (the Earth's frozen areas), and the lithosphere (the Earth's rocky component); the biosphere (all life on Earth); and the anthroposphere (which includes those parts of the Earth that have been made or modified by humans). These components are interdependent and have coevolved, and any conception of the Earth system must conceive of the Earth as a 'unified, complex, [and] evolving system beyond the sum of its parts', rather than as separate ecosystems.[19]

In simplified terms, Earth system science investigates what the Earth system is, how it operates, how its processes and components interact, how system change happens, how system equilibrium is upset, and how the system dynamics of the Earth continuously try to re-establish equilibrium.[20] Earth system science grew out of the recognition of the failure of 'classical analytical science' (which was concerned with studying system components in isolation)[21] to embrace a systems perspective encompassing 'complex interactions, synergies between system components, non-linear responses and multiple feedbacks [and] also embrac[ing] both biophysical and anthropogenic drivers of change … as closely interwoven and interactive processes'.[22] Having therefore arisen amid calls for a new 'science of the Earth',[23] Earth system science represents a 'paradigm shift in the earth and life sciences' as it is concerned with 'a new object', namely the entire Earth system.[24]

Spanning several fields, this scientific domain includes perspectives from, among many others, hydrologists, physicists, geographers, biologists, geologists and climatologists. Scientific tools to contribute to understanding the changing Earth system include observation and monitoring programmes, experiments, modelling, reconstructing of past environmental changes, assessments, and syntheses.[25] Earth system science furthermore draws on significant advances in computer modelling, remote sensing, global observation systems, and global datasets in order to form a better understanding of the Earth system.[26] Several important concepts have emerged from Earth system science research, including that of tipping elements,[27] the planetary boundaries framework,[28] and the Anthropocene[29]; the latter arguably being '[t]he most influential concept' emanating from Earth system science.[30]

A central premise of Earth system science is that of systems thinking. In broad terms:

> A system is an entity that maintains its existence and functions as a whole through the interaction of its

[17] Kotzé, *supra* n. 6.
[18] Jianguo Liu et al., *Systems Integration for Global Sustainability*, 347 Sci. 1258832 (2015).
[19] *Understanding the Earth System: Global Change Science for Application* Box 2, xvii–xviii (Sarah Cornell, I. C. Prentice, Joanna House & Catherine Downy eds, Cambridge University Press 2012); Hamilton, *supra* n. 9, at 94; Arnim Kuhn & Thomas Heckelei, *Anthroposphere*, in *Impacts of Global Change on the Hydrological Cycle in West and Northwest Africa* (Peter Speth, Michael Christoph & Bernd Diekkrüger eds, Springer 2010). *See also* Figure 3, 'An updated conceptual model of the Earth System' in Will Steffen et al., *The Emergence and Evolution of Earth System Science*, 2 Nature Rev. Earth & Envt. 54, 61 (2020).
[20] *See* e.g., Timothy Lenton, *Earth System Science: A Very Short Introduction* (Oxford University Press 2016).
[21] Steffen et al. eds, *supra* n. 1, at 1–2.
[22] *Ibid.*, at 2.
[23] Steffen et al., *supra* n. 19, at 56.
[24] Hamilton, *supra* n. 9, at 93 and 103.
[25] Steffen et al. eds, *supra* n. 1, at 255; Steffen et al., *supra* n. 19, at 58–59.
[26] International Biosphere-Geosphere Programme, *Global Change and the Earth System: A Planet Under Pressure*, IGPB Science Series No. 4, 1, 5 (2011).
[27] Timothy M. Lenton et al., *Tipping Elements in the Earth's Climate System*, 105(6) Proc. Nat'l Acad. Sci. 1786 (2008).
[28] Johan Rockström et al., *Planetary Boundaries: Exploring the Safe Operating Space for Humanity*, 14(2) Ecology & Soc'y 32 (2009); Rockström et al., *supra* n. 4; Steffen et al., *supra* n. 3.
[29] Crutzen & Stoermer, *supra* n. 4; Steffen, Crutzen & McNeill, *supra* n. 4.
[30] Steffen et al., *supra* n. 19, at 59.

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> parts … this group of interacting, interrelated or interdependent parts that form a complex and unified whole must have a specific purpose, and in order for the system to optimally carry out its purpose all parts must be present. Thus, the system attempts to maintain its stability through feedback. The interrelationships among the variables are connected by a cause and effect feedback loop, and consequently the status of one or more variables, affects the status of the other variables. Yet, the properties attributable to the system as a whole are not those of the individual components that make up the system.[31]

Such an understanding of a system also applies in the context of Earth system science, which shows us that the Earth is 'a single, planetary-level complex system, with a multitude of interacting biotic and abiotic components', where interference with one aspect of the system upsets other aspects.[32] It also tells us that humans are an integral and interacting part of the Earth system, and that humans have become significant drivers of Earth system change;[33] the Earth system is complex, dynamic and unpredictable, while human pressures add yet another layer of complexity.

