Int Environ Agreements
https://doi.org/10.1007/s10784-019-09454-7

ORIGINAL PAPER

An economic analysis of international environmental rights

Jesse L. Reynolds[1]

Accepted: 10 October 2019

Abstract
This article offers a descriptive and normative economic analysis of international environmental rights. States, sovereignty, international negotiations, and international law resemble legal persons, property, the market, and private law, respectively. Just as the initial entitlement of persons' property rights is important to increasing welfare when transaction costs are significant, so too is that of states' sovereignty rights, including those regarding the environment. What is the initial entitlement of these rights? Is this relatively efficient? How are these rights protected? The article considers three possible initial entitlements. First, states' right to cause transboundary environmental harm and, second, their right to be free therefrom are each rejected due to weak theoretical support and insufficient state practice. These initial entitlements would also be less efficient. In contrast, an initial entitlement consisting of both the prevention of transboundary harm and the equitable use of shared natural resources is supported by theory and practice. This entitlement appears relatively efficient, and the relevant legal instruments reveal an implicit underlying economic logic. These international environmental rights are generally protected by mechanisms that resemble liability.

Keywords Law and economics · Property rights · International environmental law · Polluter pays · Transboundary harm

1 Introduction

To a great extent, law concerns rights, which are legitimately recognized claims by an actor to something against another actor. Legal scholarship often asks descriptive and normative questions concerning rights. What are rights, and what should they be? What is actors' initial entitlement of rights, and what should it be? What duties among other actors does a given right imply? May rights be transferred? If rights have been violated, which remedies may the rights-holder seek, and to which ones should he or she have access? This article

✉ Jesse L. Reynolds
reynolds@law.ucla.edu

[1] Emmett Institute on Climate Change and the Environment, School of Law, University of California, Los Angeles, 385 Charles E. Young Drive East, 1242 Law Building, Los Angeles, CA 90095, USA

Published online: 19 October 2019

descriptively and normatively considers international environmental rights, issues that lie at the intersection of three specific areas of legal scholarship.

First, the environment can be an object of rights. These include a right to be free from others' environmental harm and a right to use the natural environment as one chooses. These are primarily property rights, in that they concern how the rights-holder may or may not legitimately use his or her property. Environmental law asks questions analogous to the ones above: How does a government protect both the right of potential victims (here called "recipients" of environmental harm) to enjoy their property free of external negative effects and the right of polluters (here, "sources") to use his or her property, and how should it? To use a classic example, suppose that emission from a coal-fired electricity generator interferes with a commercial laundry facility's operation. Does the former have a right to emit, or does the latter have a right to clean air? If environmental rights have been violated, which remedies does a government provide, and which ones should it?

Second, the application of economics—the study of how actors use their limited resources to meet their diverse wants—to analyze law is one method to understand rights. Central to the economic analysis of law (sometimes called "law and economics") are the explanation, prediction, and prescription of rights, particularly property rights. Its primary normative criterion is efficiency, which is the maximization of well-being, or welfare, given existing constraints.[1] This approach has become influential and has been called "the most important development in legal scholarship of the twentieth century" (Ackerman, quoted in Cooter and Ulen 2011: 2). Specifically, there is a modest literature on the economic analysis of environmental law (e.g., Livermore and Revesz 2014). In the case of environmental property rights, an economic analysis explores which party has the right, whether there are substantial barriers to transferring it if the rights-holder values it less than the other party, and whether the law should reduce those barriers or reallocate who has the initial right.

Third, legal rights exist in the international context. International legal scholarship investigates states as rights-holders and concomitant duty-bearers. It asks what their rights are and what they should be, as well as how states may and should protect their rights. International law and the rights provided therein are distinct from domestic legal rights in that there are no centralized maker, enforcer, and binding arbitrator of law, rights, and duties. Because this causes many of the more intractable environmental problems to be transboundary, international environmental law has long been a robust subfield (e.g., Birnie et al. 2009) that explores states' rights and obligations regarding activities that might affect the environments of other states or of areas beyond national jurisdiction. For instance, to what extents do states have the right to fish in the high seas and a duty to protect fisheries? Likewise, there is a growing literature on the economic analysis of international law—sometimes called "rational choice"—that explores how states interact with one another to rationally increase their welfare (e.g., Guzman 2008; Trachtman 2008; Posner and Sykes 2013).

[1] To be specific, welfare is the satisfaction of preferences, which can presumably be transitively ranked and can be revealed through behavior. A voluntary trade or other action by a perfectly informed actor with negligible negative third-party impacts necessarily increases welfare, or at least does not decrease it. In reality, behavior can be involuntary and have negative impacts, and information is often imperfect.

Claims regarding efficiency generally require aggregating multiple actors' welfares, yet perfect interpersonal welfare comparisons are impossible. Economists thus often point to Pareto improvements, in which at least one actor's welfare increases and no actor's welfare decreases, and to Kaldor–Hicks improvements, in which those who are made better off would be (at least hypothetically) willing to compensate those who are made worse off. In this paper, claims of relative efficiency refer to Kaldor–Hicks improvements.

However, research at the intersection of these three domains—that is, the economic analysis of international environmental law—has been limited largely to game theoretic analyses of rulemaking and compliance (e.g., Barrett 2003). The economic analysis of international environmental rights remains poorly studied. To address this lacuna, this article offers an initial economic analysis of states' rights regarding the environment. It asks three questions. First, what is states' initial entitlement of international environmental rights? Second, is this initial entitlement efficient relative to other major possibilities? Third, how are these rights protected?

In the following two sections, I provide background on the economic analysis of property rights, first in general and then specifically in the international context. Sections 4, 5, and 6 describe three possible initial entitlements of international environmental rights. For these, brief legal analyses answer which is—or has been—the initial entitlement, and brief economic analyses assess their relative efficiencies. The final full section explores how international environmental rights could be and are protected. A short conclusion ends the article.

2 Property rights

A foundational axiom of economics is that actors expend their limited resources to pursue their diverse preferences. To some extent, an actor can do so individually. Yet because their resources and preferences vary, actors also cooperate to exchange the former to satisfy the latter. Trade—one form of cooperative action—is important to increasing welfare. Some trade is simple, but contracts are useful in complex situations to clarify expectations and the agreed-upon consequences of failing to meet them.

Although trade can increase welfare, there are sometimes barriers. A government can help domestic actors overcome these, at least in some cases, by creating and enforcing rules—which are collectively called "law"—backed by the credible threat of legitimate force. Through such law, the government can further improve actors' welfares. Indeed, one possible goal of law is to maximize society's welfare given its resources and preferences, that is, to strive for efficiency. This is the central proposition of the economic analysis of law.

Many of law's welfare-increasing functions involve property rights. Among other things, law allocates an initial entitlement of property rights in the absence of any agreed-upon exchange and helps protect them in the event of infringement. The initial entitlement can evolve through new case law and statutes, often as a result of technological change. For example, the developments of taller buildings, air pollution, and aircraft catalyzed evolution in real property's associated rights to air and airspace (Cole 2011).

