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Introducing Cumulative Environmental Impacts as a Central Problem for Law

Environmental and natural resources laws across the world confront a common problem: the need to deal with the "thousand cuts"[1] of interacting harms to ecosystems and people caused by multiple contributors over space and time. These environmental problems are not the Bhopals or Love Canals, the Mariana Dams or the Deepwater Horizons that make the front pages of newspapers: horrific, but singular and legally relatively straightforward problems. Our thorniest legal environmental issues are the large-scale, insidious, often slow-motion environmental tragedies that have many authors – large and small – cumulative environmental problems. Climate change, biodiversity loss, and urban air pollution are just some of these often intractable and seemingly diverse problems.

We often have plenty of laws directed to these problems, yet still they remain. Stubborn, intractable, often devastating. How can this be? This book analyzes why these types of environmental problems are so difficult to manage, reaching into many fields of research beyond the silo of law[2] to seek insights for designing rules to address cumulative environmental problems. Not even the most heroically optimistic of lawyers would argue that rules alone can fix these problems. But they can do better.

[1] This well-known metaphor has also found its way into formal legal contexts, e.g., in European biodiversity law; see *Sweetman v. Pleanala* [2012] EUECJ C-258/11, Opinion of AG Sharpston, [67].

[2] Mathias Siems, "Bringing in Foreign Ideas: The Quest for 'Better Law' in Implicit Comparative Law" in Nicholas H. D. Foster, Maria Federica Moscati and Michael Palmer (eds), *Interdisciplinary Study and Comparative Law* (Wildy, Simmonds & Hill 2016) 186–208, 208.

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1.1 DEFINING AND DESCRIBING CUMULATIVE ENVIRONMENTAL HARMS

Cumulative environmental problems are neither new nor unusual. They occur the world over, through time, at different scales: a city, the world, the body of a single living thing, and much in between. In late nineteenth-century London, cumulative harm appeared in the form of over 2 million tons of manure excreted by the estimated 200,000 horses used for transport in the city, and their smells, dust, and disease.[3] The advent of motorized vehicles addressed that cumulative problem, but created a new one, as air pollution from ever-increasing vehicles stunted the lung growth of children.[4] Over a century later, in 2019, London introduced an "ultra-low emissions zone" that imposes steep charges on all but the cleanest of vehicles to reduce cumulative pollution from road transport.[5] Air quality has improved dramatically.[6]

We see cumulative harm globally. Our biodiversity is threatened by the cumulative effects of land use change, direct overexploitation, pollution, atmospheric warming, and invasive species.[7] So profound is human influence on the environment globally that its "magnitude, variety and longevity" arguably constitutes a new geological epoch, the Anthropocene.[8]

We see cumulative harm in the body of a single animal. When Lulu the killer whale died in 2016 in a fishing net off the coast of Scotland, she was one of the most contaminated animals ever found. Shockingly high levels of toxic polychlorinated biphenyls (PCBs) had accumulated in her body, at more than 100 times the levels known to harm the health of cetaceans.[9]

At their deceptively simplest, cumulative environmental problems might be understood as "aggregate effects caused by many actions." Environmental

[3] Peter Atkins, "The 'Charmed Circle'" in Peter Atkins (ed), *Animal Cities: Beastly Urban Histories* (Routledge 2012) 53–76, 66, 76.

[4] Royal College of Physicians, *Every Breath We Take: The Lifelong Impact of Air Pollution* (2016) 7, www.rcp.ac.uk/improving-care/resources/every-breath-we-take-the-lifelong-impact-of-air-pollution/.

[5] Ibid.

[6] Mayor of London, *Air Quality in London 2016–2024* (Greater London Authority 2024) 5–6.

[7] See generally Peter Stoett and others, "Biodiversity" in Paul Ekins, Joyeeta Gupta and Pierre Boileau (eds), *Global Environment Outlook 6: Healthy Planet, Healthy People* (United Nations Environment Programme 2019) 141–173, 148. See also Corey J. A. Bradshaw and others, "Underestimating the Challenges of Avoiding a Ghastly Future" (2021) 1:615419 *Frontiers in Conservation Science* 1–10.

[8] Simon L. Lewis and Mark A. Maslin, "Defining the Anthropocene" (2015) 519(7542) *Nature* 171, 171.

[9] Rebecca Morelle, "'Shocking' Levels of PCB Chemicals in UK Killer Whale Lulu" (BBC News, May 2, 2017) www.bbc.com/news/science-environment-39738582.

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impact assessment laws offer more nuanced definitions and typologies of cumulative environmental effects.[10] An influential definition is "the impact on the environment which results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency . . . or person undertakes such other actions."[11]

This book focuses on what might be considered the most difficult kinds of cumulative environmental problems: problems caused by relatively large numbers of diverse actors, which cause biophysical effects that aggregate in complex and unpredictable ways over relatively long periods of time, at spatial scales that extend across the boundaries of jurisdictions and legal regimes that often deal with narrow elements of the environment, such as biodiversity or water pollution.[12]

Such problems interact with our legal systems in different ways. At one end of the spectrum are the complex interactions between multiple larger projects that are often highly regulated. In northern Canada, the Bathurst herd of migratory tundra caribou, which are culturally and economically significant to First Nations, is declining. The causes are diverse: changes to their habitat caused by multiple diamond mines, roads, and other industrial development and exploration activities across their range.[13] At the other end of the spectrum lie the aggregate impacts of numerous small, typically unregulated activities, such as the impacts on human health of indoor air pollution from household cooking, motor vehicle air pollution, and poor access to healthy food, combined with heat waves exacerbated by climate change.[14]

Although scientists often examine the cumulative nature of many important environmental harms, there is comparatively little legal work on cumulative environmental problems as a type of problem faced around the world. Legal scholars more commonly analyze a particular problem in a particular legal jurisdiction – say, plastic waste in international law,[15]

[10] For a review of these, see Peter N. Duinker and others, "Scientific Dimensions of Cumulative Effects Assessment: Toward Improvements in Guidance for Practice" (2013) 21 *Environmental Reviews* 40–52, 43.

[11] Ibid, 42.

