A SKETCH OF ECOLOGICAL PROPERTY: TOWARD A LAW OF BIOGEOCHEMICAL CYCLES

BY

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We are already seeing the combined effects of a global bundle of ecological catastrophes: not only climate change, but also ocean acidification, mass extinctions, habitat losses, and different types of chemical pollution. Legal adaptation to the unfolding ecological catastrophes has so far been public law–focused: mostly international law and administrative/environmental law. We can now say leaving ecological adaptation to domestic and international public law has not brought the required results, and it is time to "ecologize" property law at the very least. But how can this be done?

The way to make property law ecologically responsive is to change the basic building blocks of property rights. Instead of imaginary containers made up of invisible lines on the ground, property would be maintained and calculated as shares of the basic biogeochemical cycles that sustain all life on Earth (the carbon cycle, the water cycle, the nitrogen cycle). The first principles of property should be the collective responsibility to maintain existing biogeochemical cycles as cycles, and not create new poisonous cycles such as the dioxin cycle, the methylmercury cycle, or the microplastics cycle. Further basic principles would include limited alienability, cyclical trade, and staggered ownership of resources. These principles would both make property ecologically responsive and maintain it as a workable system of entitlements and free-market exchanges. Such a system is not only possible, but also has strong examples and antecedents within the common law as well as statutory and international regulatory systems.

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> *If water were our chief symbol for property, we might think of property rights—and perhaps other rights—in a quite different way. We might think of rights literally and figuratively as more fluid and less fenced-in; we might think of property as entailing less of the awesome Blackstonian power of exclusion and more of the qualities of flexibility, reasonableness and moderation, attentiveness to others, and cooperative solutions to common problems.*
>
> Carol M. Rose[1]

[1] Carol M. Rose, *Property as the Keystone Right?*, 71 NOTRE DAME L. REV. 329, 351 (1996).

The highest Excellence is like water.
Water, Excellent at being of benefit
to the thousands of things,
does not contend—
it settles in places everyone else avoids.
Yes, it is just about Tao.

Lao Tzu[2]

I. INTRODUCTION: ECOLOGICAL CATASTROPHE AND THE LACK OF AN ADEQUATE LEGAL RESPONSE

It is almost unnecessary to restate the critical condition the natural environment is currently in. Climate systems are in disequilibrium:[3] "once-in-a-century" cataclysms have become annual events,[4] global sea levels are rising,[5] and species of wildlife are going extinct at rates unprecedented in dozens, of millions of years.[6] Meanwhile oceans and freshwaters alike are being flooded with fertilizers, heavy metals, and plastics.[7] If more than a few pockets of the Earth are to be left habitable, urgent action must be taken by all. Climate scientists are in agreement:

> Ultimately, the transformations necessary to achieve the Stabilized Earth pathway require a fundamental reorientation and restructuring of national and international institutions toward more effective governance at the Earth System level, with a much stronger emphasis on planetary concerns

[2] Lao Tzu, *Tao Te Ching*, *in* THE TAO OF THE TAO TE CHING: A TRANSLATION AND COMMENTARY 16 (David L. Hall & Roger T. Ames eds., 1992).

[3] *See generally* Jens-Christian Svenning & Brody Sandel, *Disequilibrium Vegetation Dynamics Under FutureClimate Change*, 100 AM. J. BOTANY 1266, 1267 (2013) (covering the definition, causes, and current and future prevalence of climate disequilibrium). *See also* Marcia McNutt, *Time's Up, CO_2*, 365 SCI. 411, 411 (2019) (detailing the disruption to climates globally, as climate change has increased the frequency and severity of extreme weather events).

[4] *See, e.g.*, Doyle Rice, *You Just Lived Through the Warmest Decade on Record—And it's Only Going to Get Hotter*, USA TODAY (Dec. 3, 2019), https://perma.cc/MV4M-W3UZ (noting "once-in-a-century" extreme weather events—like heat waves and floods—have become "more regular occurrences").

[5] *See* Anny Cazenave et al., *Contemporary Sea Level Changes from Satellite Altimetry: What Have We Learned? What are the New Challenges?*, 62 ADVANCES IN SPACE RES. 1639, 1640 (2018) (explaining why global sea levels are rising and how the increases are measured); BRIAN FAGAN, THE ATTACKING OCEAN: THE PAST, PRESENT AND FUTURE OF RISING SEA LEVELS 13 (2013) (predicting a "long-term acceleration of sea level rise").

[6] *See, e.g.*, ELIZABETH KOLBERT, THE SIXTH EXTINCTION: AN UNNATURAL HISTORY 17–18 (2014) (estimating that a quarter of all mammals, a fifth of all reptiles, and a sixth of all birds are headed toward extinction).

[7] *See* Tord Kjellström et al., *Air and Water Pollution: Burden and Strategies for Control*, *in* DISEASE CONTROL PRIORITIES IN DEVELOPING COUNTRIES 817, 820–21 (Dean T. Jamison et al. eds., 2d ed. 2006) (discussing different types of water pollutants and how they occur).

> in economic governance, global trade, investments and finance, and technological development.[8]

Or, in James Gustave Speth's more dramatic words:

> all we have to do to destroy the planet's climate and biota . . . is to keep doing exactly what we are doing today, with no growth in the human population or the world economy. . . . But, of course, human activities are not holding at current levels—they are accelerating, dramatically.[9]

The fate of the natural environment (itself nowhere "natural" anymore if natural is thought of as pristine or untouched by humans)[10] is entwined with the fate of the global economy and political power.[11] It is also dependent upon traditional notions of democracy, property, statehood, personhood, and wealth, which all contribute in some way to the crisis.[12]

What can we do, what should we do—particularly "we" lawyers, legal academics, policymakers, and political thinkers? Of course, we should all reduce our consumption as much as possible and take every opportunity to push ecologically friendly policies. Even more importantly, we should work on just principles for the necessary redistribution of resources that is occurring due to environmental degradation and develop the principles for the (re)creation of an ecologically friendly economy that will not create further environmental crises in a couple of decades down the line. Make no mistake, we are living in the midst of several interrelated environmental crises—climate change and mass extinction are merely the two most pressing ones—and an integrated solution should be most welcome.[13]

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[8] Will Steffen et al., *Trajectories of the Earth System in the Anthropocene*, 115 PNAS 8252, 8257 (2018).

[9] JAMES GUSTAVE SPETH, THE BRIDGE AT THE EDGE OF THE WORLD: CAPITALISM, THE ENVIRONMENT, AND CROSSING FROM CRISIS TO STABILITY, at x (2008).

[10] *Cf.* Paul Crutzen, *The Geology of Mankind*, NATURE, Jan. 3, 2002, at 23 (arguing that anthropogenic emissions of carbon dioxide may have vastly changed the natural environment for generations); Daniel Chernilo, *The Question of the Human in the Anthropocene Debate*, 20 EUR. J. SOC. THEORY 44, 44 (2017) ("[H]umans are now to be considered a major force of nature."); Will Steffen et al., *The Anthropocene: Conceptual and Historical Perspectives*, 369 PHIL. TRANSACTIONS ROYAL SOC'Y A 842, 842–43 (2011) (noting that humans are significantly altering Earth's systems, threatening a "broad range of ecosystem services" across the world).

[11] *See* JEDEDIAH PURDY, AFTER NATURE: A POLITICS FOR THE ANTHROPOCENE 19 (2015).

[12] *See generally* Jedediah Purdy, *American Natures: The Shape of Conflict in Environmental Law*, 36 HARV. ENV'T L. REV. 169 (2012) (outlining different approaches to nature based on the roles that individualism, rationalism, romanticist epiphanies, and other values play in American land politics) [hereinafter *American Natures*]; TIMOTHY MITCHELL, CARBON DEMOCRACY: POLITICAL POWER IN THE AGE OF OIL 12, 19–20, 29, 31–32 (2011) (outlining the development of oil-based economies as an alternative to coal-based economies as part of a global, political push to weaken labor movements).

[13] *See* ANDERS WIJKMAN & JOHAN ROCKSTRÖM, BANKRUPTING NATURE: DENYING OUR PLANETARY BOUNDARIES 2 (rev. ed. 2012) (urging a comprehensive solution that evaluates the flawed relationship between humanity and nature through the organization of the economic, political, and educational systems); Johan Rockström et al., *Planetary Boundaries:*

Developing environmental law without integrating it with other branches of the law will not be enough. Environmental law has certainly proven to be too little to save the Earth so far,[14] due to four major reasons: First, like all centralized administrative laws, environmental law is highly susceptible to industry takeover.[15] Second, even when and where it is efficient, environmental law is still an afterthought to economic concerns, a post-planning regulatory procedure that is a nuisance to developers at best and ineffective box-checking at worst.[16] Third, "[t]he central question of environmental policy is [and has been] 'how much?' How much pollution should we release into the ecosystem? How much timber should we cut from the forests?"[17] The accompanying background assumption is that there is an ideal (or at least ideally efficient) amount of pollution, and that human life without pollution cannot go on.[18] Environmental law therefore aims to minimize pollution but not challenge a system of production built to create waste. Finally, environmental law was designed to affect only industrial players, leaving consumers mostly unregulated and blissfully ignorant of the effects of their actions.[19]

Exploring the Safe Operating Space for Humanity, ECOLOGY & SOC'Y, 2009, https://perma.cc/JW7U-W83P ("Human activities increasingly influence the Earth's climate . . . raising concern that further pressure on the Earth System could destabilize critical biophysical systems . . . at continental to planetary scales."); Will Steffen et al., *Planetary Boundaries: Guiding Human Development on a Changing Planet*, 347 SCI. 736, 736 (2015) (identifying the framework of planetary boundaries that are necessary for sustaining earth systems).

14 Louis J. Kotzé, *Earth System Law for the Anthropocene*, SUSTAINABILITY, Nov. 2019, at 2 ("[R]ecent studies suggest that international environmental law has failed to address the ever-deepening socio-ecological crisis of the Anthropocene, and that it even might have contributed to causing and exacerbating it.").