If environmental law is to be capable of responding to the challenges of the Anthropocene, it is important that this understanding of the Earth as a complex, unified, and evolving system, in which humans play an integral and interacting role, is reflected in environmental law. Indeed, Garver argues that a 'systems-based perspective of law as a complex adaptive system that interacts and evolves along with other complex systems … can provide the foundation for a transition to a mutually enhancing human-Earth relationship'.[34] While elaborated on in sections 3 and 4 below, some of the implications of this perspective for environmental law are briefly highlighted.

First, the treatment by environmental law of different concerns in isolation, without considering their interdependence, can no longer be feasible. For example, the problems of climate change and stratospheric ozone depletion have largely been dealt with as unrelated issues in international environmental law. However, the phasing out of hydrochlorofluorocarbons (HCFCs) under the Montreal Protocol on Substances that Deplete the Ozone Layer resulted in a drastic increase in the use of hydrofluorocarbons (HFCs), which contributed to climate change.[35] While this problem was subsequently remedied,[36] this example demonstrates how problem-shifting can arise when separate legal regimes are created in respect of different (but related) environmental concerns and applied in isolation.[37] At the regional level, the 2009 EU Renewable Energy Directive provided that, by 2020, energy from renewable sources should account for 10% of final consumption of energy in transport.[38] While this measure (and the Directive generally) was intended to contribute to climate change mitigation, it drove demand for biofuels, which resulted in unsustainable land-use changes in distant areas.[39]

Furthermore, in order to be able to respond to complexity, unpredictability, and non-linearity, 'legal systems must become more flexible and adaptive while remaining firmly grounded in a commitment to a mutually enhancing human-Earth relationship'.[40] For example, Fernández Fernández and Malwé – in proposing the development of an international framework convention on planetary boundaries – argue that the planetary boundaries framework is a useful tool to navigate the 'inherent complexity of the functioning of the Earth system, including the multi-scale interactions between its different biophysical processes'.[41] They furthermore argue that such a framework convention would have the advantage of being

[31] Orit Assaraf & Nir Orion, *Development of Systems Thinking Skills in the Context of Earth System Education*, 42(5) J. Res. Sci. Teaching 518, 519–520 (2005).

[32] Will Steffen et al., *Stratigraphic and Earth System Approaches to Defining the Anthropocene*, 4(8) Earth's Future 324, 325 (2016).

[33] Will Steffen et al., *Trajectories of the Earth System in the Anthropocene*, 115(33) Proc. Nat'l Acad. Sci. 8252, 8256 (2018); Steffen et al., *supra* n. 19, at 61.

[34] Geoffrey Garver, *A Systems-Based Tool for Transitioning to Law for a Mutually Enhancing Human-Earth Relationship*, 157 Ecological Econ. 165, 167 (2019).

[35] *See* Polvani et al., who highlight the substantial contribution of ozone-depleting substances to Arctic warming: Lorenzo M. Polvani et al., *Substantial Twentieth-Century Arctic Warming Caused by Ozone-Depleting Substances*, 10 Nature Climate Change 130 (2020). *See also* Rakhyun E. Kim & Klaus Bosselmann, *Operationalizing Sustainable Development: Ecological Integrity as a Grundnorm of International Law*, 24(2) RECIEL 194, 200 (2015).

[36] Through the Kigali Amendment, which provided for the phasedown of HFCs beginning in 2019: *see* United Nations Environment Programme 'Annex I: Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer' (Report of the twenty-eighth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer) (UNEP/OzL.Pro.28/12), https://ozone.unep.org/sites/default/files/2019-04/MOP-28-12E.pdf.

[37] Rakhyun E. Kim & Harro van Asselt, *Global Governance: Problem Shifting in the Anthropocene and the Limits of International Law*, in Res. Handbook Int'l L. & Nat. Res. (Edward Elgar 2016).

[38] European Parliament and Council of the European Union, *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC* (2009), Art. 3(4), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN.

[39] *See* e.g., Hallie Eakin et al., *Significance of Telecoupling for Exploration of Land-Use Change*, in *Rethinking Global Land Use in an Urban Era* 145–146 (Karen C. Seto & Anette Reenberg eds, MIT Press 2014); Jens Newig et al., *What Is Governance in Global Telecoupling?*, 24(3) Ecology & Soc'y 26, 2 (2019).

[40] Garver, *supra* n. 34, at 168.

[41] Edgar Fernández Fernández & Claire Malwé, *The Emergence of the 'Planetary Boundaries' Concept in International Environmental Law: A Proposal for a Framework Convention*, 28 RECIEL 48, 56 (2019).