[12] As explained further later, this definition has some similarities with earlier work, e.g., J. B. Ruhl and James Salzman, "Climate Change, Dead Zones, and Massive Problems in the Administrative State: A Guide for Whittling Away" (2010) 98 *California Law Review* 59–120.

[13] See generally Anne Gunn, Don Russell and Lorne Greig, "Insights into Integrating Cumulative Effects and Collaborative Co-Management for Migratory Tundra Caribou Herds in the Northwest Territories, Canada" (2014) 19(4) *Ecology and Society* 4.

[14] Tord Kjellstrom and others, "Urban Environmental Health Hazards and Health Equity" (2007) 84 *Journal of Urban Health* 86–97, 90–91.

[15] E.g., Joan M. Bondareff, Maggie Carey and Carleen Lyden-Kluss, "Plastics in the Ocean: The Environmental Plague of Our Time" (2017) 22 *Roger Williams University Law Review* 383;

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greenhouse gas pollution in Australia,[16] or soil contamination in China.[17] This book starts to fill that gap.

1.2 RULES AND THE CUMULATIVE IMPACT MINDSET OF THIS BOOK

The core objective of this book is to demonstrate how formal rules can be used to protect things we care about from the cumulative threats they face. I present a framework for assessing how laws can do this by performing four key interacting functions – conceptualization, information, regulatory intervention, and coordination – the CIRCle Framework of legal functions (Figure 1.1).

Environment-related legal literature is replete with examples of legal regimes in which one of these functions is missing, weak, or unlinked to another function. Emerging rights of nature can lack clarity in relation to what, precisely, is protected, perhaps until a court decision,[18] or may define an element of nature too narrowly to facilitate considering cumulative impacts[19] (unclear or weak *conceptualization*). Environmental harm from agriculture often occurs under exemptions from legal requirements so vast they have been termed an "anti-law" of the environment[20] (a lack of comprehensiveness in *intervention*). Laws and policies make only limited use of available scientific tools for evaluating cumulative impacts in sensitive marine systems[21] (a regulatory weakness related to *information*). Climate adaptation initiatives like buying out properties in risk-prone areas may overlook local contexts and

Luisa Cortat Simonetti Goncalves and Michael Gerbert Faure, "International Law Instruments to Address the Plastic Soup" (2019) 43 *William & Mary Environmental Law and Policy Review* 871–948.

[16] E.g., Jacqueline Peel, "The *Living Wonders* Case: A Backwards Step in Australian Climate Litigation on Coal Mines" (2024) 36 *Journal of Environmental Law* 125–132.

[17] E.g., Takashi Itakura, "Current Issues with the Regulatory Framework for Managing Soil Contamination in China" (2015) 18 *Asia Pacific Journal of Environmental Law* 119–146.

[18] Ruth Barcan, "The Campaign for Legal Personhood for the Great Barrier Reef: Finding Political and Pedagogical Value in a Spectacular Failure of Care" (2020) 3 *Environment and Planning E: Nature and Space* 810–832, 823–824; Mihnea Tănăsescu and others, "Rights of Nature and Rivers in Ecuador's Constitutional Court" (2024) *The International Journal of Human Rights* 1–23, 10–11.

[19] Rebecca Nelson, "Sick City Streams: New Approaches to Legal Treatments" (2020) 43 *Melbourne University Law Review* 748–821, 768–770.

[20] J. B. Ruhl, "Farms, Their Environmental Harms, and Environmental Law" (2000) 27 *Ecology Law Quarterly* 263–349, 293–327.

[21] Christian Simeoni and others, "Evaluating the Combined Effect of Climate and Anthropogenic Stressors on Marine Coastal Ecosystems: Insights from a Systematic Review of Cumulative Impact Assessment Approaches" (2023) 861:160687 *Science of The Total Environment* 1–18, 15.

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FIGURE 1.1 Applying the CIRCle Framework for assessing rules relevant to cumulative environmental problems

community histories of injustice, and agencies may fail to coordinate their responses; as a result, agencies sometimes buy out flood-prone properties while new houses are built on the same floodplain[22] (a failure of government–stakeholder and interagency *coordination*). This book is informed by these kinds of gaps and weaknesses, but focuses on designing laws to help provide *solutions*. This does not sound particularly radical, but the mindset behind it[23] differs in important ways from that of some other approaches.

1.2.1 *A Broader View of Regulatory Functions and Integration in Environment-Related Law*

For academic readers, the CIRCle Framework contributes to interdisciplinary, policy-oriented environmental law scholarship and regulatory studies by offering a new view of, and structure for analyzing, legal functions for addressing cumulative environmental problems. The Framework was derived deductively from multiple disciplinary literatures on why dealing with cumulative environmental problems is difficult. It was refined inductively by comparing conceptually broad functions of laws across subject matter areas and diverse jurisdictions in a way that seeks similarities in *types* of problems, without assuming similarities in goals. It embraces and seeks to explore differences in how problems are solved,[24] as I discuss further later on.[25]

I argue that each Framework function is indispensable to a regime of laws to address cumulative environmental problems. A regime that lacks one of these functions does not respond, as completely as it might, to the barriers that

[22] A. R. Siders, "The Administrator's Dilemma: Closing the Gap between Climate Adaptation Justice in Theory and Practice" (2022) 137 *Environmental Science and Policy* 280–289, 286–287.

[23] Others first used this terminology in the context of scientific EIA: A. John Sinclair, Meinhard Doelle and Peter N. Duinker, "Looking Up, Down, and Sideways: Reconceiving Cumulative Effects Assessment as a Mindset" (2017) 62 *Environmental Impact Assessment Review* 183–194.

[24] I adopt this approach, recognizing past criticism of functionalism in comparative law based on assuming similar goals and approaches to solutions: e.g., Naomi Creutzfeldt, Agnieszka Kubal and Fernanda Pirie, "Introduction: Exploring the Comparative in Socio-Legal Studies" (2016) 12 *International Journal of Law in Context* 377–389, 378–379; Oliver Brand, "Conceptual Comparisons: Towards a Coherent Methodology of Comparative Legal Studies" (2006) 32 *Brooklyn Journal of International Law* 405–466, 414–415, 418–419. Conceptualization as a CIRCle Framework function, for example, allows for comparing across cumulative environmental problems that have very different goals (see Chapter 4).