15 *See, e.g.*, MARY CHRISTINA WOOD, NATURE'S TRUST: ENVIRONMENTAL LAW FOR A NEW ECOLOGICAL AGE 68–83 (2014) (exploring how politics and inappropriate bias can enter through rule-making, technical determinations, and enforcement choices).

16 Braden R. Allenby, *Industrial Ecology: Governance, Laws and Regulations*, *in* A HANDBOOK OF INDUSTRIAL ECOLOGY 60, 60 (Robert U. Ayres & Leslie W. Ayres eds., 2002) ("As overhead, environment was essentially an afterthought, to be taken care of once the core activity, whether it was producing widgets in the firm, or carrying out national security policy as a nation state, was already done.").

17 Amy Sinden, *The Tragedy of the Commons and the Myth of a Private Property Solution*, 78 U. COLO. L. REV. 533, 534 (2007).

18 *See* WILLIAM F. BAXTER, PEOPLE OR PENGUINS: THE CASE FOR OPTIMAL POLLUTION 8–9 (1974) (arguing the standard of "clean" air and water is a normative one and that tradeoffs must be made between environment and human welfare).

19 James Salzman, *Beyond the Smokestack: Environmental Protection in the Service Economy*, 47 UCLA L. REV. 411, 414 (1999) ("While literally thousands of books and articles have explored the implications of smokestack industries for environmental law and policy, a mere handful have considered the service sector. No legal scholarship has focused on the subject."); James Salzman, *Sustainable Consumption and the Law*, 27 ENV'T L. 1243, 1244 (1997) ("By narrowly focusing on basic pollution issues such as the production and disposal of waste, our laws have largely ignored other significant contributors to environmental harms. Chief among these contributors . . . is consumption.") [hereinafter Salzman, *Sustainable Consumption*].

All of this has to change. An ecologically responsible legal system will have to do much more than regulate the impact of certain industries and ban or limit the emission of certain poisonous materials. "We arguably need a new legal paradigm that must be able to fully respond to the complex physically, reciprocally, and temporally interlinked Earth system."[20] The technicality of environmental law has to be transcended: the basic principles of ecologically responsible governance should be as well-known and well-revered as the basic principles of contracts or constitutional law and just as integrated into everyday life.[21] The assumption of "some pollution is necessary"[22] has to be changed so we can start thinking at least about a zero-emission, zero-pollution, circular economy—the only type of economy that can sustain 7–10 billion people for more than a single century.[23]

One of the bon-mots of current environmentalist writers is "it is easier to imagine the end of the world than the end of capitalism."[24] There is certainly a stark and frightening chasm in the literature on political responses to the impending ecological crisis. The only scholars to treat the severity of environmental collapse seriously enough are anti-capitalist scholars, who often blame a semi-personified "Capital[ism]" for all the ills of current society and have little attention to address legal problems of exchange and production.[25] Without integration into our current systems of private law, the global and national "carbon budgets" created by scientists are impossible to implement unless we resort to a global system of rationing or a "green dictatorship."[26] On the other end of

[20] Kotzé, *supra* note 14, at 5.

[21] *See generally* LOUIS J. KOTZÉ, GLOBAL ENVIRONMENTAL CONSTITUTIONALISM IN THE ANTHROPOCENE 134 (2016) (indicating the importance of environmental law).

[22] BAXTER, *supra* note 18, at 8–9.

[23] Similar approaches have been labeled "Earth-centered law," "Earth systems law," "Anthropocene environmental law," "Earth justice," "planetary boundaries law," and "Lex Anthropocenae." *See* Kotzé, *supra* note 14, at 1, 5–6 (explaining that these names could be more instructive and specific for international environmentalism); Klaus Bosselmann, *Shifting the Legal Paradigm: Earth-Centred Law and Governance*, *in* THE SAFE OPERATING SPACE TREATY: A NEW APPROACH TO MANAGING OUR USE OF THE EARTH SYSTEM 64, 65 (Paulo Magalhães et al. eds., 2016) (discussing how the U.N. is exploring ways to adopt earth-centric criteria).

[24] Usually traced to MARK FISHER, CAPITALIST REALISM: IS THERE NO ALTERNATIVE? 2 (2009).

[25] *See, e.g.*, ANNIE LEONARD, THE STORY OF STUFF: HOW OUR OBSESSION WITH STUFF IS TRASHING THE PLANET, OUR COMMUNITIES, AND OUR HEALTH—AND A VISION FOR CHANGE, at xxi–xxii, xxvi (2010) (critiquing the role of trash in economic growth and the functions of capitalism without discussing supply chain theory or trade policies); NAOMI KLEIN, THIS CHANGES EVERYTHING: CAPITALISM VS. THE CLIMATE 21–22 (2014) (posing climate change as a battle between capitalism and the planet in which "capitalism is winning hands down"); ERNST ULRICH VON WEIZSÄCKER & ANDERS WIJKMAN, COME ON! CAPITALISM, SHORT-TERMISM, POPULATION AND THE DESTRUCTION OF THE PLANET 63–83 (2018) (outlining proposed changes to investment markets, urbanism, and agriculture to avert ecological crises).

[26] *See, e.g.*, Renaud Gignac & H. Damon Matthews, *Allocating a 2° C Cumulative Carbon Budget to Countries*, ENV'T RES. LETTERS, July 10, 2015, at 1, 2, https://perma.cc/58RG-LNV7 (calculating a "global carbon budget" to be allocated between nation-states, adherence to which would avert catastrophic climate change); Corinne Le Quéré et al., *Global Carbon*

the spectrum, technocratic writers propose minor modifications to cap-and-trade programs, taxes, or financial incentives as solutions for the apocalypse.[27] In this second group, the assumptions are that ecological collapse will have a minimal effect on social, economic, and political institutions:[28]

> American weather will curdle to such a degree that Tennessee will become an incubator for malaria, yet Wall Street banks and patent lawyers will saunter along as usual. Rising oceans will submerge coastal financial centers beneath several feet of saltwater, yet commodities markets will pay top dollar for Greenlandic uranium.[29]

The entire legal system—"economic governance, global trade, investments and finance"[30]—has to be "ecologized" to avoid a dystopic future, which means a revision of political philosophy and constitutional theory as well. This "ecologization" of the law will also serve as a much-needed concretization of green political theory, which is unfortunately often too vague to be of guidance.[31] The starting point for the ecologization of law should be property law. In Part II, this Article will argue property law is the appropriate foundation for an ecological legal system because of its global recognition and decentralized enforcement. Property thus

Budget 2017, 10 EARTH SYS. SCI. DATA 407, 407 (2018) (explaining the data sets and methodology to quantify the global carbon budget over time).

[27] *See, e.g.*, Ethan Yale, *Taxing Cap-and-Trade Environmental Regulation*, 37 J. LEGAL STUD. 535, 536 (2008) (concluding that an income tax will not undermine the cost-effectiveness of cap-and-trade regulation but can interfere with the cost-effectiveness of permit allocation); Alice Kaswan, *Decentralizing Cap-and-Trade? State Controls Within a Federal Greenhouse Gas Cap-and-Trade Program*, 28 VA. ENV'T L.J. 343, 346–47 (2010) (describing why states should retain autonomy within a federal cap-and-trade program); Marjan Peeters et al., *A Governance Perspective on the Choice Between "Cap and Trade" and "Credit and Trade" for an Emissions Trading Regime*, 16 EUR. ENV'T L. REV. 191, 195 (2007) (explaining the need for a serious reconsideration of the current cap-and-trade approach while posing the use of a "credit-and-trade approach").

[28] *See* Jesse Barron, *How Big Business is Hedging Against the Apocalypse*, N.Y. TIMES MAG. (Apr. 11, 2019), https://perma.cc/6CUR-DARB (explaining how the financial system continues with "business as usual" given the lack of incentives to worry about climate change).

[29] *Id.*

[30] Steffen et al., *supra* note 8, at 8257.

[31] *See, e.g.*, Daniel Deudney, *Global Village Sovereignty: Intergenerational Sovereign Publics, Federal-Republican Earth Constitutions, and Planetary Identities*, *in* THE GREENING OF SOVEREIGNTY IN WORLD POLITICS 299, 303 (Karen T. Litfin ed., 1998) ("First, sovereignty situated in an intergenerational public provides the basis for a federal-republican Earth constitution. Second, Earth nationality and Gaian Earth religion provides the basis for community and identity necessary to instantiate and maintain this sovereign and the legitimate authorities consistent with it."). Much of what passes as green political philosophy is either this type of vague Earth-centered utopianism, or standard liberal, conservative, communist etc. ideology with a few drops of environmentalism added. *See generally* ROGER SCRUNTON, HOW TO THINK SERIOUSLY ABOUT THE PLANET: THE CASE FOR AN ENVIRONMENTAL CONSERVATISM (2012) (discussing how climate science is filled with political interests and how current climate change remedies are unrealistic).

escapes the problems that have plagued tax law, administrative (environmental) law, and public international law, which have all been unsuccessful in halting ecological catastrophes.[32]

An ecological property law nevertheless has to differ from the current-day common law of property in two key features, as this Article argues in Part III: 1) the right to abandon has to be abolished, and 2) the measure of property should not be arbitrary boundary lines on the ground, but the actual geophysical forces that create and sustain life on Earth—biogeochemical cycles. Part IV provides a primer on three basic biogeochemical cycles, which are in sore need of ecological propertization: the water cycle, the carbon cycle, and the nitrogen cycle.

Parts V and VI set up a number of basic principles for an ecological law of property to deal with the basic question of how a property regime could function and organize a market economy without allowing for individual or collective abandonment of materials. These basic principles include staggered collective ownership of biogeochemical cycles, limited alienability of waste materials, and the overarching obligation to maintain biogeochemical cycles as cycles. Each Part also applies and illustrates these principles, through the example of buying and then disposing of a cup of coffee. Part VII, the conclusion, demonstrates these basic principles are not as alien from current-day property law as they may look at first glance: many similar institutions already exist in property law, including water law and other laws of ownership in flows, extended producer liability for consumer goods, the growing trend to give rights to (living) objects of property, and the obligation to label consumable goods with ingredients.