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adaptive in response to developing scientific knowledge and could promote the coordination of different environment-related legal regimes.[42]

In addition, it will no longer be feasible to treat the human and non-human worlds as unconnected components. Through the Earth system perspective, we have been able to recognize that the Cartesian separation between humanity (as the rational subject endowed with legal personhood) and nature is simply illusionary.[43] Indeed, as much as humans have become geological agents responsible for pushing the planet into a new geological epoch, so too are '[h]umans … utterly dependent on the integrity of Earth's ecological systems'.[44] Environmental law must reflect this interdependency. As Bosselmann says: '[t]he challenge ahead is to internalize ecological realities into human law and governance'.[45]

III. Mind the Gap

If we accept that our social institutions must (also) act on the knowledge generated by the natural sciences, and if we accept that the 'grand challenge for [Earth system science] is to achieve a deep integration of biophysical processes and human dynamics to build a truly unified understanding of the Earth System',[46] the question that arises for present purposes is: have our social regulatory institutions, including environmental law, been able to embrace such a deeper understanding of an integrated Earth system into their regulatory domains? Mindful of the risk of over-generalizing, the emerging view seems to be that endeavours to integrate the Earth system perspective into social science domains have only occurred more recently[47] and, thus far, remain 'substantially underdeveloped'.[48] There is accordingly still a disconnect between Earth system science and the broader social science domain despite several attempts, such as the Earth system governance research project,[49] to link Earth systems science more clearly with the social science domain.

This disconnect is particularly stark in the area of environmental law, the focus of our present discussion. Environmental law is a key part of the institutional mix aimed at regulating human behaviour vis-à-vis the life-sustaining 'environment'. Characterized as it is by its anthropocentric, state-centric, reductionist and linear nature, however, environmental law is fundamentally designed to operate in Holocene-like conditions, while it is premised on assumptions of relative Holocene stability, predictability, linearity and harmony.[50] In practical terms this means, among others, that environmental law is unable to fully provide the institutional setting required by vulnerable humans and more-than-humans to adapt to Earth system change.[51] The failing international climate law regime is an apt example. Environmental law is also unable to fully consider and respond to adaptive cycles and slow variables when governing fisheries, forestry or agro-ecosystems, for example, and this can lead to resource collapse.[52] Other regulatory failures of environmental law derive from its lack of a 'scale and level' perspective,[53] where socio-economic and environmental interactions between distant socio-ecological systems that occur at a global level, also known as telecoupling (see further below),[54] often result in injustices and human rights infringements at a very local scale.[55] For example, demand for palm oil from Indonesia – driven in part by the EU Renewable Energy Directive – has resulted in, inter alia, wildlife habitat loss, water scarcity, water pollution, impacts on food security, and increased food and feedstuff prices.[56]

Although insights from Earth system science increasingly sensitize us to the complexities of the relationship between the interlinked biogeochemical and human

[42] *Ibid.*, at 53 and 56.
[43] Joshua C. Gellers, *Earth System Law and the Legal Status of Non-Humans in the Anthropocene*, 7 Earth System Governance 100083 (2021).
[44] Klaus Bosselmann, *Shifting the Legal Paradigm: Earth-Centred Law and Governance*, in *The Safe Operating Space Treaty: A New Approach to Managing Our Use of the Earth System* 66 (Paulo Magalhães, Will Steffen, Klaus Bosselmann, Alexandra Aragão & Viriato Soromenho-Marques eds, Cambridge Scholars Publishing 2016).
[45] *Ibid.*
[46] Steffen et al., *supra* n. 19, at 54.
[47] Rakhyun E. Kim & Klaus Bosselmann, *International Environmental Law in the Anthropocene: Towards a Purposive System of Multilateral Environmental Agreements*, 2(2) Transnat'l Envtl. L. 285 (2013); Rakhyun E. Kim & Brendan Mackey, *International Environmental Law as a Complex Adaptive System*, 14 Int'l Envtl. Agreements 5 (2014); Cardesa-Salzmann & Cocciolo, *supra* n. 8.
[48] Stephens, *supra* n. 8, at 135.
[49] Frank Biermann, *Earth System Governance: World Politics in the Anthropocene* (MIT Press 2014); https://www.earthsystem-governance.org/.
[50] Kotzé & Kim, *supra* n. 14.
[51] Sophie Marjanac & Lindene Patton, *Extreme Weather Event Attribution Science and Climate Change Litigation: An Essential Step in the Causal Chain?*, 36(3) J. Energy & Nat. Res. L. 265 (2018).
[52] Lance Gunderson et al., *Assessing Resilience in Social-Ecological Systems: Workbook for Practitioners* (Resilience Alliance 2010), Version 2.0; Lance H. Gunderson, Barbara Cosens & Ahjond S. Garmestani, *Adaptive Governance of Riverine and Wetland Ecosystem Goods and Services*, 183(2) J. Envtl. Mgmt. 353 (2016).
[53] Ahjond Garmestani et al., *Untapped Capacity for Resilience in Environmental Law*, 116(40) Proc. Nat'l Acad. Sci. United States of America 19899 (2019).
[54] Jianguo Liu et al., *Framing Sustainability in a Telecoupled World*, 18 Ecology & Soc'y 26 (2013).
[55] Ellen Hey, *International Law, Planetary Boundaries and Teleconnections*, in *Research Handbook on Law, Governance and Planetary Boundaries* 167 (Duncan French & Louis J. Kotzé eds, Edward Elgar 2021).
[56] Maria Cristina Rulli et al., *Interdependencies and Telecoupling of Oil Palm Expansion at the Expense of Indonesian Rainforest*, 105 Renewable & Sustainable Energy Rev. 499, 505–507 (2019).