More specifically, government helps protect property rights in three general ways (Calabresi and Melamed 1972). First, in injunction, an actor whose rights have been violated can ex post ask a court to order a trespasser to cease. Thus, under a "property rule," ex ante permission is required before infringing upon a property right. Second, in liability, an actor whose rights have been violated can ex post ask a court to compel the trespasser to pay damages. Therefore, under a "liability rule," ex ante permission is not strictly required for infringement but the potential violator should be aware of possible damages that he or she will need to pay. Third, in administration, a public body centrally manages property rights in complex ways.

The Coase theorem is foundational to the economic analysis of property rights. It asserts that private bargaining will maximize actors' welfare, independent of the initial assignment of property rights, if transaction costs are negligible (Coase 1960). Such transaction costs that can cause the Coase theorem to be less applicable include monopoly and monopsony; collective action, holdouts, and other strategic behaviors; rent seeking; uncertainty and imperfect information; small and poorly functioning markets; behavioral limitations and bounded rationality; searching, monitoring, and enforcement costs; and—important in this paper—poorly defined and unprotected property rights.[2] This theorem can be applied to environmental phenomena, such as pollution from a source to a recipient. Returning to the example in the introduction, if the commercial laundry has an initial right to clean air but the electricity generator more highly values its emissions, then the latter will make a side payment to the former to transfer the right. Alternatively, if the generator has an initial right to emit but the laundry more highly values its clean air, then the latter will likewise make a side payment to the former to transfer the right. Hence, the initial entitlement of rights has no impact on their final distribution, which will reflect the actors' relative valuation of their rights.

While the Coase theorem and the example given assume negligible transaction costs, Coase and others recognized that transaction costs are often great enough to prevent bargaining and that the initial entitlement of rights consequently does affect ultimate welfare. In response to these actual conditions, Robert Cooter asserts that law should seek to minimize the harm arising from failures in private bargaining that can arise because of significant transaction costs (Cooter 1982). To do this, it should allocate initial property rights to the set of actors who generally value them most. This way, if they are unable to reach an agreement due to high transaction costs, then the one who most highly values the rights already has them. As transaction costs rise, so too does the importance of this initial entitlement of property rights.

3 International sovereignty rights

The economic analysis of property rights can be applied to international law. This is evident in a four-part analogy, in which states, sovereignty, international negotiations, and international law, respectively, resemble in some ways legal persons, property, the market, and private law. Let us consider each pair. First, states—the primary actors in the international order—use their limited resources to pursue their diverse preferences, as persons do. It can thus be useful to think of states as having welfares. Second, states have legitimate claims to possess, use, transfer, reap the benefits of, and exclude others from their territories, as well as to protect these rights, much like persons can do with property. These claims are a core aspect of sovereign authority over territory, the foundation of statehood. Legal scholar Richard Barnes observes that

> sovereignty shares a close conceptual relationship with property. Territorial sovereignty in particular has been developed largely by reference to concepts of private ownership, to the extent that it mirrors the conceptual modus operandi of property. It is no mere coincidence that the doctrinal modes of acquisition of territory under

[2] Here, "transaction costs" are used broadly to encompass all obstacles—including poorly defined property rights—to reaching an agreement regarding a transaction.

international law parallel the modes of acquisition of property under domestic law (Barnes 2009: 13; see also Cooley 2000).

States' territorial rights can be thought of as a bundle of quasi-property rights, hereinafter "sovereignty rights" (admittedly a somewhat imprecise phrase). Third, if one state values another's sovereignty rights more than the rights-holder does, then the former can offer something of value in exchange for the latter to transfer the sovereignty right. States negotiate in forums of varying formality and can codify an exchange in a treaty, while persons do so in markets and can codify exchanges in contracts (Scott and Stephan 2006).[3] Indeed, international law can be thought of as a sort of market in sovereignty rights.[4] Fourth, public international law—especially that found in custom—provides for states their initial entitlements of sovereignty rights and acceptable protective measures, while private law provides the same for persons and their property.[5]

In other important ways, states, sovereignty, international negotiations, and international law are unlike individuals, property, markets, and private law. First, states are complex transgenerational institutions, whereas people are singular human actors. Although ascribing preferences and welfare to the former is not straightforward, states act *as if* they have preferences that they could rank. Second, sovereignty cannot truly be fully transferred as property can. Most treaties are merely promises to (not) exercise sovereignty at certain times and places, and in certain ways. And states can later break these promises. Third, transaction costs in international negotiations are generally high due to several reasons. Their sovereignty rights' precise contours are often poorly defined. Reaching, implementing, and monitoring an agreement require substantial effort, including in information acquisition and negotiation. Sometimes, only one state can offer to "sell" and only one can offer to "buy" the given sovereignty right, leading to bilateral monopoly and costly strategic bargaining. Other times, the unanimous consent of many "seller" states must be obtained, which results in holdout problems. For various reasons that include security, states are reluctant to "unbundle" their sovereignty rights. Furthermore, they are also reluctant to overtly use financial side payments as compensation (Blocher and Gulati 2017).[6] Instead, states more often compensate in other issue areas through linkage, resulting in a barter market. Together, transaction costs prevent many potentially welfare-increasing exchanges. Finally, there is no central body with the recognized authority to develop and enforce international law—including by the legitimate use of force, if necessary—whereas the private law of property and contracts can be enforced by the state.

Despite high transaction costs, states regularly exchange their sovereignty rights through numerous contract-like treaties. Some have been overtly financial, such as Russia's sale of Alaska to the USA. Seemingly unrelated issues have been bartered, including when Russia ratified the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) in exchange for its membership in the World Trade Organization (Henry and McIntosh Sundstrom 2007: 58–59). Some treaties are symmetrical trades in

[3] This analogy is at least as old as Holland (1924: 393–394).

[4] Trachtman (2008: 8) calls it a market in jurisdiction.

[5] This analogy can be traced to Lauterpacht (1927). For an economic analysis of customary international law, see De Mot et al. (2017).

[6] When cash is used, it is often disguised, such as "development aid."

sovereignty rights. For example, the USA and Canada agreed to limit their takes of Pacific coast salmon from their territorial waters.[7]

As stated above, law—among other things—allocates initial entitlements of property or sovereignty rights and helps protect these rights. What is the initial entitlement of sovereignty rights in international law? Here, "initial entitlement" does not mean the earliest entitlement that one can reconstruct, but instead is a baseline of rights in the absence of contracts. In the international context, this would be the sovereignty rights that a new state would have prior to joining any treaties. Therefore, international law's customary rules and principles can define an initial entitlement of sovereignty rights (Barrett 2003: 115). As in the domestic context, this initial entitlement of sovereignty rights changes over time. For instance, states' control over territorial waters grew from three to twelve nautical miles, plus additions of a 200 mile exclusive economic zone and a continental shelf, as military, fishing, and extraction technologies developed.

How does international law help protect property rights? Because there is no centralized international legal authority, states must take protective and enforcement action themselves. The extent to which this is done through property rules (i.e., injunction), liability rules, or administration is unclear, although both practice and theory indicate some of each.