II. WHY PROPERTY LAW?

So far, lawyers and policymakers have looked to international law and tax law as the starting points for enforcing the "greening" of our global economic system. Both of these approaches have been abject failures, but property law holds the key to an ecologically respectful economic system. Diplomats have gathered every year since the adoption of the U.N. Framework Convention on Climate Change in 1994,[33] to negotiate and sign the Kyoto Protocol in 1997,[34] the Copenhagen Accord in 2009,[35] and the Paris Agreement in 2015.[36] While we cannot yet

[32] *See* discussion *infra* Part II.

[33] United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107 (entered into force Mar. 21, 1994).

[34] Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, 2303 U.N.T.S. 162 (entered into force Feb. 16, 2005).

[35] U.N. Framework Convention on Climate Change, *Report of the Conference of the Parties on its Fifteenth Session, held in Copenhagen from 7 to 9 December 2009*, U.N. Doc. FCCC /CP/2009/11/Add.1, at 4 (Mar. 30, 2010) (taking note of the Copenhagen Accord).

[36] U.N. Framework Convention on Climate Change, *Report of the Conference of the Parties on its Twenty-First Session, held in Paris from 30 to 13 December 2015*, U.N. Doc. FCCC /CP/2015/10/Add.1, at 2 (Jan. 29, 2016) (adopting the Paris Agreement).

pronounce on the Paris Agreement, all previous agreements can uncontroversially be claimed as failures in the attempt to stop the growth of greenhouse gas emissions.[37] Carbon taxes have been an even greater failure: very few jurisdictions have accepted them[38] and what constitutes the right amount—the true social cost of carbon—has been elusive as well.[39]

Property needs to be the starting point for several reasons. Because "[p]roperty is a platform for the rest of private law"[40] and arguably "the keystone right"[41] that is the foundation for most other basic rights.[42] An ecological transformation of property law will bring about a corresponding transformation of contracts, torts, international trade, administrative law, and constitutional law. Without reforming property, any "green" constitutionalism or political philosophy is vacuous. Secondly, property is enmeshed in a system of capitalist private law that incentivizes owners to be good stewards of their properties[43] *and* gives individual owners standing to sue interferers and interlopers in tort.[44]

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[37] *See, e.g.*, Ole Rogeberg et al., *International Climate Treaties: The Case for Pessimism*, 1 CLIMATE L. 177, 177 (2010) (discussing how ineffective the Kyoto Protocol is in decreasing global emissions); William R. Moomaw, *Can the International Treaty System Address Climate Change?*, FLETCHER F. WORLD AFF., Winter 2013, at 105, 109–10 (highlighting the problems with the Copenhagen Accord).

[38] Canada, Mexico, Japan, South Africa, about half of the members of the European Union, Argentina, Chile, and Colombia are the only states to have implemented a carbon tax. WORLD BANK GRP., STATE AND TRENDS OF CARBON PRICING 2020, at 24 (2020). Notably missing from this list are the biggest carbon consumers: The United States, China, and India. *Id.*

[39] Kenneth W. Costello, *Would a U.S. Carbon Tax Change Things?*, REG., Fall 2019, at 10, 10 ("[I]f the [social cost of carbon] is so speculative that we have little idea of its optimal value, there is the risk that an 'excessively high' tax on carbon would result in the opposite problem: an inefficient subsidy to clean energy.").

[40] Henry E. Smith, *Property as the Law of Things*, 125 HARV. L. REV. 1691, 1691 (2012).

[41] Rose, *supra* note 1, at 333.

[42] *See id.* (arguing the right to property is the "central right on which all others rest"); JAMES W. ELY, JR., THE GUARDIAN OF EVERY OTHER RIGHT: A CONSTITUTIONAL HISTORY OF PROPERTY RIGHTS 3, 9 (3d ed. 2008) (detailing the constitutional protections for property right); Laura S. Underkuffler-Freund, *Property: A Special Right*, 71 NOTRE DAME L. REV. 1033, 1035–42 (1996) (describing the protection of property as the core of American constitutional rights). *See generally* Eduardo M. Peñalver, *Property as Entrance*, 91 VA. L. REV. 1889, 1890–1907 (2005) ("[P]roperty actually serves to facilitate 'entrance' into community by tying individuals into social groups."). See also Lockean theories on statehood and territoriality; for example: A. John Simmons, *On the Territorial Rights of States*, 11 PHIL. ISSUES 300, 314 (2001) (explaining how, under Locke's theory, property ownership creates the boundaries of society).

[43] *See* Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 355 (1967) ("[A]n owner of a private right to use land acts as a broker whose wealth depends on how well he takes into account the competing claims of the present and the future."); Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1317 (1993) (discussing how private ownership promotes individual liberty, political stability, and economic prosperity); Eduardo M. Peñalver, *Land Virtues*, 94 CORNELL L. REV. 821, 833 (2009) (explaining landowners desire to increase the market value of their property).

[44] *See generally Ownership Rights in Real Property*, N.Y.C. BAR, https://perma.cc/ZV74-Q2YT (last visited Oct. 16, 2020) (describing the rights guaranteed by property ownership).

Whereas environmental law is (and indeed, most of public law) susceptible to regulatory capture and mismanagement by administrative agencies, property's decentralized enforcement mechanism is one of its greatest strengths, and a possible antidote to the failures of the regulatory state.[45]

Property law is also international in a way that public international law could only dream of being. While international law "stops at the border" (that is, each state is bound by international treaties only if they ratified or otherwise accessed the treaties in question),[46] property truly is global. The protection of property by human rights instruments[47]—and its centrality in classical liberalism and the constitutional thought derived from it[48]—ensures it is viewed as a fundamental precondition of civilized human existence.[49] Apart from some minor examples such as alcohol[50] or cannabis,[51] there is no instance of property rights from one country not being accepted or recognized in another country.

Integrating environmental law and property law is arguably a historical necessity: environmental law was born from property law and must return into it. This is the lesson of Jedidiah Purdy's conceptual mini-history of environmental protection during the last 150 years.[52] Purdy describes three stages through which environmental law developed from property law. The first stage (Stage 1) of (proto-)environmental law evolved in the 1870s–1900s, and was completely embedded in the property system: it involved the setting aside of certain tracts, selected

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45 Thomas W. Merrill, *Private Property and the Politics of Environmental Protection*, 28 HARV. J.L. & PUB. POL'Y 69, 69–70 (2004).

46 Vienna Convention on the Law of Treaties, art. 26, May 23, 1969, 1155 U.N.T.S. 331.

47 *See, e.g.*, G.A. Res. 217 (III) A, Universal Declaration of Human Rights, art. 17, U.N.G.A. Res. 217A (III), (Dec. 10, 1948) ("Everyone has the right to own property alone as well as in association with others."); Protocol 1 to the Convention for the Protection of Human Rights and Fundamental Freedoms, art. 1, Mar. 20, 1952, 213 U.N.T.S. 221 ("Every natural or legal person is entitled to the peaceful enjoyment of his possessions."); Organization of American States, American Convention on Human Rights art. 21, Nov. 22, 1969, 1144 U.N.T.S. 123 (describing the fundamental right to own property).

48 *Cf.* Duncan Kennedy, *Two Globalizations of Law & Legal Thought: 1850–1968*, 36 SUFFOLK U. L. REV. 631, 632, 645, 654 (2003) (describing the 19th-century characterization of property, contracts, and torts as quintessentially "legal," and therefore both universal and separate from public law and family law which were dependent on "culture" and "politics" and therefore local and variable). *See also* KATHARINA PISTOR, THE CODE OF CAPITAL: HOW THE LAW CREATES WEALTH AND INEQUALITY 13–15 (2019) (discussing the universality or *erga omnes* character as a key attribute of property rights); ELY, *supra* note 42, at 3 (explaining that the protection given to property is consistent with a major theme of American Constitutionalism).

49 JOHN G. SPRANKLING, THE INTERNATIONAL LAW OF PROPERTY 7, 9–10 (2014).

50 *See, e.g.*, Sean Carberry, *What A Fella Has to Do to Get A Drink Around the Muslim World*, NPR (July 6, 2013), https://perma.cc/DH9H-8KHE.

51 *See, e.g.*, *Cannabis and the U.S.–Canada border*, U.S. EMBASSY & CONSULATES IN CAN., https://perma.cc/NQ4Q-MBTS (last visited Oct. 17, 2020).

52 *See* PURDY, *supra* note 11, at 137, 216–18 (explaining that major environmental laws, including the Clean Air Act, Clean Water Act, and National Environmental Policy Act, all center on regulating property, including what citizens can do on their own property and how to utilize federal property).

for their natural beauty, biodiversity, or ecological importance, as non-transferable and non-developable.[53] This marked the birth of national parks and nature reserves.[54]

The second stage (Stage 2), in the 1960s, began with the realization that industrial effluents could impact great harms on both human health and other life forms, and thus the "media" that transported such materials—wind and water—must be regulated as well.[55] This marked the birth of air and water pollution regulation, which disregarded property boundaries just like the pollutants they regulated.[56] It was at this second stage that environmental protection separated from property law.[57]

The third stage (Stage 3), Purdy argues, is the one that we are approaching now, where environmental law must take off from its *raison d'être* until now: stopping pollution and "the mission of saving a charismatic species or a special place."[58] Purdy convincingly argues that the logic of the third stage runs completely counter to the first two:

> The major greenhouse gases, notably those that are carbon-based, are elements in planetary cycles integral to life as we know it. They are the very opposite of "unnatural." Nor are they toxic. Moreover, because the climate system is always changing . . . there is no stable "baseline" of an undisturbed world, a baseline analogous to, say, a river without pollution.[59]

Whereas Stage 1 was completely integrated into the general regime of property in land, Stage 2 introduced a body of regulation that clashed directly with previously undisputed rights to use one's property as one pleases.[60] It has therefore incurred a substantial backlash against environmental regulation of any kind (at least in the United States).[61] And in the present, Stage 3 arguably requires a reintegration of property and environmental values, but one that is focused on material flows "in planetary cycles integral to life," instead of economic value.[62]

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[53] *Id.* at 137–38.