[25] See Section 2.4 of Chapter 2.

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we know stand in the way of addressing cumulative environmental harm.[26] These CIRCle Framework functions must be integrated – linked to each other – as later chapters explain. This argument notes, as a starting point, the established concepts in policy design of consistency (mutually reinforcing tools for intervention), coherence (logical coexistence of policy goals), and congruence (mutually supportive goals and instruments for intervention).[27] Alongside these concepts, the CIRCle Framework emphasizes the need for mutually supportive integration of *functions* – conceptualization, information, regulatory intervention, and coordination – among the elements of a legal regime for dealing with a cumulative environmental problem. I describe these mutually supportive links as simply "regulatory integration" or "integrated" regulatory functions[28] and describe these links in more detail specific to each function in subsequent chapters.[29]

These arguments adopt a mindset about what law can do, and in fact does, that is broader than is sometimes offered through policy design literature or legal literature.[30] For example, when these literatures deal with "policy mixes," or "instrument mixes," as is central to the issue of cumulative impacts, they tend to focus on mechanisms for changing behavior,[31] that is, intervention, and links to policy goals in a general sense. Important typologies of difficult problems, which have also informed this work, tend to focus on what

[26] See Chapter 2 for a discussion of why it is difficult to address cumulative environmental problems.

[27] Michael Howlett and Jeremy Rayner, "Coherence, Congruence and Consistency in Policy Mixes" in Michael Howlett and Ishani Mukherjee (eds), *Routledge Handbook of Policy Design* (Routledge 2018) 389–403, 393–394.

[28] This term also has useful echoes in the environmental management literature on "integrated catchment management," which, like cumulative environmental problems more generally, focuses on integrating different kinds of impacts on a watershed: see, e.g., Rebecca Nelson, "Challenges to Improved Integrated Management of the Murray-Darling Basin" in Barry Hart and others (eds), *Murray-Darling Basin, Australia: Its Future Management* (Elsevier 2021) 339–361.

[29] These links are summarized in Figure 4.2 (focus on conceptualization), Figure 5.2 (focus on information), Figure 6.1 (focus on regulatory intervention), and Figure 7.2 (focus on coordination).

[30] Many other scholars have also focused on the individual functions in focus here, as discussed in Chapters 4 to 7.

[31] E.g., Heleen L. P. Mees and others, "A Method for the Deliberate and Deliberative Selection of Policy Instrument Mixes for Climate Change Adaptation" (2014) 19(2) *Ecology and Society* 1–15; Vilis Brukas and Ola Sallnäs, "Forest Management Plan as a Policy Instrument: Carrot, Stick or Sermon?" (2012) 29 *Land Use Policy* 605–613, 606; Christopher Hood, "Intellectual Obsolescence and Intellectual Makeovers: Reflections on the Tools of Government after Two Decades" (2007) 20 *Governance* 127–144, 139.

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to do and who should do it, for example, through collaboration.[32] In the context of cumulative environmental problems, the CIRCle Framework suggests that law must do more to overcome barriers to effective solutions by delivering and linking a broader set of functions. Legal mechanisms can, and should, help us clarify what is important, gather and share information that we need to protect it or restore it, take action, and coordinate government actors and stakeholder groups to do these things, in an integrated way.

1.2.2 *Learning across Disciplines, Legal Contexts, and Jurisdictions*

This book is intended to span boundaries in different ways. Perhaps the longest spans lie between law and the many disciplines that help answer the question: Why is it difficult to deal with cumulative environmental problems?[33] The answers both point to the value of formal rules, and to psychological, technical, political, and many other challenges that rule designers should consider.

Just as important are the bridges between areas of law and their physical contexts. Much, though by no means all, legal scholarship focuses on a single body of law. Scholarly silos often separate, say, land use planning law from water law from endangered species law. By contrast, each chapter here spans multiple legal areas using the "bridge" of a CIRCle Framework function. Since each of these legal areas faces challenges in regulating cumulative problems, they have developed, unsurprisingly, different approaches to undertaking the same broad function. This variety provides tremendous scope for lesson learning.

Finally, this book responds to calls for learning across jurisdictions to improve responses to cumulative effects and environmental law and policy more generally.[34] This occurs in two ways. The first is the numerous examples

[32] E.g., Ruhl and Salzman, "Climate Change," 79–92 (typology of "massive problems"); Benjamin Cashore and Steven Bernstein, "Bringing the Environment Back In: Overcoming the Tragedy of the Diffusion of the Commons Metaphor" (2022) 43(3) *Perspectives on Politics* 478–501 (typology of problems based on sustainability concepts with distinct moral underpinnings and prescriptions for approaches to solutions); Brian W. Head, *Wicked Problems in Public Policy: Understanding and Responding to Complex Challenges* (Palgrave Macmillan 2022) 102–105 (collaborative approaches for environmental policy). For further discussion, see Chapter 2.

[33] See generally Chapter 2.

[34] E.g., Jonathan B. Wiener, "Learning to Manage the Multirisk World" (2020) 40 *Risk Analysis* 2137–2143, 2140; Robert E. Lutz, "The Laws of Environmental Management: A Comparative Study" (1976) 24(3) *American Journal of Comparative Law* 447, 448–449; Elizabeth Fisher and others, "Maturity and Methodology: Starting a Debate about Environmental Law Scholarship" (2009) 21 *Journal of Environmental Law* 213–250, 242–243; Raul Pacheco-Vega,

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that appear in each chapter that deals with a CIRCle Framework function, drawn from 73 jurisdictions across 55 countries. The objective is not to recommend any example or to screen for examples using "best practice" criteria – if such a thing is even possible to determine across such a variety of contexts. Rather, these are illustrative examples[35] drawn from searches of scholarly and gray literatures, including yearbooks of legal developments around the world, legal inventories produced by international organizations, and digests of global laws for practitioners.[36] Diversity was the key objective in selecting these illustrative examples: diverse jurisdictions in terms of legal tradition and degree of industrialization; diverse environment-related issues that are important in the relevant jurisdiction; and diverse approaches to undertaking a CIRCle Framework function. The second way that the book spans jurisdictions is through three major case studies, introduced later in this chapter.