First, the existence of numerous treaties through which states exchange sovereignty rights indicates that these rights are protected to a substantial degree through injunction-like mechanisms. That is, states' practice shows that they recognize that they should obtain ex ante permission before infringing upon others' sovereignty.

Second, liability protects rights through the ex post payment of damages for harm. Violations of sovereignty rights without ex ante permission regularly occur, the consequences of which are given in the customary international law of state responsibility for wrongful acts. In this, states are responsible for their actions and omissions that are attributable to them and that are contrary to their obligations under international law. In principle, responsibility entails, among other things, restitution (re-establishing the situation that existed before the wrongful act) and compensation (providing something of value) (International Law Commission 2001b: Articles 35–36)—in other words, liability, or at least a form thereof.

Third, administration is sometimes used in international law, but not often. One example is the management of locations and frequencies of geostationary satellites by the International Telecommunications Union, an agency of the United Nations (UN).[8]

Any way in which one state's actions affect other states could be governed by sovereignty rights. This includes territorial control, people, and materials that cross borders, expropriation, intellectual property, and contraband (Sprankling 2011). This article focuses on environmental sovereignty rights, such as those regarding transboundary harm and shared natural resources.

One might ask whether the initial entitlement of environmental sovereignty rights matters from a welfare perspective. After all, the core of the Coase theorem is that the initial entitlement of property rights does not affect ultimate welfare when transaction costs

[7] Treaty between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon, January 28, 1985, in force March 18, 1985. Available at http://www.psc.org/download/45/miscellaneous/2337/treaty.pdf.

[8] International Telecommunication Convention, Final Protocol, Additional Protocols, Resolutions, Recommendations and Opinions, October 25, 1973, in force January 1, 1975. Available at http://search.itu.int/history/HistoryDigitalCollectionDocLibrary/5.10.61.en.100.pdf.

are negligible. Yet transaction costs for states to reach agreements are quite high. Consequently, in the international arena, the Coase theorem is less applicable than Cooter's assertion that law should allocate initial property rights to the actors who generally value them most. The initial entitlement will therefore be important.

4 Source states' environmental sovereignty rights: the Harmon Doctrine and the right to exploit natural resources

This section and the following two identify three possible initial entitlements of environmental sovereignty rights under international law and explore the extent to which each is supported by international legal agreements, state practice, and the rulings of international tribunals. An economic analysis indicates whether and under what circumstances each initial entitlement could be relatively efficient.

The first possible initial entitlements of environmental sovereignty rights are one in which source states have a right to cause transboundary environmental harm in other states and to exploit shared natural resources. This could be justified because a state has absolute control of its territory. Legal theory and state practice supported this as states' initial entitlement until relatively recently. In the seventeenth century, the writings of Hugo Grotius and Cornelis van Bijnkershoek as well as the Treaty of Westphalia allocated to states a right to absolutely control their territory. In its 1895 dispute with downstream Mexico regarding the transboundary Rio Grande, the upstream USA asserted the so-called Harmon Doctrine, in which it claimed its absolute environmental sovereignty right as a source state. Postcolonial states made similar claims of absolute environmental sovereignty rights from the 1950s to the 1970s regarding the exploitation of natural resources, which the UN General Assembly repeatedly endorsed.[9] For example, one of its Resolutions declared that "Every State has and shall freely exercise full permanent sovereignty, including possession, use and disposal, over all its wealth, natural resources and economic activities."[10] This is echoed in the human right of self-determination, which includes a provision that "All peoples may, for their own ends, freely dispose of their natural wealth and resources without prejudice to any obligations arising out of international economic co-operation, based upon the principle of mutual benefit, and international law."[11] The International Court of Justice

[9] UN General Assembly Resolution A/Res/523(VI), of January 12, 1952, on Integrated Economic Development and Commercial Agreements. Available at http://daccess-ods.un.org/access.nsf/Get?OpenAgent&DS=A/RES/523(VI)&Lang=E&Area=RESOLUTION; UN General Assembly Resolution A/Res/626(VII), of December 21, 1952, on the Right to Exploit Freely Natural Wealth and Resources. Available at http://daccess-ods.un.org/access.nsf/Get?OpenAgent&DS=A/RES/626(VII)&Lang=E&Area=RESOLUTION; UN General Assembly Resolution A/Res/1803(XVII), of December 14, 1962, on Permanent Sovereignty over Natural Resources. Available at http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/1803(XVII); UN General Assembly Resolution A/Res/S-6/3201, of May 1, 1974, on the Declaration on the Establishment of a New International Economic Order. Available at http://legal.un.org/avl/pdf/ha/ga_3201/ga_3201_ph_e.pdf; UN General Assembly Resolution A/Res/3281(XXIX), of December 12, 1974, on the Charter of Economic Rights and Duties of States. Available at http://www.un.org/ga/search/view_doc.asp?symbol=a/res/3281(XXIX).

[10] Charter of Economic Rights and Duties of States, ibid, Article 2.1.

[11] International Covenant on Civil and Political Rights, December 16, 1966, in force March 23, 1976, available at http://www.ohchr.org/Documents/ProfessionalInterest/ccpr.pdf, Article 1.2; International Covenant on Economic, Social and Cultural Rights, December 16, 1966, in force January 3, 1976, available at http://www.ohchr.org/Documents/ProfessionalInterest/cescr.pdf, Article 1.2.

(ICJ) confirmed that states' permanent sovereignty over natural resources is customary international law.[12] Note that these twentieth century claims of sovereignty over natural resources did not include a right to cause transboundary environmental harm. Nevertheless, since roughly 1970, claims of source states' environmental sovereignty rights have become decreasingly common and no longer represent the initial entitlement of environmental sovereignty rights.

Source states' environmental sovereignty rights are economically justified under some conditions. When transaction costs to negotiate possible transfers of rights are great, as in the international context, an initial entitlement to either the source or recipient state is more efficient. Because it is nearly impossible for a recipient state to physically block or otherwise prevent transboundary harm, source states' environmental sovereignty rights are the default in an anarchic international environment (Wiener 1999: 768).[13] Coasian bargaining and cooperation are possible to some degree under this initial entitlement. If the recipient state values its environment more than the source state values its harmful activity, then the former can offer side payments for the latter to stop. If the source state reneges on the agreement and resumes the harmful activity, then the recipient can end its payments. Furthermore, because the recipient state can do little to prevent transboundary environmental harm, it would be the beneficiary of any international cooperative agreement to reduce the source state's harmful activity.[14]

However, in the twentieth century, changes in international governance, technology, and economic interdependence lowered transaction costs. Specifically, new international forums—many affiliated with the UN—offered sites for the progressive development of international law regarding sovereignty rights' definitions, treaties' default terms and rules, and reallocative multilateral treaties. Standing tribunals further provided venues for international dispute settlement. Rapid and inexpensive means of travel and communication facilitated the negotiation of agreements. Identifying environmental harm, attributing its source, and monitoring compliance were accelerated through observation technologies. Greater international integration, especially in economic domains, expanded the possibilities of issue linkage (Barrett 1997). At the same time, other new technologies—such as nuclear power and the maritime transportation of oil—amplified transboundary environmental risks and created new ones. The negative third-party impacts of such hazardous activities increased the potential benefit of some degree of recipient states' environmental sovereignty rights, whether achieved through individual exchanges or through a new initial entitlement. Together, these changes caused source states' environmental sovereignty rights to no longer be the relatively more efficient initial entitlement.