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processes that are leading to Earth system decay,[57] environmental law does not yet fully embrace complexity and non-linearity in order to adequately respond to these complex, non-linear and multi-scale characteristics of the Earth system and the multiple governance challenges they give rise to.[58] For example, the planetary boundaries framework[59] 'guides the levels of human perturbations that can be absorbed by the Earth System whilst maintaining a stable, Holocene-like state'.[60] However, evidence suggests that several regimes in international environmental law that have been designed to regulate human activities in relation to these boundaries, with the notable exception of the ozone regime,[61] are not fully consistent with the limits imposed by the planetary boundaries framework; nor do they seem to recognize, and actually have the ability to respond to, the interactions among these interacting boundaries.[62] While the recognition in the EU's 7th Environment Action Programme of planetary boundaries and the importance of avoiding their transgression is promising,[63] the Environment Action Plan assigns 'no specific content' to the planetary boundaries framework which would be necessary for its operationalization.[64] In sum, when one superimposes international environmental law regimes onto the planetary boundaries framework, it becomes clear that these regimes do not (yet) provide the 'legal boundaries that prevent human activities from reaching and breaching planetary boundaries'.[65]

From a systems perspective, given the complex nature of this socio-economic-ecological interplay, environmental law has not been altogether effective in governing (and limiting) anthropogenic cross-scale and cross-level interactions, principally because it has not been designed with this objective in mind.[66] There are several concerns in this respect. First, environmental law is generally seen to be reactive instead of proactive, and focused on singular cause-and-effect relationships that act independently from other cause-and-effect relationships, while it is divided into separate, autonomous regimes (biodiversity, climate change, ozone, etc.) that act independently with little synergies between them.[67] We observe this clearly in the field of international environmental law. Second, the anthropocentric ontology of environmental law superimposes the anthroposphere on the atmosphere, the hydrosphere, the cryosphere, the lithosphere, and the biosphere, with the result that many of the negative impacts on ecological aspects (e.g., loss of soil fertility and water ecosystem services as a result of industrial agriculture) remain unforeseen and unseen and, therefore, unregulated by environmental law.[68] Third, the linear and reductionist design of environmental law also does not allow it to foresee and address the effects of cross-scale and cross-level socio-economic and ecological interactions (such as forced migration and water depletion as a result of mining).[69] Based on the foregoing, there seem to be at least three regulatory challenges that 'systems regulation' aims to solve.

Its non-systems oriented, Holocene characteristics have now become problematic, not only for environmental law itself, but also for its practitioners and scholars, simply because environmental law is not fully fit for purpose any longer in the new Anthropocene epoch, which is anything but predictable, stable, harmonious and linear. Living in the Anthropocene, after all, means living in a complex and uncertain epoch,[70] and we urgently need innovative and up-to-date social regulatory institutions (including environmental law) that are fit for purpose and able to respond to the 'new' Anthropocene reality and the multiple complex governance challenges emanating from a complex Earth system. What is required are new regulatory approaches 'that conceptualize the earth as [being] composed of integrated social–ecological subcomponents across multiple spatial levels of the planet'.[71] Developing Earth system-oriented laws that are more appropriate for the Anthropocene context is therefore arguably central to the attempt to cater more comprehensively and holistically, in a legal sense, for the governance challenges related to the Earth system.

[57] Melvyn Shapiro et al., *An Earth-System Prediction Initiative for the Twenty-first Century*, 91(10) Bull. Am. Meteorological Soc'y 1377 (2010).
[58] Garmestani et al., *supra* n. 53.
[59] Rockström et al., *supra* n. 4, at 472.
[60] Steffen et al., *supra* n. 19, at 60.
[61] Louise du Toit, *Stratospheric Ozone Depletion*, in *Research Handbook on Law, Governance and Planetary Boundaries* 261 (Duncan French & Louis J. Kotzé eds, Edward Elgar 2021).
[62] *Research Handbook on Law, Governance and Planetary Boundaries* (Duncan French & Louis J. Kotzé eds, Edward Elgar 2021).
[63] European Parliament and Council of the European Union, *Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living Well, Within the Limits of our Planet'* (2013), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN. *See* e.g., para. 8 and para. 71(1) to the Annex.
[64] Fernández Fernández & Malwé, *supra* n. 41, at 52.
[65] Guillaume Chapron, Yaffa Epstein, Arie Trouwborst & José Vicente López-Bao, *Bolster Legal Boundaries to Stay Within Planetary Boundaries*, 1(1) Nature Ecology & Evolution 0086 (2017).
[66] Kotzé, *supra* n. 6, at 91–102.
[67] *See* generally, *Regime Interaction in International Law: Facing Fragmentation* (Margaret Young ed, Cambridge University Press 2012); and, specifically, Kim & Bosselmann, *supra* n. 47.
[68] Gabriel Lopez Porras, Lindsay C. Stringer & Claire H. Quinn, *Corruption and Conflicts as Barriers to Adaptive Governance: Water Governance in Dryland Systems in the Rio del Carmen Watershed*, 660 Sci. Total Env't 519 (2019).
[69] Miriam Alfie Cohen, *Conflictos socio-ambientales: La Minería en Wirikuta y Cananea*, 191 El Cotidiano 97 (2015).
[70] Hamilton, *supra* n. 9.
[71] Gesche Krause, *The Scientific Challenge of Bridging the Gap from the Local to the Earth System Level: Lessons from the Study of Mangroves and People in North Brazil*, 14 Regional Envtl. Change 2089, 2100–2101 (2014).