This boundary-spanning research approach builds on my past research using large-scale, multi-jurisdictional,[37] cross-sectoral,[38] and cross-disciplinary

"Environmental Regulation, Governance, and Policy Instruments, 20 Years after the Stick, Carrot, and Sermon Typology" (2020) 22 *Journal of Environmental Policy and Planning* 620–635, 631.

[35] Jack S. Levy, "Case Studies: Types, Designs, and Logics of Inference" (2008) 25 *Conflict Management and Peace Science* 1–18, 6–7 ("they aim to give the reader a 'feel' for a theoretical argument by providing a concrete example of its application, or to demonstrate the empirical relevance of a theoretical proposition").

[36] E.g., *Oxford Yearbook of International Environmental Law* (Maria Gavouneli and Timo Koivurova eds, first published 1990); IUCN, The Biodiversity Consultancy and Durrell Institute of Conservation and Ecology, Global Inventory of Biodiversity Offset Policies, https://portals.iucn.org/offsetpolicy; Chambers and Partners, Environmental Law 2023, https://practiceguides.chambers.com/practice-guides/environmental-law-2023.

[37] E.g., Rebecca Nelson and L. M. Shirley, "The Latent Potential of Cumulative Effects Concepts in National and International Environmental Impact Assessment Regimes" (2023) 12(1) *Transnational Environmental Law* 150–174; Rebecca Nelson, "Paying Back the River: A First Analysis of Western Groundwater Offset Rules and Lessons for Other Natural Resources" (2015) 34 *Stanford Environmental Law Journal* 129–194; Rebecca Nelson, "Allocations and Legal Trends in the 21st Century" in Josselin Rouillard and others (eds), *Water Resources Allocation and Agriculture: Transitioning from Open to Regulated Access* (IWA 2022) 25–36.

[38] E.g., Rebecca Nelson, "Breaking Backs and Boiling Frogs: Warnings from a Dialogue between Federal Water Law and Environmental Law" (2019) 42 *University of New South Wales Law Journal* 1179–1214; Rebecca Nelson, "Victims and Villains: Cities and the Environment on the Constitutional Stage" in Erika Arban (ed), *Cities in Federal Constitutional Theory* (OUP 2022) 161–179; Rebecca Nelson, Lee Godden and Bruce Lindsay, *A Pathway to Cultural Flows in Australia* (National Native Title Council 2018) www.mdba.gov.au/sites/default/files/publications/a-pathway-to-cultural-flows-in-australia_1.pdf.

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methods.[39] It also draws from my experience working across government, nonprofit, and private sectors in interdisciplinary environments.

Aiming for breadth and boundary spanning necessarily trades off the ability to draw deep conclusions about any one area of law, jurisdiction, or cumulative problem context. I leave for future work the many productive avenues of inquiry that arise and offer the CIRCle Framework as a potential structure for analysis.

1.2.3 *Regulatory Functions as Ingredients with Sample Menus*

The CIRCle Framework describes and prescribes broad legal functions, noting that it would be impossible to make detailed prescriptions that would suit diverse problems and legal contexts around the globe. Regardless of whether you or your jurisdiction embraces command-and-control regulation, cap-and-trade mechanisms for property rights or earth jurisprudence; whether you work on microplastic pollution or landscape-scale biodiversity conservation, these regulatory concepts and contexts require a structure, a menu with the right ingredients. Those ingredients are the CIRCle Framework functions. They are intended to be assembled into different dishes to suit different contexts.

To continue the metaphor, this book does not recommend a set menu: If CIRCle Framework functions are the ingredients, then the many examples that illustrate each Framework function are a sample international buffet. But a caution is also warranted: Law in practice may differ from law on paper. The appropriateness of an approach illustrated by an example should be considered in light of the local context and regulatory culture. The fact that an example is included also does not mean it is implemented effectively – each example is necessarily presented in an abstracted way, outside its social context. The examples merely show that an approach is possible, and, as a matter of regulatory design, deals with an important need in responding to cumulative environmental problems. While I have tried to ensure that each example is used in practice, it lies to future work to empirically evaluate these mechanisms, and how they link to others, in their real-world contexts.

[39] E.g., Nelson, "Sick City Streams"; Rebecca Nelson, "Regulating Hidden Risks to Conservation Lands in Resource Rich Areas" (2021) 40 *University of Queensland Law Journal* 491–530; Nicola Ulibarri and others, "Assessing the Feasibility of Managed Aquifer Recharge in California" (2021) 57:e2020WR029292 *Water Resources Research* 1–18.

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1.2.4 A Starting Focus on What We Care About

As I discuss in more detail later in this book,[40] the core and first analytical step of the CIRCle Framework is being clear about the thing we care about, which I call the "matter of concern" (Figure 1.1, Step 1). Only after we are clear about exactly what it is that we want to protect or restore can we assess how threats and legal mechanisms affect that thing.

Importantly, I do not argue that laws should focus on any specific matter of concern. A legal system might reflect concern about a species, a cultural landscape, a disadvantaged community, a river, an airshed, and many other things that matter. All of these things, and many others, can benefit from a cumulative impacts approach that centers on that thing, and understanding and dealing with impacts to it.

Starting with what we care about can be distinguished from focusing at once on specific categories or sizes of impacts. That is, a cumulative impacts mindset urges approaching a problem without any assumptions about targets for regulation, say, large corporations or particular industries. Rather, the aim is to understand the kinds of actions – all of them that may aggregate to become significant – that may affect the matter of concern. This encompasses impacts that are both large and small, and that are caused by "background" effects (say, the spread of an introduced species) and past human activities that have ongoing effects, as well as current and proposed human impacts. Small actions, as well as large ones, can aggregate to become significant. This does not necessarily mean limiting those small actions, or blaming those who undertake them. But recognizing these impacts is important, as is considering acceptable ways to intervene where they accumulate to cause significant unacceptable harm.[41]

1.2.5 Optimism

In its orientation and its findings, this book is optimistic. Yes, cumulative environmental problems can seem massive and intractable. But if a central failing of environmental law, on paper or in practice, is not taking account of cumulative environmental effects, existing laws also have "untapped potential . . . to address environmental change" and provide "a more expedient approach to addressing environmental change than waiting for full-scale

[40] See generally Chapter 4 (Conceptualization as a CIRCle Framework function).
[41] See Chapter 6 (Regulatory intervention as a CIRCle Framework function).