[54] *Id.*

[55] *See id.* at 216–17 (explaining the advent of regulation focused on controlling the level of man-made pollution).

[56] *See id.* (describing how the new anti-pollution statutes aimed to regulate toxins wherever they end up, including private industry and property).

[57] *See id.* at 220–22 (providing case illustrations of courts deciding between the property and environmental protection model). *See also* RICHARD J. LAZARUS, THE MAKING OF ENVIRONMENTAL LAW 50 (2004) (noting that the regulatory premise of 1970s environmental regulation no longer relied on government proprietary ownership over a particular resource, but instead utilized the government's police power to regulate harmful private activities).

[58] PURDY, *supra* note 11, at 251.

[59] *Id.* at 250.

[60] *See id.* at 208–17.

[61] *Id.* at 218–22 (describing legal challenges to this new body of environmental regulation on the basis of traditional principles of property ownership); *American Natures*, *supra* note 12, at 172–74 (discussing four different conceptions of how Americans use and value the natural world).

[62] PURDY, *supra* note 11, at 250–51.

III. THE CENTRALITY AND HARMFULNESS OF THE RIGHT TO ABANDON IN PROPERTY LAW

So, what exactly is objectionable about property from an ecological perspective? Most doctrines and rules within property law have no direct impact on the natural environment, but rather determine who has control of (and often responsibility for) a specific resource.[63] Leases deal with the balance of powers and rights between the lessor and the lessee, independent of the type of resource,[64] and the law of fixtures allocates hard-to-remove goods between current and future owners.[65] Neither subdomain involves resource use directly.[66] There are, however, two specific doctrines that encourage environmental harm: the right to destroy and the right to abandon.[67]

The right to destroy (*jus abutendi*) allows an owner to abuse or destroy their property or generally handle it in less-than-ideal ways—including from an environmental point of view.[68] The obverse of this right is lack of "rights *by* property" as opposed to "rights *to* property;" apart from corporations, no other objects of property can be self-owning.[69]

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[63] *See generally* W.D. Seitz & J.C. Headley, *Changing Natural Resource Property Rights: An Overview*, 15 NAT. RESOURCES J. 639 (1975) (discussing how property rights determine the allocation of many natural resources, such as surface and minerals, water, and land).

[64] *See* Hiram H. Lesar, *The Landlord-Tenant Relation in Perspective: From Status to Contract and Back in 900 Years?*, 9 U. KAN. L. REV. 369, 372 (1961) (discussing the division of rights between a lessor and lessee in relation to apartments located in urban centers).

[65] *See* Alphonse M. Squillante, *The Law of Fixtures: Common Law and the UCC Part I*, 89 COM. L. J. 501, 501–02 (1984).

[66] *See id.* at 501 (describing fixtures as permanent objects with which no resource use is associated); Ryan Hendrie, *Learning Basics–The Different Types of Lease Agreements*, INNERVISION (Aug. 16, 2018), https://perma.cc/L4SX-2P54 (defining a lease as an agreement to balance rights and obligations between lessor and lessee).

[67] For a similar analysis, see Joseph L. Sax, *Environmental Law Forty Years Later: Looking Back and Looking Ahead*, *in* BIODIVERSITY CONSERVATION, LAW + LIVELIHOODS: BRIDGING THE NORTH-SOUTH DIVIDE 9, 11–13 (Michael I. Jeffery et al. eds., 2008) (explaining how certain structural aspects of property law are harmful to the environment). *See also* Lior Jacob Strahilevitz, *The Right to Abandon*, 158 U. PENN. L. REV. 355, 360, 364, 371 (2010) (noting that the right to abandon and the right to destroy allow property owners to make unilateral decisions to the detriment of everyone else, including the environment, if not prohibited by law).

[68] Lior Jacob Strahilevitz, *The Right to Destroy*, 114 YALE L.J. 781, 785, 787, 798–99 (2005). For a similar analysis about how the right to destroy trumps obligations to preserve artworks and cultural heritage, see JOSEPH L. SAX, PLAYING DARTS WITH A REMBRANDT 9–10, 35, 42 (1999) (arguing that owners of valuable works of art have the *prima facie* right to destroy these works, despite society's interests in preserving such significant works).

[69] *See* Sierra Club v. Morton, 405 U.S. 727, 742 (1972) (Douglas J., dissenting) (arguing—so far, unsuccessfully—that natural landscapes should have standing in lawsuits); CHRISTOPHER D. STONE, SHOULD TREES HAVE STANDING? LAW, MORALITY AND THE ENVIRONMENT 2–4 (3d ed. 2010) (discussing granting rights to the natural environment); BRUCE ZIFF, PRINCIPLES OF PROPERTY LAW 68–69 (7th ed. 2018) (considering the lack of rights given to inanimate objects in property law).

Objects, animals, and ecosystems thus do not have a baseline right to exist or right to be unperturbed.[70]

The right to abandon allows owners to unilaterally relinquish property rights, and thus responsibility as well, over objects they no longer want to own.[71] Mostly, these objects are economic "bads" with no exchange value and no, or negative-use value (e.g., trash and other types of waste).[72] While scholars have debated the value and even the existence of the right to abandon, they have agreed that it is a marginal doctrine that applies to chattels that are thrown away.[73] According to this view, the right to abandon and the right to destroy have been substantially curtailed by environmental law and by environmentally oriented municipal administrative laws such as anti-littering laws.[74]

However, this view ignores the fact that abandonment happens anyway in a large-scale and socially organized fashion.[75] Garbage is "abandoned" at landfills and effluents and polluting gases are abandoned into the atmosphere and watercourses at the point of "disposal."[76]

Simply abolishing or reversing these doctrines would be both insufficient and unsatisfactory: such a move would arguably destroy the system of common law property without leaving an alternate system that would be both fair(er) and economically workable.[77] A legal system where people cannot claim what they find, cannot use up or get rid of things, and cannot modify their holdings is a system without property law, a system of pure rationing—or even a chimerical vision of no interaction between humans and their material environment. An ecological law of

[70] *But see infra* notes 232–245 and accompanying text (describing efforts to grant personhood and legal rights to mountains, rivers, ecosystems, animals, and/or Nature as such).

[71] Eduardo M. Peñalver, *The Illusory Right to Abandon*, 109 MICH. L. REV. 191, 192 (2010) ("Simply put, [abandonment] law is said to empower owners of chattels to abandon them by unambiguously manifesting the intent do so.").

[72] *See* Lior J. Strahilevitz, *The Right to Abandon*, 158 U. PA. L. REV. 355, 406–07 (2010) (considering the impact of and rule for the abandonment of negative-subject-value, negative-market-value resources). "A bad is a commodity that the consumer doesn't like. For example, suppose that the commodities in question are now pepperoni and anchovies—and the consumer loves pepperoni but dislikes anchovies." HAL R. VARIAN, INTERMEDIATE MICROECONOMICS: A MODERN APPROACH 41 (Jack Repcheck ed., 8th ed. 2010). Hal Varian does not specifically address objects that *nobody* likes, because they are useless, unpleasant, dangerous, or all three. *Id.*

[73] Strahilevitz, *supra* note 67, at 358–59 ("For whatever reason, legal scholars have nearly abandoned the topic and remained oblivious to its charms."); Peñalver, *supra* note 71, at 192 ("This humble doctrine seems so easy that it merits only the most passing mention in property casebooks and is ignored altogether by many.").

[74] Strahilevitz, *supra* note 67, at 363–64.

[75] Vividly described in LEONARD, *supra* note 25, at 182–228 (discussing the ways in which "stuff" systematically works its way to landfills or incinerators).

[76] *Id.* at 207 (explaining that the purpose of a landfill is to bury trash). *Id.* at 209 (describing releases of methane gas and other VOCs). *Industrial Wastewater*, U.S. ENV'T PROTECTION AGENCY, https://perma.cc/Y8L6-K9Z5 (last visited Oct. 18, 2020) (describing how waste is discharged into the water system through point sources).

[77] LEONARD, *supra* note 25, at 239 ("[N]o matter how much we scale back our consumption, we still can't achieve a truly sustainable lifestyle."); Strahilevitz, *supra* note 67, at 390 (describing how abandonment is rooted in the common law system).

property must still be *a law of property*, preserving as much as possible the positive values of individual freedom and enterprise that undergird current property law.[78]

This Article argues this is possible, if not easy to (re)create. A look at the history of waste disposal shows us that a system of property without substantial waste is not a pipe dream. An ecologically sustainable system of property was existent, even ubiquitous, before the 1900s.[79] As Susan Strasser writes in her history of household waste:

> Most Americans produced little trash before the twentieth century. . . . [M]ost food, hardware, and cleaning products [were sold] in bulk. . . . [C]ustomers practiced habits of reuse that had prevailed in agricultural communities here and abroad. Women boiled food scraps into soup or fed them to domestic animals . . . . Durable items were passed on to people of other classes or generations, or stored in attics or basements for later use. Objects of no use to adults became playthings for children. Broken or worn-out things could be brought back to their makers, fixed by somebody handy, or taken to people who specialized in repairs. And items beyond repair might be dismantled, their parts reused or sold to junk men who sold them to manufacturers.[80]

In Strasser's description, the ubiquity of reuse and recycling was not only a household phenomenon, but a key part of early industrial sourcing as well:[81]

> [I]n cities, ragmen worked the streets, usually buying bones, paper, old iron, and bottles as well as rags. These small-time entrepreneurs sold the junk to dealers who marketed it in turn to manufacturers. The regional, national, and even international trade in rags was brisk because they were in high demand for papermaking and for "shoddy," cloth made in part from recycled fibers. Grease and gelatine could be extracted from bones; otherwise, bones were made into knife handles, ground for fertilizer, or burned into charcoal for use in sugar refining. Bottles were generally refilled . . . .
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> . . . .
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> This trade in used goods amounted to a system for reuse and recycling that provided crucial domestic sources of raw materials for early industrialism. Scavenging was essential to that system, a chore and a common pastime for poor children, who foraged for shreds of canvas or bits of metal on the docks, for coal on the railroad tracks, and for bottles and food on the streets and in

[78] *Cf.* Peñalver, *supra* note 43, at 828 (supporting an Aristotelian approach to land use rather than a normative version of law and economics to incorporate positive values).