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Earth system law has recently been proposed as such a new regulatory approach. Rooted as it is in the Anthropocene's complex planetary context, 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. Earth system law seeks to respond to the Earth system's instability and unpredictability through a continuous norm development process that drives meaningful transformations as well as inter- and trans-disciplinary learning and deliberation. Fully embracing the need to guide the making of desirable planetary futures and opportunities for increasing adaptive capacity and resilience of the entire living order, Earth system law potentially offers: an inter-disciplinary analytical framework to better understand and respond to the legal dimensions of Earth system governance; the normative foundations to govern the full spectrum of Earth system relationships in a way that promotes planetary integrity and justice in their fullest sense; and the legal means to facilitate transformative Earth system governance for long-term sustainability.[72] Importantly, 'the Earth system … is the new, all-encompassing focal point that must direct the orientation of juridical science and of all governance and normative-juridico efforts in the Anthropocene epoch'.[73]

In terms of the foregoing description, Earth system law is not so much a new body of law as it is a vision or imaginary of what law could be or become for the purpose of facilitating the legal aspects of Earth system governance in the Anthropocene epoch. 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 which the Earth system perspective could inspire innovative legal responses, and reforms of social behaviour (and reforms of the law itself), to confront the complex challenges posed by a complex interconnected Earth system. How is it possible, in practical terms, to 'see' environmental law through an Earth system lens?

IV. Bridging the Gap

One way to explore how environmental law could embrace the Earth system perspective in more practical terms, is by relying on insights gained from the notion of telecoupling. Telecoupling builds on the earlier concept of teleconnections, which originated in atmospheric sciences and is concerned with the connections between climatic systems over distances.[74] The telecoupling concept, for its part, originated in land change science, and is essentially a process that connects distant systems.[75] Telecoupling seeks to identify, understand and address socio-economic and environmental interactions and feedbacks between distant human–environment systems, otherwise understood as interactions among 'coupled human and natural systems over distances'.[76] These interactions are characterized as 'cross-scalar, networked, and complex socioeconomic and environmental interactions between two or more distant and distinct coupled human-environment systems'; with the telecoupling framework offering 'a tool for describing and characterizing telecouplings by classifying sending, receiving, and spill-over systems, and flows between these systems, as well as the agents, causes, and effects within them'.[77] The framework thus consists of five key elements that must all be *simultaneously* considered: systems (divided into sending, receiving, and/or spill-over systems); flows (the connection between systems); agents (which facilitate or hinder flows and may consist of corporations, governments and civil society); causes (which produce telecoupling); and effects (social, economic, and ecological).[78]

In more practical terms, telecoupling will typically be concerned with, for example, the contribution of groundwater irrigation in India to precipitation in East Africa, on which East African societies depend for agricultural purposes,[79] or the cultivation of bioenergy crops in South-east Asia for the production of biofuels for use in the EU.[80] The degree of complexity arising from such telecoupled examples ultimately requires a systems approach that focuses on the integration of different components of coupled human and non-human systems, which are traditionally not studied and governed in an integrated way. Lack of integration can result in 'sustainability solutions in one system … caus[ing] deleterious effects in other systems',[81] or problem-shifting as alluded to above. In particular, telecoupling arising from the trade of products, especially biomass-related products, is becoming increasingly important. Indeed, Kastner, Erb, and Haberl found that 'the EU depends, to a considerable and growing extent, on productive capacities of ecosystems outside its boundaries', with the result that the ecological impacts of trade occur disproportionately in other countries and regions.[82] The telecoupling framework thus has the

[72] Rakhyun E. Kim & Louis J. Kotzé, *Planetary Boundaries at the Intersection of Earth System Law, Science, and Governance: A State-of-the-Art Review*, 00 Rev. Eur. Comp. & Int'l Envtl. L. 1, 11 (2020).
[73] Kotzé & Kim, *supra* n. 14, at 10.
[74] Hey, *supra* n. 55, at 167; Newig et al., *supra* n. 39, at 3.
[75] Vanessa Hull & Jianguo Liu, *Telecoupling: A New Frontier for Global Sustainability*, 23(4) Ecology & Soc'y 41 (2018).
[76] Liu et al., *supra* n. 54, at 26; Jens Newig et al., *Governing Global Telecoupling Toward Environmental Sustainability*, 25 (4) Ecology & Soc'y 21, 1 (2020).
[77] Cecilie Friis & Jonas Østergaard Nielsen, *On the System. Boundary Choices, Implications, and Solutions in Telecoupling Land Use Change Research*, 9(6) Sustainability 974 (2017).
[78] Liu et al., *supra* n. 54.
[79] Patrick W. Keys et al., *Anthropocene Risk*, 2 Nature Sustainability 667, 669 (2019).
[80] *See* Rulli et al., *supra* n. 56.
[81] Liu et al., *supra* n. 18, at 1258832-1.
[82] Thomas Kastner, Karl-Heinz Erb & Helmut Haberl, *Global Human Appropriation of Net Primary Production for Biomass Consumption in the European Union, 1986–2007*, 19(5) J. Indus. Ecology 825, 829, 832 (2015).