[12] *Armed Activities (Democratic Republic of the Congo v. Uganda)*, Judgment, December 19, 2005, *ICJ Reports* 2005, paragraph 244.

[13] "Anarchic" here does not mean without rules but instead without centralized rule making, rule enforcement, and binding dispute resolution.

[14] Wiener (1999: 750–755) thus suggests that this entitlement of rights be called "beneficiaries pay."

5 Recipient states' environmental sovereignty rights: the polluter pays principle

A second possible initial entitlement of environmental sovereignty rights is that recipient states have an environmental sovereignty right to be free of deleterious transboundary harm, including depletion of their shared natural resources. In legal terms, recipient states' environmental sovereignty rights are captured in the "polluter pays" principle, in which the source state should bear the costs of preventing, remediating, and compensating for any resulting harm. In other words, the principle calls for recipients' environmental sovereignty rights that are protected by a liability rule.

States have, to some degree, rhetorically adopted an international polluter pays approach to environmental sovereignty rights but have not done so in practice. The principle's most important articulation is in the nonbinding Rio Declaration, which is the only such provision in a global legal instrument:

> National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.[15]

Notably, this passage calls upon states to ensure that domestic polluters pay but says nothing about transboundary harm or shared natural resources. This is due to, among other things, "the view held by a number of states… that the polluter pays principle is applicable at the domestic level but does not govern relations or responsibilities between states at the international level" (Sands and Peel 2012: 229).[16]

The polluter pays principle is likewise not strongly operationalized in multilateral environmental treaties. I found seventeen regional environmental agreements that are in force and invoke the principle. Most of these are European and are promulgated by either the Organisation for Economic Co-operation and Development, the UN Economic Commission for Europe, or the European Union. Roughly half of these treaties cite the polluter pays principle only in their nonbinding preambles. Among the other agreements, the obligatory provisions that contain the principle either do not specify whether to operationalize it internationally or only domestically, or they provide that states are obligated to be merely *guided* by the principle in their implementation of the agreement and development of other environmental policies.

Furthermore, there are numerous instances in which states have made international agreements contrary to the polluter pays principle.[17] In fact, Scott Barrett argues that "Payment by the victim-state is not the exception. It is rather the rule" (Barrett 2003: 130). As a first counterexample, he cites the Rhine River, where the downstream Netherlands

[15] The Stockholm Convention on Persistent Organic Pollutants, a global agreement, reaffirmed the Rio Declaration's statement of the principle. Convention on Persistent Organic Pollutants, Stockholm, May 22, 2001, in force May 17, 2004, Available at http://chm.pops.int/Portals/0/download.aspx?d=UNEP-POPS-COP-CONVTEXT-2009.En.pdf. Preamble paragraph 17.

[16] At states' request, the International Law Commission explicitly excluded consideration of the polluter pays principle in its development of Draft Guidelines on the Protection of the Atmosphere (International Law Commission 2018 Guideline 2.2; see Sand 2017: 206–207).

[17] Environmental policies that are contrary to the polluter pays principle also continue to occur domestically. For example, subsidies for zero carbon and renewable energy, insulation, or more environmentally friendly equipment are payments to polluters.

disproportionately paid for upstream Germany and especially France to reduce their salt pollution (see Dieperink 2011). A second counterexample is the joint implementation of greenhouse gas emissions reductions, such as in the UNFCCC and its Kyoto Protocol.[18] There, states with obligations to reduce emissions can pay other states—including those without obligations—to reduce their emissions. Effectively, some polluters are paid to stop polluting. Third, in debt-for-nature swaps, states relieve the debt of other states—a type of payment—in exchange for the latter to agree to not engage in environmentally destructive practices (Knicley 2012). Fourth, industrialized countries sometimes pay developing ones to preserve ecosystems. Such "payments for ecosystem services" amount to paying the state that has been destroying valuable ecosystems to stop doing so (Davidson 2012).[19]

Not only do states frequently not grant environmental sovereignty rights to recipient states, but they also consistently reject state liability for environmental harm, a key feature of an operationalized polluter pays principle. The International Law Commission (ILC) had to abandon efforts toward establishing liability because "few governments, in whatever context, have shown any enthusiasm for accepting that no-fault liability for damage caused by activities within their jurisdiction should fall on states themselves" (Birnie et al. 2009: 223). Even the ILC's more modest suggestion that states ensure access to justice for civil liability is limited to draft principles, not articles. There, strict civil liability for hazardous activities is merely recommended. Moreover, only three international legal regimes (those for nuclear accidents, the maritime transport of oil, and space activities) provide for liability for transboundary environmental harm, and numerous multilateral environmental agreements that would have established liability failed to attract sufficient participation to come into effect.

Is states' rejection of an international polluter pays principle supported by economic analysis? The ILC claims in its commentary to its Draft Articles on the Prevention of Transboundary Harm from Hazardous Activities that the principle "is conceived as the most efficient means of allocating the cost of pollution prevention and control measures so as to encourage the rational use of scarce resources" (International Law Commission 2001a: 163). However, such a statement is contrary to Cooter's assertion that, in the presence of significant transaction costs, which party should be initially allocated the rights and how they should be protected depend upon the specific problem at hand. Although source liability is often relatively efficient in the domestic context, with few sources with greater knowledge and many recipients with lesser knowledge (Shavell 1984), international environmental harm is structurally different, as described above.

Even though, as noted in the previous section, either the source or recipient state should typically have clear property rights when transaction costs are high, allocating them to the recipient state would be less efficient. This is because Coasian cooperation would collapse in the anarchic international context, in which agreements are consensual and self-enforced and in which pollution is asymmetrical with respect to source and recipient. Suppose that, in a recipient states' initial entitlement, the source state values its environmentally harmful activity more than the recipient values its clean environment and it offers the latter a side

[18] United Nations Framework Convention on Climate Change, May 9, 1992, in force March 21, 1994, Article 4.2(a). Available at https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf; Kyoto Protocol to the United Nations Framework Convention on Climate Change, December 10, 1997, in force February 16, 2005, Articles 3.1, 12. Available at https://unfccc.int/sites/default/files/kpeng.pdf.

[19] These policies in which the state that pollutes or engages in an otherwise environmentally harmful practice can be particularly problematic by creating perverse incentives to increase the harmful behavior to be eligible for more payments (Wiener 1999: 755–757).

payment for permission to pollute. If the recipient state rejects the offer, then the source state could simply engage in the activity and the recipient state would have no genuine recourse to stop it. Knowing this, the source state has little incentive to cooperate. To be relatively efficient, recipient states' environmental sovereignty rights would require a centralized enforcer of rules and—especially if protected through liability—an arbitrator of disputes that can issue binding decisions, both of which the international order lacks. In other words, the international context is structurally different from the domestic one due to greater transaction costs, the most important of which is the lack of a supranational authority to determine fault, causation, and harm and to secure payment of damages. Indeed, in their classic environmental policy text, economists William Baumol and Wallace Oates assert that "the Polluter-Pays-Principle is more likely to constitute reason for delay and evasion than for an effective program to control transnational pollution" (Baumol and Oates 1988: 283; see also d'Arge and Kneese 1980: 441; Mabey et al. 1997: 12; Wiener 1999: 752; Mamlyuk 2009: 47).