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environmental law reform."[42] This book confirms this untapped potential in the context of cumulative environmental problems. Many areas of law can deal with cumulative environmental effects[43] – they are just too seldom structured and refined to do so.

In aiming to demonstrate how we might harness this untapped potential to deal with cumulative effects, I take a wide, panoramic view of relevant laws in terms of geography and subject matter. Using diverse illustrative examples from across the world not only demonstrates that different jurisdictions and areas of law face similar challenges; I hope that it also points to the potential for crafting solutions in one area of law by gaining inspiration from another (how might wildlife conservation law learn from approaches used to address cumulative air pollution?; how might rules for water resources benefit from approaches used in landscape planning?).

It is also a cause for optimism that the illustrative examples that appear in this book are so geographically diverse – and they are just a subset of what might have been included. The CIRCle Framework functions are not the exclusive preserve of any one legal tradition, nor expressed through a single rigid approach, nor found only in industrialized countries. Far from it. We see them around the world, in different forms, in place as we speak. This is important, because it expands the potential to identify precedents and lessons that speak to regulatory designers more broadly than might otherwise be the case – while recognizing that in some situations laws will require transformational change.

1.3 SCOPE OF RELEVANT RULES

If the core objective of this book is to advance a framework for evaluating formal rules that respond to cumulative environmental problems, a key question is the scope of those rules. This is worth clarifying carefully, given that different terminology is used in different places.[44] I include rules that are legally binding, including legislation adopted by a national or subnational parliament or congress or local government; regulations adopted by executive agencies; and, to a lesser degree, policy that is officially adopted by an agency of government or an institution, which might not be directly legally binding. This includes, for example, guidance on assessing cumulative impacts under environmental

[42] Ahjond Garmestani and others, "Untapped Capacity for Resilience in Environmental Law" (2019) 116 *Proceedings of the National Academy of Sciences* 19899–19904, 19899.

[43] See Chapter 3 (Regulatory Landscape).

[44] E.g., Nir Kosti, David Levi-Faur and Guy Mor, "Legislation and Regulation: Three Analytical Distinctions" (2019) 7 *The Theory and Practice of Legislation* 169–178.

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impact assessment laws, or formal state guidance to local agencies on formulating statutory plans that consider cumulative effects.[45] In some jurisdictions, citizens may propose formal rules.[46] The common characteristic is that the state plays a role, though non-state actors may also feature under coordination arrangements. Indeed, I argue that cumulative environmental problems require state action because of their inherent qualities.[47]

The landscape of formal rules that undertake CIRCle Framework functions is wide – it includes those as diverse as constitutional environmental rights, natural resources management regimes, and the environmental impact assessment context that is most commonly associated with considering cumulative effects.[48] It includes formal rules that some associate with alternatives to state action, rather than state action itself, for example, rules that structure environmental markets, statutory conditions on the exercise of private property rights, and formal but voluntary rules for corporate environmental disclosures.

This work shares a well-known common feature of policy design scholarship in that it focuses on the "good side" of designing rules that are intended to achieve an aim, rather than examining how they might be misused.[49] It also does not focus significantly on rules that are not aimed at dealing with a problem, but that might indirectly undercut it. Such rules, like political campaign financing laws or international trade rules, are of great importance and potentially high indirect influence, but belong to a wider scope than can be addressed by this work.[50] Similarly, indirectly supportive rules, say, international technical capacity-building funds for environmental matters, lie beyond the present scope of this book.

1.4 HOW TO USE THIS BOOK

1.4.1 *Structure and Features*

This book serves multidisciplinary scholarly and professional audiences. It assumes a basic familiarity with modern environmental problems, such as climate change

[45] See, e.g., discussion of a policy on cumulative impacts in the context of the Great Barrier Reef (Chapter 9) and state guidance on stakeholder engagement and addressing impacts to drinking water supplies in the context of local groundwater sustainability plans in California (Chapter 8).

[46] E.g., Political Constitution of Peru 1993, rev. 2009, art. 2(20); Maeve P. Carey, *Petitions for Rulemaking: An Overview* (Congressional Research Service 2020) 9–10.

[47] See Chapter 2.

[48] See Chapter 3 (Regulatory Landscape).

[49] Giliberto Capano and Michael Howlett, "The Knowns and Unknowns of Policy Instrument Analysis: Policy Tools and the Current Research Agenda on Policy Mixes" (2020) 10:21582440199005 68 *SAGE Open* 1–13, 8.

[50] See also discussion at Section 3.2.4.

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and biodiversity loss, but does not assume familiarity with any particular jurisdiction. It is written to facilitate reading chapters independently and also sequentially. The last chapter serves as a "quick guide" to the book and translates key findings into a process for analyzing rules, summarized in Figure 1.1.

Chapters 2 and 3 adopt a theoretical posture. Chapter 2 explores multiple disciplinary insights on why cumulative environmental harms involve particularly pronounced challenges for human recognition, understanding, acceptance, and action. I argue that many of these challenges are difficult or impossible to address without the kind of well-considered, structured, and coordinated measures for which formal rules provide. Chapter 2 then advances a four-part functional framework for evaluating laws that are intended to deal with cumulative environmental problems: the CIRCle Framework (conceptualization, information, regulatory intervention, and coordination). The Framework advances the argument that law must perform and link four key functions to deliver an effective legal response to cumulative effects: clearly conceiving what and who matter (the "matter of concern"); producing, sharing, and allocating responsibility for information relevant to cumulative effects on the matter of concern; intervening in response to, or in anticipation of, unacceptable cumulative effects; and coordinating across and between levels of government, and with nongovernment entities to do these things. The design of legal mechanisms to carry out these functions should anticipate and seek to head off important challenges revealed by other disciplines. Chapter 3 lays the foundations for applying this Framework by sketching the landscape of areas of law that can help deal with cumulative environmental problems.