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benefit of revealing interconnectivity and complexity, and identifying possible governance gaps.[83]

Furthermore, since telecoupling draws on coupled systems thinking, it is a 'novel umbrella concept that enables natural and social scientists to understand and generate information for managing how humans and nature can sustainably coexist worldwide'.[84] To this end, telecoupling offers a framework for integrating feedback relationships when analysing social, economic and ecological considerations.[85] Apart from enabling integrated systems governance, another obvious benefit of such an integrated approach is that telecoupling can promote interdisciplinarity and enable 'researchers to dive deeply into systemic complexities, even if systems are far away from each other'.[86] In addition, Hey argues that the telecoupling framework, within the context of a highly complex governance issue, also 'facilitates presenting policymakers with a fuller picture of the ethical dimensions, as reflected in human rights, and the political considerations involved in the choices they make'.[87] The telecoupling framework therefore usefully embraces a systems perspective and could serve to enhance an understanding of the complexity and interconnectivity between different Earth system components and between human and non-human components and systems (while also promoting interdisciplinarity) which, as was argued above, will be necessary for developing appropriate legal (and other) responses to current socio-ecological challenges.

In order to illustrate the practical relevance of the telecoupling framework for environmental law's transformation into Earth system law, as it were, we briefly rely here on a real life scenario related to the socio-economic and ecological impacts of Canadian mining companies operating in Mexico.[88] These impacts include environmental degradation and negative impacts on, among others, health, peace, and livelihoods, which cumulatively result from poorly regulated telecouplings between and within Mexico and Canada.

In this scenario, and unravelling some of these telecouplings, several (inter alia, gold and silver) mining companies from Canada (the sending system) have been established in Mexico (the receiving system). Several causes may be cited, including a growing demand for metals; the availability of such metals in Mexico; the North American Free Trade Agreement (NAFTA, recently renegotiated as the United States Mexico Canada Agreement) which was concerned with promoting trade between Canada, Mexico, and the United States; favourable treatment of mining companies by the Mexican government, including through the granting of tax exemptions, in order to attract foreign direct investment; and technological developments that have enabled exploration and exploitation of previously inaccessible mineral resources.[89] Agents include, for example, the governments of Mexico and Canada, Canadian mining companies, Mexican workers, and Mexican communities, farmers, and ranchers. Flows include natural resources, money, fuels for transportation, and technological techniques.

The immediate socio-economic and environmental impacts (effects) caused by Canadian mining in Mexico are among the very localized effects of our scenario. Environmental impacts include extensive land destruction; loss of wildlife habitat; significant water consumption; toxic emissions from contaminated rubble; contamination due to toxic chemicals (including cyanide) used during the leaching process; and air pollution due to the smelting and refining of metals. Socio-economic impacts include noise and structural damage to buildings due to the explosives used in open-pit mining; the deprivation of smallholder farmers and communities of their land (for agriculture, forestry, and ranching, with consequent impacts, inter alia, on livelihoods), water, and sacred sites; and impacts on health. Further impacts include high levels of energy use during smelting and refining.[90] However, these impacts are not only localized. Indeed, local impacts on water resources have also negatively impacted interlinked hydroclimatic and hydro-ecological systems, soil moisture, as well as surface and groundwater flows in and across other parts of Mexico. Such changes in the hydrological cycle inevitably result in higher temperatures, desertification, droughts, heatwaves, and impacts on water availability for human and non-human use across an entire region.[91] In a more general sense, mining activities by Canadian companies have resulted in numerous water-related conflicts in Mexico, while also negatively impacting livelihoods and driving Mexican migration to the United States and Canada. Tetrault says this situation has 'given rise to a number of high-profile conflicts that pit groups of local inhabitants and their allies against transnational companies backed by the federal government'.[92] Such conflicts have arisen not only between communities and mining companies, but also within communities, and have led to threats to physical security, violence, and even murder.[93]

[83] Liu et al., *supra* n. 18, at 1258832-1 and 1258832-4.
[84] Francesco Tonini & Jianguo Liu, *Telecoupling Toolbox: Spatially Explicit Tools for Studying Telecoupled Human and Natural Systems*, 22(4) Ecology & Soc'y 11, 1 (2017).
[85] Jianguo Liu et al., *Applications for the Telecoupling Framework to Land-Change Science*, in *Rethinking Global Land Use in an Urban Era* (Karen C. Seto & Anette Reenberg eds, MIT Press 2014).
[86] Tonini & Liu, *supra* n. 84, at 1.
[87] Hey, *supra* n. 55, at 171.
[88] Gabriel Lopez Porras, *Integrating Mexican Water Law into the Earth System Law Perspective*, in *Earth System Law: Standing on the Precipice of the Anthropocene* (Timothy Cadman, Margot Hurlbert & Andrea Simonelli eds, Routledge 2021, forthcoming).
[89] Darcy Tetreault, *Social Environmental Mining Conflicts in Mexico*, 42(5) Latin Am. Persp. 48, 50 (2015).
[90] *Ibid.*, at 49 and 51.
[91] Lopez Porras, *supra* n. 88.
[92] Tetreault, *supra* n. 89, at 49.
[93] *Ibid.*, at 55.