An initial entitlement of recipient states' environmental sovereignty rights would be especially inefficient in cases of many source states. Suppose that multiple states wish to undertake or approve an activity that would provide net benefits, despite harming one or more other states' environments. Under a regime of recipient states' rights protected by a property rule, the source states would need to collectively negotiate the ex ante permission of the potentially affected states. The source states would each try to capture a maximal share of the social surplus, causing a holdout problem. Alternatively, if such rights were protected by a liability rule, then a recipient state would need to attribute and allocate the harm to specific source states, a complex challenging process. In fact, such environmental problems with many source states (as well as many recipients) have become increasingly salient in recent decades. These include overfishing of the high seas, stratospheric ozone depletion, and especially anthropogenic climate change (Barrett and Stavins 2003). Notably, the multilateral environmental agreements that govern these environmental problems do not refer to the polluter pays principle.

To summarize, although states and others often speak of the polluter pays principle—which would amount to recipient states' environmental sovereignty rights enforced by a liability rule—in practice, it is only weakly operationalized. Indeed, states regularly reject both recipient states' environmental sovereignty rights and state liability for transboundary environmental harm. From an economic perspective, this is appropriate due to the international context's greater transaction costs, most importantly the lack of a supranational authority. This is even more so among the increasingly important environmental problems with many source states. Ultimately, recipient states' environmental sovereignty rights, whether through the polluter pays principle or otherwise, have never been nor should be the initial entitlement.

6 Mixed environmental sovereignty rights: prevention of transboundary harm and equitable use of shared natural resources

The final possible initial entitlements of environmental sovereignty rights are contained in a pair of complementary doctrines. This entitlement entitles neither source nor recipient states to absolute environmental sovereignty but instead provides for a mixture of rights and duties for each.

One part of this pair is states' obligation to reduce and prevent transboundary harm. Legally, this is based upon a general principle and a related customary rule of international

law. The prevention principle states that states should prevent environmental harm instead of later remediating or compensating for it. Its international origin was the *Trail Smelter* arbitration between the USA and Canada in the early twentieth century.[20] The prevention principle was internationally formalized in the 1972 Stockholm Declaration and the 1992 Rio Declaration, the latter of which says that

> States have … the sovereign right to exploit their own resources… and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[21]

This principle is operationalized in the customary international law of transboundary harm, in which states have a duty to take steps to prevent, reduce, and control risks of significant transboundary harm, with a due diligence standard. Specifically, according to the ILC, they should perform environmental impact assessments as well as notify, consult with, and negotiate with potentially affected states (International Law Commission 2001a). In 1996, the ICJ recognized states' obligation "to ensure that activities within their jurisdiction and control respect the environment of other States" as a tenet of customary international law.[22] In other words, the recipient state has a right to preventative procedures that the source state is obligated to carry out. Presuming that the latter does so, then the source state implicitly has a limited right to cause transboundary harm grounded in its sovereign right to exploit its resources.

The other doctrine in this pair is the equitable utilization of shared natural resources, in which a state may exploit such a resource as long as this does not unreasonably interfere with the other states' rights to do so. Although this has not been clearly promulgated in a single international legal instrument, it is consistently operationalized in diverse agreements, including those concerning rivers, (semi)enclosed seas, fisheries, migratory species, ecosystems, airsheds, aquifers, oil and gas deposits, and electromagnetic spectra.[23] The shared natural resource with the most well-developed international law is transboundary watercourses, whose equitable utilization can be traced to at least the 1929 *River Oder* decision. In this, the Permanent Court of International Justice ruled that a navigable river "becomes the basis of a common legal right, the essential features of which are the perfect equality of all riparian States in the use of the whole course of the river and the exclusion of any preferential privilege of any one riparian State in relation to the others."[24] More important for the environmental questions at hand are the non-navigable uses of transboundary watercourses, whose international legal regime has been more recently developed through treaties and state practice (Dellapenna 2001; Salman 2007). Indeed, the equitable use of

[20] *Trail Smelter Arbitration (USA vs. Canada)* (1938 and 1941) 3 *RIAA* 1905.

[21] Stockholm Declaration on the Human–Environment, UN Doc. A/CONF.14/48/Rev. 1, June 16, 1972. Available at http://www.un-documents.net/unchedec.htm, Principle 21; Rio Declaration on Environment and Development, in *Report of the UN Conference on Environment and Development, Rio de Janeiro, June 3–14, 1992*, UN Doc A/CONF.151/26 (Vol I), August 12, 1992, available at http://www.unesco.org/education/pdf/RIO_E.PDF, Principle 2.

[22] *Nuclear Weapons*, Advisory Opinion, July 8, 1996, *ICJ Reports* (1996), paragraph 29. See also *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgment, April 20, 2010, *ICJ Reports* (2010), p. 14.

[23] The additional term "reasonably" is often, but not always, used as well. For brevity, this article uses "equitably" to include "reasonably," as appropriate. See Castillo-Laborde (2010).

[24] *Territorial Jurisdiction of the International Commission of the River Oder Case*, Judgment, September 10, 1929, *PCIJ Ser. A*, No. 23 (1929), p. 28.

transboundary watercourses for non-navigable purposes is arguably now customary international law, having been endorsed by the ILC, the ICJ, and the UN General Assembly.[25] The former characterized it as having "a view to attaining optimal utilization thereof, and benefits therefrom consistent with adequate protection of the watercourse" coupled with an obligation to cooperate with other riparian states in the development and protection of the watercourse (International Law Commission 1994: Article 5.1). Nevertheless, its precise contours remain unclear.[26] In other words, the source state has a limited right to use the shared natural resource and an obligation to take recipients' rights and interests into account, whereas the recipient state has a right to have its rights and interests taken into account and an obligation to allow the use of the resource.

Because the prevention of transboundary harm (in relation to states' right to exploit their natural resources) and the equitable use of shared natural resources are consistently supported by legal theory and state practice, they represent the present initial entitlement of environmental sovereignty rights. Furthermore, they are complementary in that they govern different activities. The prevention of transboundary harm is applicable to actions—often discrete ones—that pose a chance of future transboundary harm, and it can be effectively operationalized among a small number of states. Equitable use concerns continuous actions that inevitably cause transboundary harm through the resources' depletion, and it can be implemented among many states.

Economically, this pair of rights-allocating doctrines appears more efficient than the other initial entitlements. This is because one cannot say ex ante whether source states consistently place greater value on their harmful activities or whether recipient states do so with respect to their clean environment. Furthermore, developments in international governance, technology, and economic interdependence have lowered transaction costs enough that an absolute entitlement to either the source or recipient state is no longer justified. These mixed conditions suggest that international law should give some environmental sovereignty rights—as well as concomitant obligations—to each party while also reducing transaction costs. This is roughly what this pair of doctrines does.