[79] SUSAN STRASSER, WASTE AND WANT: A SOCIAL HISTORY OF TRASH 12 (1999).

[80] *Id.*

[81] *Id.* at 12–13.

> the alleys. Food and coal went home to the children's families; they sold metal, rags, bones, and bottles to junk dealers.[82]

The resemblance to "sustainable biological ecosystems, which are in general closed, or cyclical," where "[w]aste to one part of the system acts as resources to another [and] the dead body and excrement of one organism nourishes its neighbors" is very strong.[83] And so is the obvious brokenness of today's "open system," where single-use consumer items are ubiquitous, and broken or damaged goods go straight to the landfill instead of a repair shop.[84]

None of this is to look at the past with rose-tinted glasses. The old system of universal recycling did depend on massive social inequality and child labor—and still does in third-world countries where trash-picking is an organized occupation.[85] Strasser (and archeologists in general, having recovered trash heaps from every civilization in history)[86] also reminds us that no community was ever a completely closed system, and that "early-nineteenth-century industrialization created notorious air and water pollution."[87] At the same time, "the process was once generally

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[82] *Id.* at 13. Compare Robert U. Ayres, *On Industrial Ecosystems*, *in* A HANDBOOK OF INDUSTRIAL ECOLOGY, *supra* note 16, at 44, 46 (citation omitted):

> The classical illustration of this strategy was the Chicago meat packers who prided themselves on recovering and finding markets for 'everything but the squeal' of the slaughtered animals. . . [Products included] various meat products from steak to sausage, lard (some of which was saponified to produce soap), pet-food, bone-meal, blood-meal, gelatin (from hooves) and even hormones from animal parts. Pig bristles became shaving brushes and hairbrushes, while the hides were tanned to make leather.

[83] STRASSER, *supra* note 79, at 14. *Cf.* Ayres, *supra* note 82, at 44, 49 (describing industrial ecosystems where an industrial park fully captures and recycles all physical materials internally); Robert U. Ayres, *Industrial Metabolism*, *in* TECHNOLOGY AND ENVIRONMENT 23, 24–27 (Jesse H. Ausubel & Hedy E. Sladovich eds., 1989) (recounting how waste products were recovered as raw materials for reuse—limited by the fact that materials inherently degrade, disperse, and are lost over the course of use—although the waste products inevitably lose value and may cause environmental harm during disposal); ROBERT U. AYRES & LESLIE W. AYRES, ACCOUNTING FOR RESOURCES, 1: ECONOMY-WIDE APPLICATIONS OF MASS-BALANCE PRINCIPLES TO MATERIALS AND WASTE 2, 7, 10, 11, 15 (1998) (explaining that unlike many natural cycles, industrial cycles are open despite efforts to extract useful materials).

[84] STRASSER, *supra* note 79, at 15–16.

[85] Richard G. Abad, *Squatting and Scavenging in Smokey Mountain*, 39 PHIL. STUD. 263, 263–64 (1991) (describing the infamous "Smokey Mountain" landfill and slum on the outskirts of Manila, which was closed in 1995); GARBAGE DREAMS (ITVS 2010) (showing the lives of the Zabbaleen, mostly Christian trash pickers in Cairo); LANDFILL HARMONIC (Alejandra Amarilla et al. eds., 2015) (showing the lives of teenagers from Cateura, outside of Asuncion, Paraguary, and the efforts of a music teacher to create a philharmonic orchestra with instruments made from reclaimed trash).

[86] *See* Laura Allsop, *Trash or Treasure? Sifting Through Ancient Rubbish for Archaeological Gold*, CNN (Oct. 4, 2011), https://perma.cc/74KG-G6HR (describing how archaeologists have studied mounds of trash around the world).

[87] STRASSER, *supra* note 79, at 15.

cyclical, if not perfectly so,"[88] and we have no better conceptual model to turn to if we wish to keep the Earth habitable.

What is conspicuous from a lawyer's point of view is that common law property doctrines hardly changed during the turn from a closed, agro-industrial system to an open, mass consumption–based system, and certainly none of the systems identified above changed in direct response to the transformation of the industrial system.[89] The common law is not so much opposed to an ecological property system as it is indifferent to it. Such indifference was unproblematic in an economic/ecological system where almost all refuse was biodegradable and seldom produced in such quantities to erase or fundamentally alter global ecological balances.[90]

An ecological model of property (Ecological Property) would then rest on two sets of principles. First, the right to abandon and the right to alienate freely would be replaced with a cyclical conception of alienability. In other words, goods and materials would be alienable only to the extent that they remain part of an ecologically sustainable and beneficial cycle of materials.

Second, such cycles of materials—in order to remain ecologically sustainable and beneficial—must be tied to existing biogeochemical cycles. The concept of a biogeochemical cycle may well sound alien and confusing to a lawyer or political theorist, but some examples will hopefully bring back memories from high school science classes: the water cycle, the carbon cycle, the nitrogen cycle, the sulphur cycle, the phosphorus cycle.[91] In short, biogeochemical cycles are the global cycles of materials at the molecular scale, that living organisms both depend on and are composed of.[92] The well-known cause of climate change is the conversion of the carbon cycle into a "carbon line": "taking carbon (the "C" in CO_2 and CH_4) from the Earth's crust and pumping it into the atmosphere [by] extracting and burning coal, oil, and gas."[93] Many other environmental crises can also be rephrased as the divergence of existing

[88] *Id.*

[89] *See supra* notes 67–75 and accompanying text. A demonstrable and well-documented counterpoint is the change to water law during industrialization in the Northeast United States. For example, see FRANK K. UPHAM, THE GREAT PROPERTY FALLACY: THEORY, REALITY, AND GROWTH IN DEVELOPING COUNTRIES 43–57 (2018) (describing how the common law governing water rights substantially changed in large part due to judicial activism).

[90] *See* Sax, *supra* note 67, at 11–12 ("[There is] nothing in the structure of property law that provides inducement to owners and managers to maintain and restore the natural services that land and water provide.").

[91] *Biogeochemical Cycles*, ENV'T LITERACY COUNCIL, https://perma.cc/TVW3-SYE2 (last visited Oct. 14, 2020).

[92] *Id.*

[93] JOEL WAINWRIGHT & GEOFF MANN, CLIMATE LEVIATHAN: A POLITICAL THEORY OF OUR PLANETARY FUTURE, at ix (2018). *See also* Galina Churkina, *An Introduction to Carbon Cycle Science*, *in* LAND USE AND THE CARBON CYCLE: ADVANCES IN INTEGRATED SCIENCE, MANAGEMENT, AND POLICY 24, 25–27, 34 (Daniel G. Brown et al. eds., 2013) (describing the human disruption of the carbon cycle and the resulting accumulation of carbon emissions in the atmosphere).

biogeochemical cycles or the creation of new, harmful biogeochemical cycles. The destruction of the Colorado river, for example, is the regional diversion of the water cycle away from the Colorado river basin, into Californian and Arizonan homes.[94] The overwhelming plastic pollution of the oceans and the resulting destruction of marine life can be rephrased as the creation of a new and destructive, low-density polyethylene (LDPE) and high-density polyethylene (HDPE) cycle.[95]

Ecological Property relies on two sets of principles, then: 1) cyclical alienability and ownership, and 2) the reconceptualization of ownership boundaries to accord with biogeochemical cycles. The rest of this Article will expound these two principles and the background necessary to understand them. First, in Part IV, I offer a primer (or reminder) on biogeochemical cycles. Then, in Part V, through the example of a cup of coffee, I describe how cyclical alienability might work. Part V also examines how enforcement of these principles might work, and Part VI looks at already existing mechanisms in property law and administrative law that could be the foundations of Ecological Property.

IV. WHAT ARE BIOGEOCHEMICAL CYCLES? AN OVERVIEW OF GLOBAL MATERIAL FLOWS

Abandonment is made legally easy through the assumption that the ownership of chattels is contained by real property boundaries: everything within my land belongs to me. There are, of course, numerous exceptions, from finding lost or hidden valuables[96] to breeding genetically modified plants in one's fields.[97] Nevertheless, generally speaking, one has no claim to chattels outside of one's land, and putting objects into a public place is rightfully seen as an indicator of abandonment or of losing objects.[98] One of the main reasons why expensive but highly mobile

94 U.S. DEP'T OF INTERIOR BUREAU OF RECLAMATION, COLORADO RIVER BASIN WATER SUPPLY AND DEMAND STUDY 3, 26 (2012). *See also* BRUCE KEITH ET AL., CTR. FOR NATION RECONSTRUCTION & CAPACITY DEV., LIMITS TO POPULATION GROWTH AND WATER RESOURCE ADEQUACY IN THE NILE RIVER BASIN, 1994–2100, at 4–5 (2013) (finding that the Nile River Basin's water resources are depleting as regional population increases); Daniel Jaffee & Robert Case, *Draining Us Dry: Scarcity Discourses in Contention Over Bottled Water Extraction*, 23 LOCAL ENV'T 485, 493–94 (2018) (providing one of many examples of a corporation negatively impacting a water cycle by bottling water for transport outside of the region).