Chapters 4 to 7 take a "law on paper" position, undertaking a high-level analysis of how different legal approaches across environment-related laws in diverse jurisdictions can address cumulative environmental effects through each CIRCle Framework function. Each of these "function" chapters is structured first, to explain the nature of the function, its role in the CIRCle Framework and its links with other functions; second, to call attention to how that function might vary among environment-related laws in important ways; and third, to set out key, crosscutting design features that are important to delivering the function regardless of this variation. These design features are illustrated in tables that show, non-exhaustively, some important types of diversity in approaches adopted by laws around the world.

Chapters 8 to 10 take a "law in context" approach, examining three case studies of cumulative environment problems. Each case study chapter explores selected CIRCle Framework functions in their complex, real-world regulatory context. Whereas the chapters preceding these deal with individual mechanisms, the case studies explore how multiple mechanisms come together. Finally, Chapter 11 "zooms out" to offer guidance for applying the CIRCle Framework in a local context, synthesizing the book's key messages along the way.

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1.4.2 *Legal Scholars, Regulatory Practitioners, Law Reformers, and Nonlawyers*

The book will be of general interest to law and policy scholars working in environmental and natural resources fields, who seek to identify gaps, weaknesses, and conflicts in existing systems of rules and to improve those rules. A wider legal scholarly audience with intersecting interests may be interested in particular chapters, for example, those working on law, technology, and information (Chapter 5, Information), and those working on constitutional law, federalism, and environmental governance (Chapter 7, Coordination).

Other readers will be motivated by practical purposes. Some regularly work with rules for dealing with cumulative harms, implementing systems, and making decisions to assess and address cumulative environmental effects. They may work as administrators in government environmental and natural resources agencies. They may also work in international and nongovernment contexts, as policymakers in development banks and engineers working in large engineering corporations that undertake environmental impact assessments for major projects. These readers will be interested in ways to improve the structure or implementation of relevant rules, as described in Chapters 4 to 7. These chapters will also interest those who seek to reform the rules or influence how they apply in a particular instance, such as nongovernmental organizations (NGOs), actors in social movements, and informed citizen-activists.

For nonacademics and nonlawyers, Chapters 2 (multidisciplinary insights and the CIRCle Framework) and 11 (summary and guidance) form the best starting points. These chapters adopt a more general style than the chapters that dive more deeply into law, and can act as a pathfinder for the more detailed legal chapters. Nonlegal and legal practitioners alike may also be interested in a case study aligned to their field of work in terms of subject matter or area of law (see Table 1.1).

1.5 INTRODUCTION TO MAJOR CASE STUDIES

1.5.1 *Purpose and Selection*

The case studies presented in Chapters 8–10 are illustrative.[51] They were selected to draw out cumulative environmental problems that are diverse, challenging, and highly developed with respect to particular CIRCle Framework functions. Each case study focuses on a geographically constrained place and examines how multiple laws interact to deal with

[51] Levy, "Case Studies: Types, Designs, and Logics of Inference," 6–7.

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TABLE 1.1 *Key characteristics of case studies*

Case study	Groundwater depletion and environmental justice in California's Central Valley, US	Biodiversity of the Great Barrier Reef, Australia	Alpine grasslands as biocultural landscapes, Italy
Legal landscape for addressing cumulative environmental problem (bolded text indicates **major focus**)	**Water resources management plans**, safe drinking water, pollution, environmental impact assessment (EIA), land use law	EIA and **strategic assessment**; pollution law; land management standards; greenhouse gas emissions cap; carbon offsets; restoration subsidies	Constitutional protections for landscapes; landscape plans; EIA; protected species and **conservation areas**; farm subsidies; food product certification; farm inheritance law; public acquisition
Levels of governance	State and local laws	International conventions, federal and state laws	International conventions, laws at the European Union, national, provincial and local levels
Matter of concern and impacts in focus	Preventing aggregate withdrawal of water for farms and large cities reducing access to groundwater for vulnerable communities reliant on household or small community wells	Preventing decline in health of the World Heritage Great Barrier Reef due to polluted runoff from catchments and greenhouse gas emissions causing climate change, focusing on catchment grazing and coal mines	Maintaining and restoring biodiverse and culturally valuable Alpine grasslands, countering abandonment of traditional extensive grazing practices and small-scale development
CIRCle Framework functions in focus	Conceptualization and its links to the other functions	Information Intervention Links between intervention and information	Coordination Intervention Links between coordination and intervention

cumulative effects in that place. This shows how the complexity of dealing with cumulative effects derives, in part, from the fact that separate legal regimes often regulate distinct types of effects.

Research for each case study involved analyzing documentary sources related to law, policy, and the environmental context. This was supplemented by discussions with numerous local contacts familiar with the case study across government, NGOs, and academia.

Cumulative environmental problems are so common that there is no shortage of legal and factual contexts to investigate. Given this abundance of options, and the fact that this is the first monograph to concentrate on the legal aspects of regulating cumulative environmental problems, diversity was an important factor guiding the selection of case studies.

A first dimension of diversity is the key legal mechanisms that form the major focus of each case study: statutory natural resources planning, strategic environmental assessment law, and habitat protection, respectively. This approach shows that different legal mechanisms can address cumulative effects, but it also prevents directly comparing how a single type of mechanism is implemented in different contexts. These are illustrative, rather than comparative, case studies. Other elements of diversity are levels of governance (local, state/provincial, national, and transnational); jurisdictions (the United States, Australia, and Italy/Europe: Figure 1.2); natural resources (freshwater, marine, and mountain grassland), and types of concerns (resource sustainability, biodiversity, and biocultural values) (see Table 1.1).

The case studies build on past research approaches[52] and time spent physically working in each jurisdiction on issues relevant to each case study (in Australia, for most of my career as a lawyer, government adviser, and scholar; in California, for my graduate training; and in South Tyrol as a scholar in residence at the Eurac Research Institute for Comparative Federalism).

The cases do have some common dimensions. In each, the matter of concern is well-known and sometimes iconic. This acknowledged importance means that disputes tend to focus on the best way to protect or restore the matter of concern, rather than whether to do so. This maximizes the likelihood of developing – and here, illustrating – sophisticated regulatory responses. Each case study occurs in a relatively large, industrialized, high-income jurisdiction with complex and well-developed environment-related laws. This helps illustrate the challenges of integrating functions across areas of law. But it means that the case studies may not address additional issues that

[52] See Section 1.2.2.