In fact, the language used by the ILC and other bodies has an implicit logic of economic efficiency. The customary international law of prevention gives source states the right to conduct activities that pose a risk of transboundary environmental harm unless the likely harm would excessively decrease the recipient's welfare.[27] The source state's procedural obligations take the interests—that is, the welfare—of the recipient state into account and reduce transaction costs through mandatory notification, impact assessment, consultation, and negotiation. According to the ILC, the actual steps to be taken to prevent and reduce the harm are to be based upon an "equitable balance of interests," considering factors that include:

> The degree of risk of significant transboundary harm and of the availability of means of preventing such harm, or minimizing the risk thereof or repairing the harm;

[25] International Law Commission (1994); *Gabčikovo-Nagymaros Project (Hungary v. Slovakia)*, Judgment, September 25, 1997, *ICJ Reports* (1997), paragraphs 78, 85; UN General Assembly Resolution A/51/229, of May 21, 1997, on the Convention on the Law of the Non-navigational Uses of International Watercourses, Article 5. Available at http://www.un.org/documents/ga/res/51/ares51-229.htm. See also International Law Commission (2008).

[26] *Nuclear Weapons*, Advisory Opinion, July 8, 1996, *ICJ Reports* (1996), paragraph 29. See also *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgment, April 20, 2010, *ICJ Reports* (2010), p. 14.

[27] That it, it would be a Kaldor–Hicks loss.

> The importance of the activity, taking into account its overall advantages of a social, economic and technical character for the State of origin in relation to the potential harm for the State likely to be affected;…
> The economic viability of the activity in relation to the costs of prevention and to the possibility of carrying out the activity elsewhere or by other means or replacing it with an alternative activity. (International Law Commission 2001a: Article 10).

These provisions seek to increase welfare by considering the costs and benefits of the activity, the prevention and reduction of harm, and alternatives.

The equitable utilization of shared natural resources likewise entails an implicitly economic logic. The core tenet is that the source state has the right to exploit a shared resource unless this would unreasonably interfere with the recipient's equivalent right. Here, "unreasonably" could be interpreted as likely causing harm to the recipient that would exceed the source state's benefit. In other words, reasonable implies welfare-increasing (Posner 1984: 134). In the well-defined case of the non-navigable uses of transboundary watercourses, the ILC, the International Law Association, and the UN Convention on the Law of Non-Navigational Uses of International Watercourses[28] concur that the factors to consider when determining equitable utilization include:

> The social and economic needs of the watercourse States concerned;
> The population dependent on the watercourse in each watercourse State;
> The effects of the use or uses of the watercourse in one watercourse State on other watercourse States;
> Existing and potential uses of the watercourse;
> Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
> The availability of alternatives, of corresponding value, to a particular planned or existing use. (International Law Commission 1994: Article 6.1; International Law Association 2004: Article 6.1)

These factors seek to balance the costs and benefits of utilization for all parties. That is, they strive for efficiency.

7 Protection of environmental sovereignty rights

This article's final question asks how environmental sovereignty rights are protected: by property rules, by liability rules, or by administration, each of which are considered here in turn. Recall that an actor may not infringe upon a right that is protected by a property rule in the absence of the right holder's prior permission, and if he or she does, a court can enjoin the infringing action. I also noted above that the existence of international negotiation and agreements implies that states recognize that they should obtain permission before infringing on others' sovereignty rights. However, property rules are generally not used to protect environmental sovereignty rights. Due to the lack of a centralized maker, enforcer,

[28] Convention on the Law of Non-Navigational Uses of International Watercourses, May 21, 1997, in force August 17, 2014. Available at http://legal.un.org/ilc/texts/instruments/english/conventions/8_3_1997.pdf. Although the Convention provides that riparian parties shall "take all appropriate measures to prevent the causing of significant harm to other watercourse States" (Article 7), this passage was particularly controversial (McCaffrey 1998).

and binding arbitrator of international law, states cannot rely on a court for injunctive relief. One could point to the ICJ, where the logic and language of property rights and protection by injunction have been used. For example, Australia and New Zealand pleaded before the ICJ that the radioactive fallout from France's nuclear testing was "trespass."[29] Although the ICJ does not explicitly grant injunctions, some legal scholars argue that its demands that states take effective steps to comply with their international obligations are injunctive in effect (Birnie et al. 2009: 228; Crawford 2012:354). Yet such judicial injunctions remain too rare in international law and especially in the environmental domain to consider them essential to protecting sovereignty rights. Regardless, states must still consent to contentious cases at the ICJ and other international judicial bodies, whose awarded damages cannot be enforced by the implicit threat of force that is present in domestic contexts. Moreover, as noted, transboundary harm is asymmetrical, in that a source state can choose to cause it (or a risk thereof) but a recipient state cannot choose to be free of it. Thus, in the absence of a centralized international authority, transboundary harm does not lend itself to a property rule. A prohibition on transboundary harm without due diligence and without the recipient state's permission has little operative logic when the source could simply choose to cause the harm.

Liability rules are used little in the international context, also due to states' reluctance to grant authority to supranational courts. This is evident in both legal doctrine and state practice. As described above, the customary international law of responsibility provides that states are to make full reparations—including through restitution and compensation—for transboundary harm that results from their acts that are contrary to international law. This resembles the protection of sovereignty rights through liability with a negligence defense. To the extent that international law's standards approach efficient duties of care, in which the marginal cost of precaution equals the marginal reduction in expected harm from the action, then such an enforcement mechanism could increase states' welfares by inducing optimal levels of activity and precaution.[30] Such a liability rule could—in principle—be coupled with the doctrines of the prevention of transboundary harm and the equitable use of shared natural resources. However, international tribunals rarely award compensation, especially for environmental harm.[31]

As noted, for the most part, states do not rely on international administration to manage sovereignty rights, and the environment is no exception. They have not chosen to administer global commons such as the atmosphere and the high seas (e.g., Barnes et al. 2008). There are only a few cases of international environmental administration, the clearest being the International Seabed Authority's governance of the rights to minerals in seabed beyond the limits of national jurisdiction.[32] Another is how states' right to emit ozone depleting substances is, in a way, administered by the parties to the Montreal Protocol, which can

[29] The court did not consider this claim in any depth. *Nuclear Tests Cases (Australia v. France)*, Interim Measures, June 22, 1973, *ICJ Reports* (1973), paragraph 101.

[30] Because perfect interpersonal—in this case, interstate—welfare comparisons are impossible, this can be stated more precisely in Kaldor–Hicks terms: efficient duties of care are those in which the source state's marginal cost of precaution equals the recipient state's marginal willingness to pay for the source state to take precaution.

[31] But see *Certain Activities (Costa Rica vs. Nicaragua)*, Compensation, February 2, 2018. Available at http://www.icj-cij.org/files/case-related/150/150-20180202-JUD-01-00-EN.pdf.