95 *See* Ganesh Kumar et al., *Review on Plastic Wastes in Marine Environment—Biodegradation and Biotechnical Solutions*, MARINE POLLUTION BULLETIN, Jan. 2020, at 1, 1–2, 5–6 (noting that the toxic effects on marine organisms is in response to the plastic accumulation in the ocean and, of the seven types of plastics used for commercial purposes, LDPE and HDPE are common).

96 Bridges v. Hawkesworth (1851) 7 Eng. Rep. 424, 425–26; Parker v. British Airways Board [1982] 1 All ER 834 (Civ. App.) at 843–44 (Eng.); Bird v. Town of Ft. Frances [1949] O.R. 292, 294, 302 (Can. Ont.).

97 Monsanto Can. Inc. v. Schmeiser [2004] 1 SCR 902, 955 (Can.).

98 "Generally, one relinquishes personalty when he voluntarily makes it available for someone else's disposition. . . . In addition, there is a widely held and long-standing doctrine

chattels (such as automobiles or aeroplanes) must be compulsorily registered, and must indicate their registry numbers visibly on them, is to clearly establish ownership when parked in public places.[99] When it comes to water law, the common law is also clear that running water cannot be owned by individuals (though they may take a reasonable amount from the flow), and that riparian owners have an obligation to let downstream users access the same quantity and quality of water as they receive.[100]

Free-market environmentalists have long since advocated for the private ownership of all resources based on the assumption that private ownership would bring heightened responsibility as well.[101] This strategy necessarily fails where resources are highly mobile and have to stay highly mobile to fulfil their ecological function. We cannot distribute the oceans or the atmosphere by giving everyone a slice of it in an airtight container—but even if it were physically possible, this would be the end of the oceans and the atmosphere as global systems of life support. We cannot corral all animals into fields or marine reserves with barbed-wire fences or their equivalents[102]—but even if we could, that would be the end of these animals fulfilling a role in an ecological cycle. Instead of creating straight-edged "invisible line" borders around resources, property rights have to follow physically mobile resources. But how does one create a property right in the ocean or the atmosphere, or even a portion of the ocean or the atmosphere, when evaporation, absorption, chemical reactions, photosynthesis, and so many other environmental transactions are continuously changing the composition and quantity of both the oceans and the atmosphere? The answer is to create property rights not

that personalty discarded as waste is considered abandoned." Long v. Dilling Mech. Contractors Inc., 705 N.E.2d 1022, 1025 (Ind. Ct. App. 1999). *See also* Eads v. Brazelton, 79 Am. Dec 88, 95–96 (Ark. 1861); M'Goon v. Ankeny, 11 Ill. 558, 560 (1850).

99 *See* J. Francis Ireton, *The Proposed Commercial Code: A New Deal in Chattel Security*, 43 ILL. L. REV. 794, 801–02, 808 (1949) (discussing that due to the utility and nature of motor vehicles, registration would give parties notice of possession and ownership).

100 *See* T.E. Lauer, *The Common Law Background of the Riparian Doctrine*, 28 MO. L. REV. 60, 61, 86, 101–02 (1963) (showing how the common law has long recognized that no proprietor has the right to use water to the prejudice of any downstream proprietors).

101 Most prominently, see TERRY L. ANDERSON & DONALD R. LEAL, FREE MARKET ENVIRONMENTALISM (rev. ed. 2001) (arguing that market forces including private land ownership must be harnessed to improve environmental quality). *See also* James L. Huffman, *Protecting the Environment from Orthodox Environmentalism*, 15 HARV. J.L. & PUB. POL'Y 349, 350–53 (1992) (explaining that free market environmentalists believe that individuals will voluntarily allocate resources to environmental protection); Alison Rieser, *Prescriptions for the Commons: Environmental Scholarship and the Fishing Quotas Debate*, 23 HARV. ENV'T L. REV. 393, 398 (1999) (synthesizing free market environmentalism literature that discusses the "superiority of property rights in ensuring efficiency and efficacy in natural resource management"); Kristen H. Engel & Scott R. Saleska, *Subglobal Regulation of the Global Commons: The Case of Climate Change*, 32 ECOLOGY L.Q. 183, 190–91 (2005) (referring to the climate as an example of a common pool resource that is being degraded for lack of private property interests).

102 *Cf.* ANDERSON & LEAL, *supra* note 101, at 35 (suggesting barbed-wire fencing as a market-based, property-right solution to wildlife management).

in these planetary domains, but in the processes that create and regulate these domains: biogeochemical cycles.[103]

Biogeochemical cycles are the cycles of materials necessary for life, that cycle globally through the atmosphere, the Earth (geosphere), oceans and freshwater (hydrosphere), and living organisms (biosphere).[104] Biogeochemical cycles have different average speeds, varying from days to hundreds of millions of years to complete a cycle, and different "reservoirs," where large quantities of the material in question are "in storage," without motion, for long periods of time.[105] "The importance of global biogeochemical cycles is easily stated: all economic systems are just subsystems of the biosphere, dependent on its resources and services."[106] The most important ones for life on Earth are the water cycle, the carbon cycle, and the nitrogen cycle.[107] Somewhat less crucial are the phosphorus and sulfur cycles, and many other materials have biogeochemical cycles that are less crucial or are not under human interference, including oxygen, hydrogen, selenium, and silica.[108] This Part presents a short introduction to the three principal biogeochemical cycles (the water, carbon, and nitrogen cycles), and Part V.A.4. mentions some destructive man-made biogeochemical cycles.

A. The Water Cycle

The water cycle is responsible for rainfall and the existence of freshwater in general. Water evaporates from lakes, rivers, oceans, puddles, and other surfaces. Water vapor is lighter than most other molecules in the atmosphere (e.g., nitrogen and oxygen) and therefore rises until the cold air condenses the water vapor, turning it into clouds.[109] The amount of water in clouds grows until the droplets are too

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103 An alternative argument is to only create or recognize territories that are large and ecologically varied enough to be resilient: "Among juridical territories, only countries are appropriate candidates for statehood. A country is a juridical territory that has achieved a certain level of *resilience*. Resilience is an ecological concept denoting the capacity of a system to bounce back to an equilibrium." AVERY KOLERS, LAND, CONFLICT AND JUSTICE: A POLITICAL THEORY OF TERRITORY 4 (2009). This proposition is problematic in two ways: 1) arguably, it is even more utopian than this Article by denying statehood to almost all small states; and 2) possibly, it is unrealizable even with continent-sized countries such as Australia, because all ecosystems are interlinked, and climate change and other atmospheric changes can devastate even continent-sized countries. The conclusion, then, would be that the Earth can have only one sovereign and only one owner.

104 ENV'T LITERACY COUNCIL, *supra* note 91.

105 *Id.*

106 Vaclav Smil, *Global Biogeochemical Cycles*, *in* A HANDBOOK OF INDUSTRIAL ECOLOGY, *supra* note 16, at 249, 249.

107 SAMANTHA FOWLER ET AL., CONCEPTS OF BIOLOGY 538–39, 541 (2013).

108 *Id.* at 543, 546.

109 *See generally* Taikan Oki & Hyungjun Kim, *Macroscale Hydrological Modeling and Global Water Balance*, *in* TERRESTRIAL WATER CYCLE AND CLIMATE CHANGE: NATURAL AND HUMAN-INDUCED IMPACTS 3, 4 fig.1.1 (Qiuhong Tang & Taikan Oki eds., 2016) (showing the hydrological flux and storage with natural and anthropogenic cycles).

heavy to stay in the air. The water then precipitates as snow, rain, or hail. Rainfall (and snowmelt from snowfall) feeds brooks, streams, and rivers which flow into lakes or carry the liquid water back into the ocean.[110] Rainwater also seeps into the ground where it stays in the soil as groundwater. Animals drink from lakes and rivers which then release water into the ground, the rivers, and, through perspiration, into the atmosphere. Plants absorb water from the ground or from vapor in the atmosphere and transpire water back into the atmosphere. The major reservoir is the oceans, where approximately 97% of the water on Earth is stored.[111] Water molecules in the ocean may not participate in the water cycle for millions of years.[112] Other water molecules that do not reach the ocean (i.e., those that evaporate and precipitate over continental landmasses with few porous soils) may cycle quite rapidly between plants, animals, the ground, and the air.[113] Other reservoirs in the water cycle include snow, ice caps, and underground aquifers. The water cycle is especially crucial for being a carrier of other materials—indeed, all animals use and need water to flush out toxins and byproducts of metabolism.[114]

110 *Id.*

111 *Id.* at 3.

112 *See The Water Cycle*, U. CORP. FOR ATMOSPHERIC RES., https://perma.cc/2MAM-AUQ2 (last visited Feb. 25, 2021) ("The oldest ice in Antarctica has been there for 2.7 million years.").

113 *Natural Processes of Ground-Water and Surface-Water Interaction: The Hydrologic Cycle and Interactions of Ground Water and Surface Water*, U.S. GEOLOGICAL SURV., https://perma.cc/GNK6-EUDM (last updated Nov. 23, 2016).

114 *See* Chris Obenschain, *Wonderous Ways That Water Can Improve Your Health*, U.S. NEWS (July 17, 2012), https://perma.cc/A6HK-2MEX (explaining how important water is to flush out toxins from our bodies).