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In considering the legal regimes associated with some of the elements of the telecoupling framework, in regard to causes, the NAFTA (which has resulted in flourishing trade between Mexico and Canada)[94] is directly relevant. In addition, foreign direct investment in Mexico has been facilitated, inter alia, by reduced taxes, enhanced rights and privileges for foreign companies (in terms of amendments to the Foreign Investment Law of 1996), and simplified administrative procedures (in terms of amendments under the Mining Law). Furthermore, the Mining Law (Article 6) states that mining activities 'will be given preference over any other use or exploitation of the land',[95] thus clearly prioritizing mining activities and their devastating socio-economic-ecological impacts over the protection of people and nature. With regard to the effects, environmental laws (such as the General Law on Ecological Equilibrium and Environmental Protection) are weakly enforced or not enforced at all.[96] Other (national) laws that would be implicated include water law (see the discussion below), labour law (which is not properly enforced, so as not to discourage foreign investment),[97] corporate law, land use planning law, and trade law. Of course, there are also international and regional agreements to which Mexico is a party, which would also be relevant.

With regard to the law's ability to respond to the abovementioned socio-economic and environmental impacts, on the one hand, there seems to be the valid view that NAFTA has not been all that successful in providing adequate environmental and human rights protection in any meaningful sense.[98] On the other hand, the Mexican environmental law framework, although comprehensive, does not provide a fully adequate institutional and legal setting that guarantees the protection of Mexican communities' human rights and environmental resources against the impacts of mining activities.[99] For example, in terms of Mexican water legislation, water still only has monetary value and is not valued because of its functions and interactions with other Earth system processes. This means that the anthropogenic effects and feedbacks related to water systems remain unforeseen. In addition, Mexican water laws and policies are fully, but falsely, grounded in assumptions of Holocene environmental stability and linearity. As an illustration, the most recent Mexican water standards state that annual groundwater recharge has remained the same since 2013, which is most probably not correct any longer.[100] Moreover, Mexican law makes little provision for effective procedures to establish a liability regime for environmental degradation that foresees the adverse impacts of environmental pollution well in advance.[101] The results could be dire, as one recent example suggests: over 20,000 citizens were left without water for a considerable period of time as a result of one mining company's polluting actions, which, despite several lawsuits, was never held liable for the disaster or forced to carry out any environmental remediation, restoration or compensation.[102] Furthermore, as noted above, certain laws (that could assist in addressing these socio-economic and ecological impacts) have not been effectively enforced.

This would suggest that the current legal situation in Mexico is unable to address, in an integrated systems-oriented way, the type of telecouplings arising in our scenario. After all, it is clear that the impacts of transnational Canadian mining companies operating in Mexico, and channelling most of their profits back to Canada, have severe socio-economic and environmental impacts in Mexico and beyond (for example, fuelling emigration), while these local impacts also impact ecological systems well beyond any local point. The scenario above suggests that many economic activities, such as those carried out by the extractive industry, operate beyond the control of many authorities; they ignore ecological boundaries and, as a result, tend to foster socio-economic conflicts.[103] Inadequate regulation leads to environmental and societal stressors that cause pollution and overexploitation, and undermine human and non-human well-being.[104]

What makes the telecoupling framework useful for thinking about environmental law in Earth system terms, is that it enables one to *see* a whole range of deeply intertwined telecoupled issues and considerations that must be taken account of by the law. The telecoupling framework makes it difficult to ignore the complexity behind the societal (normative/legal) and ecological (biogeophysical) interactions, and makes it pertinent to reconsider, critically, general institutional inabilities to change current pathways and avoid crossing system thresholds.[105]