[32] United Nations Convention on the Law of the Sea, December 10, 1982, in force November 16, 1994, Articles 133–191. Available at http://www.un.org/Depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

adopt regulatory measures without all states' consent.[33] The prohibition on claims of sovereignty over outer space and the moratorium on Antarctic mineral extraction resemble administration, in that states could have such sovereignty rights if the respective agreements' parties were to collectively agree on granting them (Sprankling 2011).[34] Notably, each of these examples, as well as that of geostationary satellites given above, pertains to new sovereignty rights that became available due to technological change. Future novel environmental sovereignty rights that arise due to emerging technologies, such as intentionally altering the global climate through solar geoengineering, might be managed through administration (Reynolds 2019).

In the absence of centralized enforcement of international law, neither property rules, liability rules, nor administration consistently protects environmental sovereignty rights. Although this appears to leave no clear answer, considering how states can *themselves* protect their sovereignty rights is revealing. When one state violates another's sovereignty rights, the recipient or otherwise harmed state can ex post respond in three ways (Guzman 2008). First, in reciprocation, the recipient undertakes the same harmful action, directing the impact back at the source. This can be effective in some, but not all, environmental contexts, such as the use of a natural resource that is shared by two states. Second, in retaliation, the recipient undertakes a punitive action—usually one that is costly to the retaliating state—in another issue area. If the recipient state can identify an issue area in which it has some leverage over the source state, then this mechanism can be effective in many environmental contexts. Third, a source state can suffer reputational damage and find it more difficult to achieve potentially beneficial international cooperation in the future. To further this, the recipient state can "name and shame" the source.

These three mechanisms resemble liability in that a source state "may"—in a broad sense of the word—infringe upon recipients' environmental sovereignty rights, but it will be aware that it might consequently need to "pay" ex post for any incurred harm. The source state can consider the probability and expected magnitude of these costs when it decides whether to proceed. To the extents that these quasi-liability damages are actually "awarded" in the event of harm, that their value is close to the recipient state's harm, and that they are not simply a deadweight loss, these mechanisms can increase efficiency. However, these criteria are clearly not always satisfied in the international context. The extent to which they are is an interesting theoretical and empirical question.

8 Conclusion

This article's three questions can now be answered. The contemporary initial entitlement of environmental sovereignty rights is a hybrid regime in which both source and recipient states have rights and obligations that are based on the prevention of transboundary harm and the equitable use of shared natural resources. This initial entitlement is more efficient

[33] Montreal Protocol on Substances That Deplete the Ozone Layer, September 16, 1987, in force January 1, 1989. Available at https://treaties.un.org/doc/Treaties/1989/01/19890101%2003-25%20AM/Ch_XXVII_02_ap.pdf.

[34] Moreover, the Antarctic moratorium agreement was a response to the failure of a previous proposal for an administrative body. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, December 19, 1966, in force October 10, 1967, Art. II. Available at http://www.unoosa.org/pdf/publications/STSPACE11E.pdf. Protocol on Environmental Protection to the Antarctic Treaty, October 4, 1991, in force January 14, 1998, Articles 7, 25. Available at https://www.ats.aq/documents/recatt/Att006_e.pdf.

than the other possibilities in international environmental law and its scholarship that are discussed here. These environmental sovereignty rights, much like other sovereignty rights, are protected mostly through the quasi-liability mechanisms of reciprocation, retaliation, and reputation, although in some specific cases, more "typical" property rules, liability rules, and administration are evident.

The analysis presented here of the polluter pays principle may be of particular interest to scholars of international environmental law, among whom the principle seems popular (e.g., de Sadeleer 2002). Yet states do not internationally operationalize the polluter pays principle, and an economic analysis helps explain why not.

Scholars of the economic analysis of law should not be surprised. Richard Posner argues that case law in common law jurisdictions evolves toward welfare maximization and efficiency due to judges' (often subconscious) economic logic. Customary international law might exhibit a similar tendency due to implicit economic logic of state practice.

This analysis also has implications for the Coase theorem, which is central to the economic analysis of law. As noted, because transaction costs in international negotiation are substantial, welfare-improving exchanges often do not occur. These high costs are due to sovereignty rights' unclear definitions, which in turn is a consequence of a lack of a central lawmaker; the large requisite effort to reach, implement, and monitor potential exchanges; small numbers—even only one—of potential "sellers" and "buyers," leading to monopoly, monopsony, bilateral monopoly, and strategic bargaining; alternatively, numerous "sellers" whose unanimous agreement is necessary, giving rise to holdouts; states' unwillingness to "unbundle" sovereignty rights and to make financial side payments, causing inefficient barter; and the absence of a central enforcer of agreements and resolver of disputes. As a consequence, the initial allocation of property rights in the international case *does* affect both the outcome and actors' ultimate welfare. In such a setting, the Coase theorem does not hold, although this case does not contravene it.

I recognize a risk of circular reasoning here. If states act to increase their welfare, if custom is based largely on state practice, and if the initial entitlement of sovereignty rights is given in customary international law, then the initial entitlement will necessarily tend to be relatively efficient. However, the analysis offers something to scholars of both international law and of the economic analysis of law. For the former, it indicates that international law in general follows an economic logic and that customary international law specifically might develop predictably and explains why some general principles do not coalesce into binding custom. For economic analysts, it adds to the case that international environmental law resembles domestic property law and, as such, warrants some of their further attention.

Acknowledgements The author thanks the attendees of the Ius Commune Conference, November 23–24, 2017, Utrecht, The Netherlands and the participants of the Tenth Annual Meeting of the Society for Environmental Law and Economics, June 15–16, 2018, Chicago, Illinois, USA, for their feedback, and especially Dan Cole, Jonathan Wiener, and Yael Lifshitz for their specific comments at the latter. He is also grateful for the comments of two anonymous reviewers. The author sincerely thanks the Open Philanthropy Project for its support of his work.

References

Barnes, R. (2009). *Property rights and natural resources*. Oxford: Hart Publishing.

Barnes, P., Costanza, R., Hawken, P., Orr, D., Ostrom, E., et al. (2008). Creating an Earth atmospheric trust. *Science, 319*(5864), 724. https://doi.org/10.1126/science.319.5864.724b.

Barrett, S. (1997). The strategy of trade sanctions in international environmental agreements. *Resource and Energy Economics, 19*(4), 345–361. https://doi.org/10.1016/S0928-7655(97)00016-X.

Barrett, S. (2003). *Environment and statecraft: The strategy of environmental treaty-making*. Oxford: Oxford University Press.

Barrett, S., & Stavins, R. (2003). Increasing participation and compliance in international climate change agreements. *International Environmental Agreements, 3*(4), 349–376. https://doi.org/10.1023/b:Inea.0000005767.67689.28.

Baumol, W. J., & Oates, W. E. (1988). *The theory of environmental policy*. Cambridge: Cambridge University Press.

Birnie, P. W., Boyle, A., & Redgwell, C. (2009). *International law and the environment*. Oxford: Oxford University Press.

Blocher, J., & Gulati, M. (2017). A market for sovereign control. *Duke Law Journal, 66*(4), 797–843.