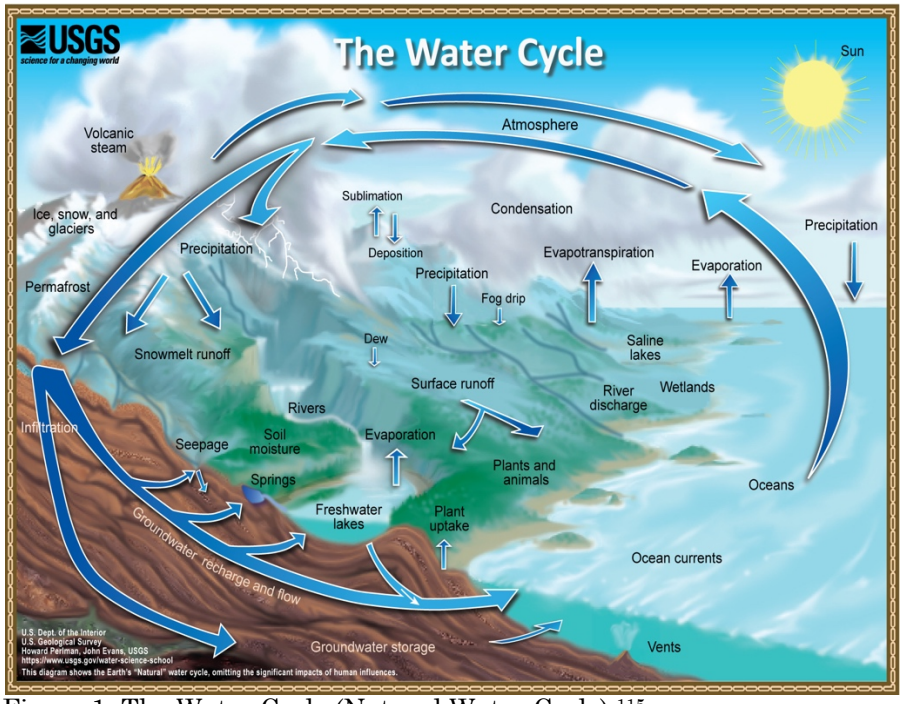

Figure 1: The Water Cycle (Natural Water Cycle).[115]

B. The Carbon Cycle

The carbon cycle is equally necessary for living organisms (which are, to a large degree, composed of carbon) and for the regulation of temperature on Earth—the "greenhouse effect."[116] Unlike the water cycle, in which water does not chemically break down and recompose, carbon within the carbon cycle goes through many chemical transformations and compound forms.[117] The most important gaseous ones in the atmosphere are methane (CH_4) and carbon dioxide (CO_2). CO_2 is absorbed by plants and separated into carbon and oxygen through photosynthesis; the oxygen is released back into the atmosphere while the carbon is integrated into organic compounds that make up a plant's body mass.[118] Animals eat the plants and thus absorb part of the carbon; they also excrete carbon compounds and, when they die, their decaying bodies

[115] Howard Perlman, *The Water Cycle (Natural Water Cycle)*, U.S. GEOLOGICAL SURV., https://perma.cc/G5FM-DG4M (last visited Jan. 28, 2021).

[116] *See* Derek T. Robinson et al., *Linking Land Use and the Carbon Cycle*, *in* LAND USE AND THE CARBON CYCLE: ADVANCES IN INTEGRATED SCIENCE, MANAGEMENT, AND POLICY, *supra* note 93, at 3, 6 (explaining the radiative trapping function of the greenhouse effect); Churkina, *supra* note 93, at 24 (outlining the ways in which the carbon cycle is essential to life on Earth).

[117] *See* Robinson, *supra* note 116, at 5–6 (enumerating the many chemical changes carbon undergoes during the carbon cycle and the relative ease at which carbon transforms).

[118] Churkina, *supra* note 93, at 29, 31.

release carbon compounds into the ground.[119] Carbon in the ground is partly washed into the oceans, where it sinks to the deep ocean over time; some carbon dioxide is also absorbed and dissolved into the ocean through contact with the atmosphere.[120] Carbon in the ground and in the deep ocean eventually turn into sedimentary rocks such as limestone, or into hydrocarbons such as coal, petroleum, and natural gas.[121] The major natural reservoir of carbon is the geosphere, containing 100 million times as much carbon as the oceans and the atmosphere combined.[122]

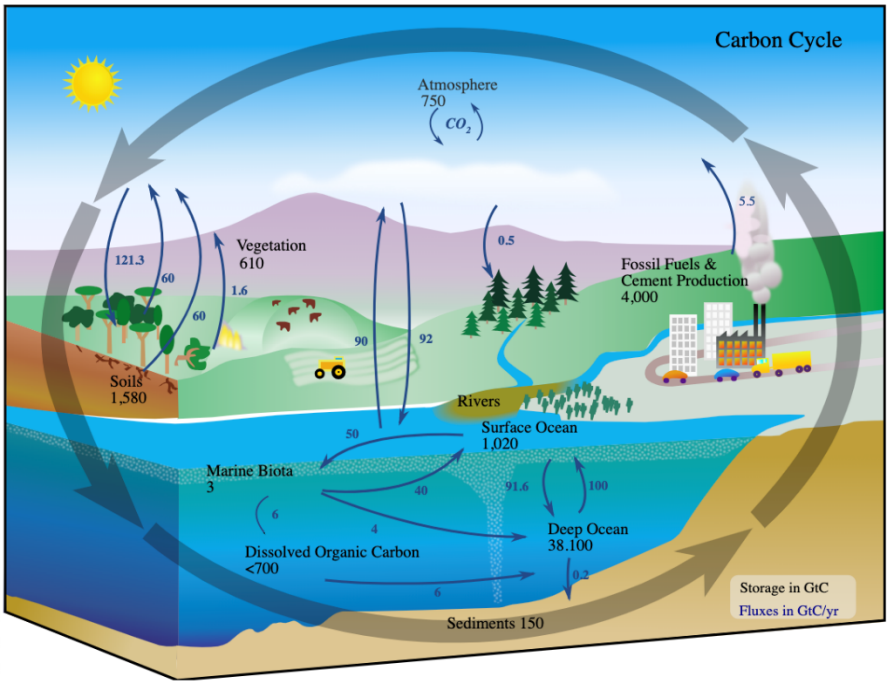

Figure 2: Simplified diagram of the carbon cycle with amounts of carbon stored and cycled in Gigatons Carbon per year (GtC/yr).[123]

As is well known, human activities, such as intensive cattle farming, mining, heating buildings, and driving motor vehicles, have drastically altered the carbon cycle.[124] These measures have increased the amount of

[119] *Id.* at 25, 31.

[120] Charles D. Keeling, *Lecture 1: Global Observations of Atmospheric CO_2*, *in* THE GLOBAL CARBON CYCLE 1–2 (Martin Heimann ed., 1993).

[121] *Id.*

[122] "Out of the total amount of C in Planet Earth 85.3% occurs in the sediments, 14.3% in the rocks, 0.06% in the oceans, 0.003% in soils and detritus, 0.001% in the atmosphere and 0.0008% in biota." Nils-Axel Mörner & Giuseppe Etiope, *Carbon Degassing from the Lithosphere*, 33 GLOBAL & PLANETARY CHANGE 185, 187 (2002).

[123] *Humans and the Global Carbon Cycle: A Faustian Bargain?*, NASA (Apr. 12, 2007), https://perma.cc/6H36-3KAY.

[124] Churkina, *supra* note 93, at 41–42.

CO_2 in the atmosphere by more than 46% since 1750.[125] It is also well known that both CO_2 and CH_4 are important "greenhouse gases": they absorb and re-emit thermal energy radiating from the surface of the Earth, thus increasing the amount of solar energy retained by the atmosphere and surface of the Earth.[126] Since 1951, an estimated 495 billion tons of carbon has been transferred into the atmosphere from underground reservoirs and is currently wreaking havoc on climates all over the planet.[127] Additionally, the increase of CO_2 in the atmosphere is also contributing to ocean acidification, as CO_2 on the surface of the oceans interact with water to form carbonic acid (H_2CO_3).[128] The modification of the acidity of the oceans (from slightly alkaline to more neutral) is interfering with the life cycles of hard-shelled marine organisms, especially corals, molluscs, and shellfish, which may have an effect on the entire marine food supply chain.[129]

C. The Nitrogen Cycle

The nitrogen cycle concerns the transformations of nitrogen between organic and inorganic forms: from inert, gaseous nitrogen (N_2) in the atmosphere into organic forms such as ammonium (NH_4^+), nitrites (NO_2^-), and nitrates (NO_3^-), which can then be absorbed by plants, and then back into N_2.[130] These organic forms of nitrogen are necessary for the creation of amino acids, the building blocks of proteins, which are, themselves, the ingredients of muscles and bone tissue in all animals.[131] In the natural

[125] From around 280 ppm to 410 ppm (and rising) today. *See* Ed J. Dlugokencky et al., *Atmospheric Composition*, *in* 100 BULL. AM. METEOROLOGICAL SOC'Y SPECIAL SUPP. ("State of the Climate in 2018") S48 (Jessica Blunden & Derek S. Arndt eds., 2019), https://perma.cc/2DYE-WGM8. *See also* Dieter Lüthi et al., *High-Resolution Carbon Dioxide Concentration Record 650,000-800,000 Years Before Present*, 453 NATURE 379, 379 (2008).

[126] ROBINSON, *supra* note 116, at 6.

[127] An estimate of yearly global emissions suggests that 171,264 million metric tons of carbon were emitted between 1950 and 1992. T.A. BODEN ET AL., ESTIMATES OF GLOBAL, REGIONAL, AND NATIONAL ANNUAL CO_2 EMISSIONS FROM FOSSIL-FUEL BURNING, HYDRAULIC CEMENT PRODUCTION, AND GAS FLARING: 1950–1992, at 23–25 (1995), https://perma.cc/KZ8F-EWVW. Between 1950 and 1970, only an estimated 64,000 metric tons of carbon were emitted. Robert J. Andres et al., *Carbon Dioxide Emissions from Fossil-Fuel Use, 1751–1950*, 51B TELLUS 759, 760–61 (1999). "From 1751 to 1995, the cumulative global total for CO_2 emissions from fossil fuel production were 250×10^9 [metric tons of carbon]. Only 25% of this was emitted by 1950." *Id.* at 764. A rough derivation of an EPA report between 1900 and 2014 shows that about 260,000 metric tons were emitted. *Global Greenhouse Gas Emissions Data*, U.S. ENV'T PROTECTION AGENCY, https://perma.cc/P2TF-XYLG (last visited Feb. 8, 2020).