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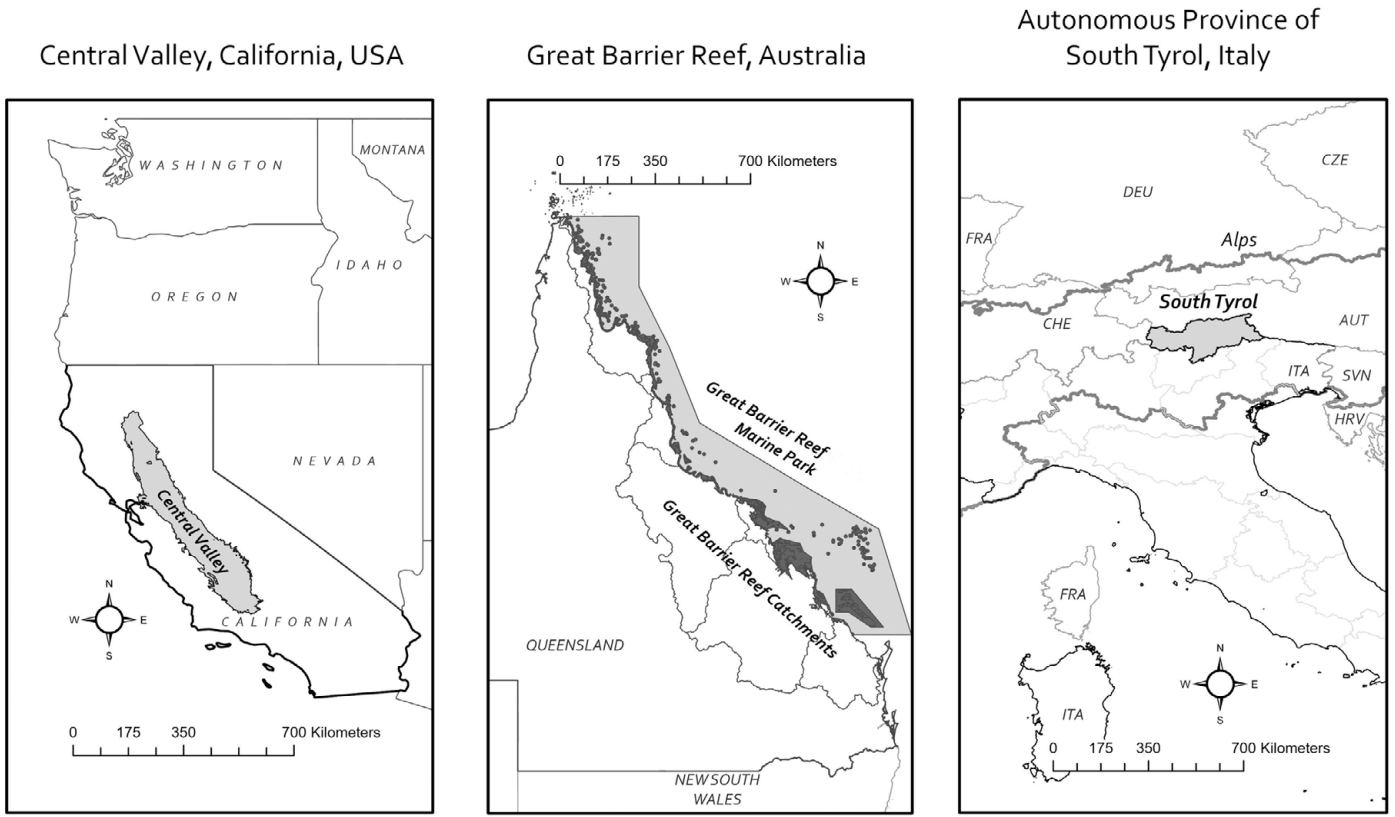


FIGURE 1.2 Major case study locations

may arise in advancing and integrating the CIRCle Framework functions in a smaller or lower-income jurisdiction, for example, a small island or large state in the Global South. These additional issues are difficult to generalize. On one hand, if there are relatively fewer government actors and fewer or less entrenched legal silos, coordination and integrating functions may be easier. On the other hand, challenges are likely where foundational environment-related laws are developing, government resourcing is heavily constrained, and contributors to cumulative impacts have lower capacity to explore ways to reduce harm. Importantly though, the selection of major case studies does not suggest that lower-income jurisdictions lack innovative legal approaches to CIRCle Framework functions: This innovation emerges clearly from the many illustrative examples used across the chapters on each Framework function (Chapters 4–7).

1.5.2 *Introducing the Case Studies*

The three case studies work sequentially through the key CIRCle Framework functions, building from a focus on conceptualization and how it links to other functions (California's Central Valley), to considering connections between information and regulatory intervention (Australia's Great Barrier Reef), and regulatory intervention and coordination (Italy's Alpine grasslands) (Table 1.1). The case studies ask diverse questions: How can the idea of environmental justice, as a cumulative impact concept, be operationalized through statutory groundwater plans? How can rules influence distant and diverse, cumulatively significant threats to a coral reef? How can the cumulative effects of human activities, and the abandonment of activities, be influenced to protect "cultural landscapes" and their habitats that inherently require human action to maintain their conditions? Here, I briefly introduce the case studies in an abstract-like, citation-free form as a prelude to fuller discussion in later chapters.

1.5.2.1 Groundwater Planning and Environmental Justice in the Central Valley of California

California's Central Valley is one of the world's thirty-seven "mega aquifers": very large reservoirs of underground water that generally span political boundaries and, together, account for most of the world's groundwater resources. The region has one of the world's most notoriously overused groundwater resources, and its aquifer is the most intensely depleted in the United States. It supports one of the most world's most productive agricultural regions and a growing population, including many disadvantaged communities. Some such

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communities lack a municipal government and public water systems, and so these communities access drinking water from domestic wells, many of which have dried up during recent droughts. But regulating cumulative withdrawals to protect groundwater levels and access to drinking water has proven challenging.