[94] Fiona Gladstone et al., *NAFTA and Environment After 25 Years: A Retrospective Analysis of the US–Mexico Border*, 119 Envtl. Sci. & Pol'y 18, Figure 1, 21 (2021).
[95] Tetreault, *supra* n. 89, at 53.
[96] *Ibid.*, at 52–53.
[97] *See* Paul Bocking, *Canadian Mining and Labor Struggles in Mexico: The Challenges of Union Organizing*, 16 Working USA: J. Labor & Soc'y 331 (2013).
[98] H. Hamner Hill, *NAFTA and Environmental Protection: The First 10 Years*, 6 J. Inst. Just. & Int'l Stud. 157 (2006); Douglas A. Schuler *The NAFTA and the Environment: Trade, Diplomacy, and Limited Protection*, 10 Int'l Trade J. 353 (1996).
[99] *See* for a general overview, Terzah N. Lewis, *Environmental Law in Mexico*, 21(1) Denv. J. Int'l L. & Pol'y 159 (Fall 1992).
[100] Gabriel Lopez Porras, Lindsay C. Stringer & Claire H. Quinn, *Seeking Common Ground in Dryland Systems: Steps Towards Adaptive Water Governance*, 12 Water 498 (2020).
[101] Lopez Porras, Stringer & Quinn, *supra* n. 68.
[102] Cohen, *supra* n. 69, at 97.
[103] Cardesa-Salzmann & Cocciolo, *supra* n. 8; Jean-François Maystadt, Giacomo De Luca, Petros G. Sekeris & John Ulimwengu, *Mineral Resources and Conflicts in DRC: A Case of Ecological Fallacy*, 66(3) Oxford Econ. Papers 721 (2014); Didi Stoltenborg & Rutgerd Boelens, *Disputes over Land and Water Rights in Gold Mining: The Case of Cerro de San Pedro, Mexico*, 41(3) Water Int'l 447 (2016).
[104] Melanie Pichler & Alina Brad, *Political Ecology and Socio-Ecological Conflicts in Southeast Asia*, 9(1) Austrian J. South-East Asian Stud. 1 (2016); Stoltenborg & Boelens, *supra* n. 103.
[105] Jonathan F. Donges et al., *Closing the Loop: Reconnecting Human Dynamics to Earth System Science*, 4 Anthropocene Rev. 151 (2017); Gabriel Lopez Porras, Lindsay C. Stringer & Claire H. Quinn, *Building Dryland Resilience: Three Principles to Support Adaptive Water Governance*, 177 Ecological Econ. 106770 (2020).

Such a 'system-awareness' that is fostered by the telecoupling framework makes it pertinent for lawyers to consider the impacts of human agency in a holistic way; to adopt a long-term thinking approach; and to recognize the many possible socio-economic-environmental trajectories that may arise, now and in future, from certain interactions.[106]

The insights provided by the telecoupling framework, in turn, enable one to begin to imagine the types of considerations that might practically be incorporated into legal measures (including regional agreements), such as: the recognition of the complexity and interconnectedness of evolving Earth system processes; the incorporation of ecological limits that may not be transgressed;[107] the inclusion of diverse voices in legal processes; the ability of the law to be adaptive in response to developments in scientific knowledge; cooperation between policy-makers across jurisdictions, governance levels, and traditionally separate spheres; cooperation between scientists and policy-makers; consideration of the interactions of diverse sets of laws (with the goal of coherence); and the ability of law to be anticipatory in order to foresee destructive socio-economic-ecological effects before they occur.[108] Ultimately, while calling for further interdisciplinary inquiry, Lenschow, Newig, and Challies highlight that '[t]he recognition of telecoupled phenomena … call[s] for strong nation states as initiators of policy instruments to bridge telecoupled regions'.[109]

V. Conclusion

Major changes in our social institutions are required in order to avoid Earth system collapse.[110] This includes changes to environmental law. While the linear and anthropocentric environmental laws that have contributed to the advent of the Anthropocene are arguably unable to prevent ongoing global change, this does not mean that environmental law cannot or should not be relevant in the future. On the contrary – as the social construct specifically designed to regulate and modify human behaviour – we must turn to environmental law to assist us in responding to the challenges of the Anthropocene. However, we require a reformed type of environmental law that recognizes that the Earth system is not static, and that it is dynamic and constantly evolving; a sort of Environmental Law 2.0, as it were, or as we term it in this article, *Earth system law.*

In order to facilitate the transformation of environmental law into Earth system law, we argued that the telecoupling framework could serve as a useful tool to analyse and *see* the interconnections between human and natural systems that take place on different levels and at different scales, by identifying their causes, effects, and feedbacks. This will arguably promote understanding of the multiple complex socio-economic and environmental interactions that must be taken account of by the law, which could contribute to addressing deleterious impacts resulting from inadequately regulated socio-economic and environmental interactions and, ultimately, to 'managing how humans and nature can sustainably coexist worldwide'.[111]

[106] Donges et al., *supra* n. 105.
[107] This would arguably respond to Bosselmann's call for the 'internaliz[ation] [of] ecological realities into human law and governance': Bosselmann, *supra* n. 44, at 66.
[108] *See* e.g., Jörg Balsiger, *Regional Sustainable Development in the European Alps*, EUI Working Papers MWP 2008/23 (2008).
[109] Andrea Lenschow, Jens Newig & Edward Challies, *Globalization's Limits to the Environmental State? Integrating Telecoupling into Global Environmental Governance*, 25(1) Envtl. Pol. 136, 137, 144, 153 (2016).
[110] Mauro Bologna & Gerardo Aquino, *Deforestation and World Population Sustainability: A Quantitative Analysis*, 10 Sci. Reports 7631 (2020).
[111] Tonini & Liu, *supra* n. 84, at 1.