Calabresi, G., & Melamed, A. D. (1972). Property rules, liability rules, and inalienability: One view of the cathedral. *Harvard Law Review, 85*(6), 1089–1128.

Coase, R. H. (1960). The problem of social cost. *Journal of Law and Economics, 3,* 1–44.

Cole, D. H. (2011). Property creation by regulation: Rights to clean air and rights to pollute. In D. H. Cole & E. Ostrom (Eds.), *Property in land and other resources* (pp. 125–154). Cambridge, MA: Lincoln Institute of Land Policy.

Cooley, A. (2000). Imperial wreckage: Property rights, sovereignty, and security in the post-Soviet space. *International Security, 25*(3), 100–127. https://doi.org/10.1162/016228800560534.

Cooter, R. (1982). The cost of Coase. *The Journal of Legal Studies, 11*(1), 1–33.

Cooter, R. B., & Ulen, T. (2011). *Law and economics* (6th ed.). Boston: Addison-Wesley.

Crawford, J. (2012). *Brownlie's principles of public international law* (8th ed.). Oxford: Oxford University Press.

d'Arge, R. C., & Kneese, A. V. (1980). State liability for international environmental degradation: An economic perspective. *Natural Resources Journal, 20*(3), 427–450.

Davidson, M. D. (2012). Distributive justice in the international regulation of global ecosystem services. *Global Environmental Change, 22*(4), 852–861. https://doi.org/10.1016/j.gloenvcha.2012.06.004.

De Mot, J., Fon, V., & Parisi, F. (2017). Customary international law. In F. Parisi (Ed.), *Production of legal rules (Encyclopedia of law and economics)* (2nd ed., pp. 293–308). Cheltenham: Edward Elgar. https://doi.org/10.4337/9781782540519.00025.

de Sadeleer, N. (2002). *Environmental principles: From political slogans to legal rules*. Oxford: Oxford University Press.

del Castillo-Laborde, L. (2010). Equitable utilization of shared resources. In R. Wolfrum (Ed.), *The Max Planck encyclopedia of public international law* (2nd ed.). Oxford: Oxford University Press.

Dellapenna, J. W. (2001). The customary international law of transboundary fresh waters. *International Journal of Global Environmental Issues, 1*(3–4), 264–305. https://doi.org/10.1504/IJGENVI.2001.000981.

Dieperink, C. (2011). International water negotiations under asymmetry, lessons from the Rhine chlorides dispute settlement (1931–2004). *International Environmental Agreements: Politics, Law and Economics, 11*(2), 139–157. https://doi.org/10.1007/s10784-010-9129-3.

Guzman, A. T. (2008). *How international law works: A rational choice theory*. Oxford: Oxford University Press.

Henry, L. A., & McIntosh Sundstrom, L. (2007). Russia and the Kyoto Protocol: Seeking an alignment of interests and image. *Global Environmental Politics, 7*(4), 47–69. https://doi.org/10.1162/glep.2007.7.4.47.

Holland, T. E. (1924). *The elements of jurisprudence* (Thirteenth ed.). Oxford: Clarendon Press.

International Law Association. (2004). Berlin rules on water resources. In A. H. A. Soons & C. Ward (Eds.), *International Law Association, report of the seventy-first conference, Berlin, 2004* (pp. 334–480). London: International Law Association.

International Law Commission. (1994). Draft articles on the law of the non-navigational uses of international watercourses and commentaries thereto and resolution on transboundary confined groundwater. In *Report of the International Law Commission on the work of its 46th session, UN Doc A/49/10* (pp. 89 –135). New York: United Nations.

International Law Commission. (2001a). Draft articles on prevention of transboundary harm from hazardous activities. In *Report of the International Law Commission on the work of its fifty-third session, UN Doc A/56/10* (pp. 146–170). New York: United Nations.

International Law Commission. (2001b). Draft articles on responsibility of states for internationally wrongful acts. In *Report of the International Law Commission on the work of its fifty-third session, UN Doc A/56/10* (pp. 26–143). New York: United Nations.

International Law Commission. (2008). Draft articles on the law of transboundary aquifers. In *Report of the International Law Commission, sixtieth session, UN Doc A/63/10* (pp. 19–79). New York: United Nations.

International Law Commission. (2018). Text of the draft guidelines on the protection of the atmosphere, together with preamble, adopted by the Commission on first reading. In *Report of the International Law Commission, seventieth session, UN Doc A/73/10* (pp. 158–200). New York: United Nations.

Knicley, J. E. (2012). Debt, nature, and indigenous rights: Twenty-five years of debt-for-nature evolution. *Harvard Environmental Law Review, 36*(1), 79–122.

Lauterpacht, H. (1927). *Private law sources and analogies of international law: With special reference to international arbitration*. London: Longmans, Green, and Co.

Livermore, M. A., & Revesz, R. L. (2014). Environmental law and economics. In F. Parisi (Ed.), *The Oxford handbook of law and economics (Private and commercial law)* (Vol. 2, pp. 509–542). Oxford: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199684205.013.43.

Mabey, N., Hall, S., Smith, C., & Gupta, S. (1997). *Argument in the greenhouse: The international economics of controlling global warming*. London: Routledge.

Mamlyuk, B. N. (2009). Analyzing the polluter pays principle through law and economics. *Southeastern Environmental Law Journal, 18*(1), 39–79.

McCaffrey, S. (1998). The UN convention on the law of the non-navigational uses of international watercourses: Prospects and pitfalls. World Bank Technical Paper (pp. 17–28).

Posner, R. A. (1984). Wealth maximization and judicial decision-making. *International Review of Law and Economics, 4*(2), 131–135. https://doi.org/10.1016/0144-8188(84)90002-4.

Posner, E. A., & Sykes, A. O. (2013). *Economic foundations of international law*. Cambridge, MA: Belknap.

Reynolds, J. L. (2019). *The governance of solar geoengineering: Managing climate change in the Anthropocene*. Cambridge: Cambridge University Press.

Salman, S. M. A. (2007). The Helsinki rules, the UN Watercourses Convention and the Berlin rules: Perspectives on international water law. *Water Resources Development, 23*(4), 625–640. https://doi.org/10.1080/07900620701488562.

Sand, P. H. (2017). The discourse on 'protection of the atmosphere' in the International Law Commission. *Review of European, Comparative & International Environmental Law, 26*(3), 201–209. https://doi.org/10.1111/reel.12212.

Sands, P., & Peel, J. (2012). *Principles of international environmental law* (3rd edn.). Cambridge: Cambridge University Press.

Scott, R. E., & Stephan, P. B. (2006). *The limits of leviathan: Contract theory and the enforcement of international law*. Cambridge: Cambridge University Press.

Shavell, S. (1984). Liability for harm versus regulation of safety. *Journal of Legal Studies, 13*(2), 357–374.

Sprankling, J. G. (2011). The emergence of international property law. *North Carolina Law Review, 90*(2), 461–509.

Trachtman, J. P. (2008). *The economic structure of international law*. Cambridge, MA: Harvard University Press.

Wiener, J. B. (1999). Global environmental regulation: Instrument choice in legal context. *Yale Law Journal, 108*(4), 677–800.