No federal or state agency regulates groundwater withdrawals in California in a general sense. A strong traditional preference for "local control" of groundwater inhibited comprehensive state-level monitoring and regulation of groundwater until the twenty-first century. When state legislation finally appeared, it was prompted in part by a major drought and its effects on the Central Valley. California introduced statewide monitoring legislation, identified groundwater basins that were "critically overdrafted," and ultimately passed the 2014 Sustainable Groundwater Management Act. The Act requires self-nominated local "groundwater sustainability agencies" to manage groundwater to achieve sustainable groundwater conditions.

This case study uses the Sustainable Groundwater Management Act as a springboard for introducing the CIRCle Framework in a real-world context, focusing on how it provides for conceptualizing what and who matter in groundwater management, and how these decisions connect with functions for information, regulatory intervention, and coordination. California laws and policies spotlight the question of "who matters" through the concept of environmental justice. This inherently cumulative concept speaks to the unfair aggregation of environmental and socioeconomic stressors on subpopulations. This case study shows how groundwater depletion, access to drinking water, and environmental justice collide in local groundwater sustainability plans, and how an integrated response depends on good information, diverse interventions, and multilevel interactions.

1.5.2.2 Strategic Assessment and Biodiversity of the Great Barrier Reef

Australia's Great Barrier Reef ("Reef") is the world's largest coral reef ecosystem. It was inscribed on the list of World Heritage in 1981 on the basis of being of exceptional natural beauty, an outstanding example of earth's history, representing significant ongoing ecological and biological processes, and providing important natural habitat for in situ conservation of biodiversity. The Reef faces cumulative threats from diverse activities – developments such as ports and shipping, global climate change, coastal development, regional catchment runoff from agriculture, urban development, clearing of native vegetation, and extractive activities. Dealing with these stressors is fraught with controversy, particularly related to agriculture, associated regional land

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clearing, and extractive activities. These activities are economically valuable but contribute directly to water quality problems for the Reef and to global climate change, which in turn affects the Reef.

Concerned at these threats, in 2012 the World Heritage Committee requested that Australia complete a strategic environmental assessment for the Reef, which the Committee would scrutinize to ensure that it properly addressed cumulative impacts. Though strategic assessments are often considered tools for producing information at a point in time, the resulting joint federal- and state-level strategic assessments for the Reef also influenced ongoing information arrangements. The assessments also anticipated and led to contentious changes in regulatory interventions in relation to water quality. However, they were decidedly silent on climate change mitigation, focusing instead, half-heartedly, on adaptation.

Focusing on the contrasting impacts of cattle grazing and coal mining, this case study examines how the strategic assessments have supported two key regulatory functions of the CIRCle Framework for managing cumulative impacts: information and regulatory intervention. It shows that regulatory strategic assessment can provide for entrenching and integrating ongoing information collection and can directly influence diverse regulatory interventions to address cumulative impacts. At the same time, the Reef context reveals ongoing regulatory challenges in making comprehensive links between the intersecting problems of water quality and climate change.

1.5.2.3 Alpine Grasslands as Biocultural Landscapes in South Tyrol, Italy

Traditional pastoral practices have maintained Alpine grasslands over thousands of years, and Alpine biodiversity and local cultural heritage now depend on these practices. Across the Alps, biocultural grassland landscapes face diverse threats. Some herders abandon pastures and meadows as traditional, labor-intensive agricultural methods become uneconomic. In other cases, grasslands give way to intensive agriculture and developments such as infrastructure for urban expansion, tourism accommodation, and renewable energy projects. That is, harmful effects of nonuse, as well as new uses, accumulate to threaten Alpine grasslands. This type of cumulative environmental problem has analogs in other places where elements of the environment require active management. Nonuse challenges a typical legal focus on prohibiting or restricting activities to prevent environmental harm rather than encouraging or compelling action.

Harms to Alpine grasslands are not distributed uniformly: The Autonomous Province of Bolzano/Bozen-South Tyrol ("South Tyrol"), Italy, experiences

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some of the lowest rates of land abandonment and high rates of grassland retention. This relative success occurs in the context of complex regulatory arrangements. Interventions engage interlinked laws for nature, impact assessment, agriculture, landscape, and governance. Each of these areas comprises laws at the international, European Union (EU), national, provincial, and municipal levels.

This case study investigates how a diverse set of regulatory interventions, many focused on incentives, provides for maintaining and restoring grasslands in South Tyrol. It reveals how diverse forms of coordination – links between areas of laws, coordinating institutions, and dispute resolution processes – facilitate implementation in a context of deep multilevel governance.

1.6 CONCLUSION

By bringing together experience across diverse geographic places and legal areas and presenting a new framework for analysis, this book aims to spur greater regulatory engagement with cumulative environmental problems. The case studies presented in this book, and its illustrative examples, scratch the surface of the almost infinite combinations of threats and legal responses that arise in cumulative environmental problems. They highlight some of the challenges that regulatory designers face in addressing these problems and show how laws that undertake the CIRCle Framework functions – conceptualization, information, regulatory intervention, and coordination – can help.

The great diversity of legal mechanisms presented in this book suggests that there is significant scope for empirical research to delve deeper in relation to single case studies, as well as undertake comparative investigations across key variables in the mechanisms for individual CIRCle Framework functions, for example, comparing institution-based and rules-based legal mechanisms for coordination. It would also be useful to explore how the different mechanisms, and their evolution, sustain responses to cumulative environmental problems over time, as cumulative environmental problems change – questions that require deeper study of implementation experience. Another question that this book raises for further investigation is how best to combine coordination mechanisms for different Framework functions, and the extent to which different functions may benefit from different approaches in disparate contexts.

So many thinkers, and so much knowledge across diverse disciplines, can help us to deal with cumulative environmental problems. Rules can be responsive to this knowledge. Rules for key CIRCle Framework functions can be designed to counter the human cognitive quirks, dizzying complexity,

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ethical ambiguity, and other spanners in the works of social responsiveness that produce inaction and incomplete action when faced with cumulative environmental problems. Not only *can* they do it, but around the world, they actually *do* do it across many areas of law. Probably not perfectly, and not without difficulty – but in a way that gives us fertile ground for learning lessons to apply across diverse problems, to act to protect what matters.

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