[128] NICOLA BARNARD & STEFAN HAIN, SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY, CBD TECHNICAL SERIES NO. 45: SCIENTIFIC SYNTHESIS OF THE IMPACTS OF OCEAN FERTILIZATION ON MARINE BIODIVERSITY 40 (2009).

[129] *Id.*

[130] HERMANN BOTHE ET AL., *Preface to*, BIOLOGY OF THE NITROGEN CYCLE, at xiii (Hermann Bothe, Stuart J. Ferguson, & William E. Newton eds., 2007).

[131] HUGH S. GORMAN, THE STORY OF N: A SOCIAL HISTORY OF THE NITROGEN CYCLE AND THE CHALLENGE OF SUSTAINABILITY 11–12 (2013).

nitrogen cycle, both nitrification and denitrification are mostly done by bacteria in soils.[132]

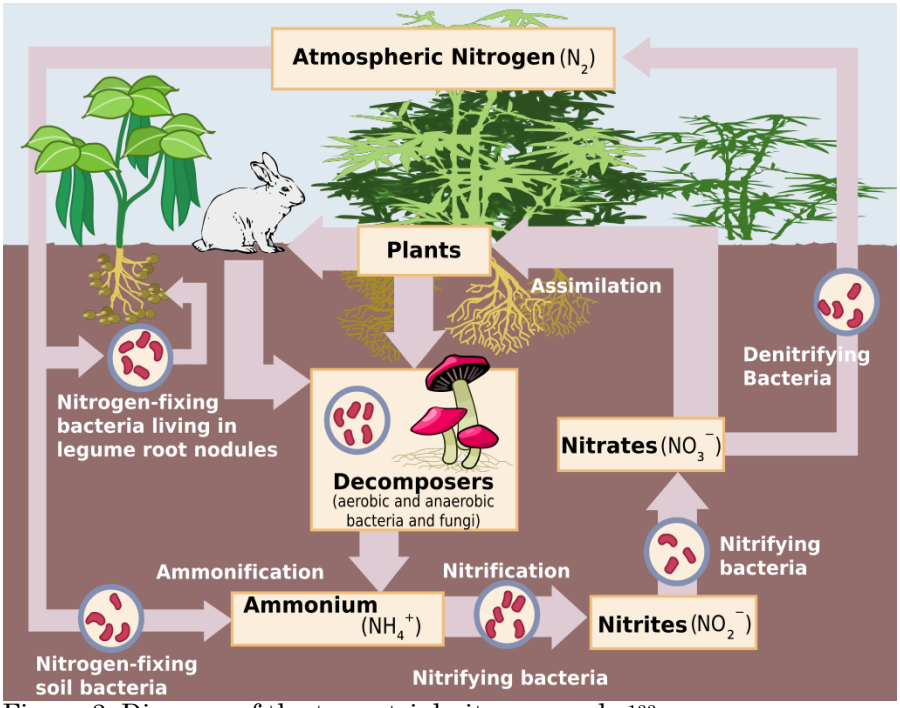

Figure 3: Diagram of the terrestrial nitrogen cycle.[133]

An abundant supply of organic nitrogen in the soil boosts plant life considerably—because of this, nitrogen is the primary ingredient of most fertilizers.[134] As fertilizer use has skyrocketed over the last 100 years, the release of nitrogen into the environment has also exploded.[135] Nitrite, nitrate, and ammonium are all toxic to humans and animals over a certain concentration, especially so to marine animals.[136] The increase of nitrogen in waters has caused algae to multiply in the nitrogen-rich areas, which suck up water-dissolved oxygen and thereby suffocate all

[132] *Id.* at 17–18.

[133] *Biogeochemical Cycles*, OPEN OR., https://perma.cc/7K4X-6JRP (last visited Jan. 28, 2021).

[134] *See* Arvin R. Mosier et al., *Nitrogen Fertilizer: An Essential Component of Increased Food, Feed, and Fiber Production*, *in* AGRICULTURE AND THE NITROGEN CYCLE: ASSESSING THE IMPACTS OF FERTILIZER USE ON FOOD PRODUCTION AND THE ENVIRONMENT 3, 3–4 (Arvin R. Mosier et al. eds., 2004) (noting that nitrogen improves soil fertility by preserving organic matter and is partly responsible for the mass increase in global food production).

[135] Mark B. Peoples et al., *Pathways of Nitrogen Loss and Their Impacts on Human Health and the Environment*, *in* AGRICULTURE AND THE NITROGEN CYCLE: ASSESSING THE IMPACTS OF FERTILIZER USE ON FOOD PRODUCTION AND THE ENVIRONMENT, *supra* note 134, at 53–54.

[136] *Id.* at 63, 65; BOTHE ET AL., *supra* note 130, at xvi.

other organisms nearby, creating oceanic "dead zones."[137] Abundant ammonia (NH_3) in the atmosphere creates relatively high levels of nitric acid (HNO_3) through a reaction with water vapor, which results in destructive acid rains.[138] Increased levels of nitrous oxide (N_2O) contribute to global warming (N_2O also being a greenhouse gas) and to the destruction of atmospheric ozone.[139]

We can see that biogeochemical cycles are global, foundational, and interconnected. They evade and transcend not only property boundaries and national boundaries, but also the boundaries between living organisms, organic matter and inorganic minerals; and between solid, liquid, and gaseous forms of matter. These characteristics already suggest some preliminary principles on managing biogeochemical cycles, so as to remedy ongoing environmental crises and to prevent new ones from forming.

V. ECOLOGICAL PROPERTY IN A CUP OF COFFEE

A. Basic Legal Principles

Let us take a specific everyday example to show what is wrong with current-day property and how it could be different. After writing these words, I will go downstairs and pay $3.99 for a medium espresso in the law school café. The cup of hot liquid that I receive for my money includes hot water and coffee bean extracts in a paper cup; I am free to add sugar, milk, soymilk, or half-and-half; stir with a freely available wooden stirrer; and cover my cup with a plastic lid if I want to take it away. I can drink the coffee then and there, pour it down the drain in the nearest bathroom, or take it with me to drink or pour out elsewhere. I can recycle the cup and the lid or throw them into any garbage anywhere. These are my legal options: apart from paying the price of the coffee and not littering, I have no further obligations regarding the coffee. Coffee drinkers all over North America, and in a lot of places in the rest of the world, receive similar options and treatment every day. The café similarly has obligations not to litter (in addition to abiding by labor and health and safety standards), but it can also simply throw all the coffee grounds, leftovers, and used cups in trash bags and let the garbage collectors take them away. Its obligations too, generally end with putting out the trash bags and selling the coffee.

We can see in the trashcans the institutionalized right (and even obligation) to abandon; that is the endpoint of both my coffee cup and the café's treatment of its leftovers and refuse. Many other suppliers in the coffee commodity chain—from the coffee-growers (presumably) using pesticides and chemical fertilizers, to the shipping companies

137 GORMAN, *supra* note 131, at 150–51.
138 *Id.* at 103, 111; BOTHE ET AL., *supra* note 130, at xvi.
139 Peoples et al., *supra* note 135, at 64.

transporting the coffee, to the distributors packaging it—are similarly free to create and abandon harmful materials. These harmful materials range from the pesticides that are washed off the plants into the water cycle; to the CO_2 emitted by the ships, trains, and trucks; and to the hemp sacks, plastic bags, and pouches for coffee beans that get dumped at landfills or make their way into the oceans.

But, what if my responsibilities did not end with simply throwing the cup in the appropriate container and forgetting about it? What if we had an obligation to make sure the paper cup was part of a circular, zero-waste economy? After enjoying my coffee with milk and sugar in a paper cup, I could not just throw out the cup—I would have to make sure the cup ends up as mulch, and eventually as a tree back in the forest where the paper pulp came from (or at least some other forest). Instead of my liberty to abandon the cup at the nearest trashcan, for free, I would have the obligation of holding onto it until I can dispose of it properly, and quite likely pay for the privilege of relinquishing the paper cup that I have accepted responsibility for.

Waste management companies would not only have to safely transport the cup to a landfill or a paper mill that uses recycled paper, but make sure the materials contained in the cup rejoin the proper biogeochemical cycles: the cellulose and paraffin in the paper are broken down into carbon, hydrogen, and oxygen, which are then returned into the atmosphere, underground and/or into living trees in the correct proportions. If this is too difficult or expensive to do, then that should discourage paper cup manufacturers and users from making, buying, and using paper cups. Cafés could or would become porcelain cup or bring-your-own-cup only.

These obligations could be taken on by the café, either for a fee or built into the price of the coffee. The café's obligations would also extend to making sure that equivalent amounts of carbon are returned to wherever the coffee, sugar, milk, and other foodstuffs originate. In order to better manage these obligations, the café can source the coffee from wherever it wants, as well as the water it uses, and the sugar and milk it offers to customers as further ingredients. It can decide what type and make of espresso machine it purchases and the cups, stirrers, or spoons it offers to customers. It can decide to cater to customers on the go, or to adopt a "European" style and offer only porcelain cups and metal spoons.

What if other actors in the supply chain similarly had an obligation to take care of their effluents and externalities, even if they could not locate the exact CO_2 and pesticide molecules they released? The coffee transporters would have to make sure that for every pound of CO_2 they released into the atmosphere, an equivalent amount of carbon would be returned underground, where the fuel that was turned into CO_2 originated. The distributors would have to make sure their bags and sachets biodegrade and rejoin the biogeochemical cycles that they are from. The farmers would have to use pesticides that also biodegrade into

basic organic materials, and not pesticides that stay intact and continue to poison animals and ultimately, humans, generation after generation.

What legal principles would be necessary to create this type of responsibility? Three basic principles of Ecological Property are necessary: 1) an obligation to maintain biogeochemical cycles as cycles (i.e., return materials to appropriate sinks and reservoirs); 2) a principle of collective ownership that frames and justifies collective responsibility; and 3) the obligation not to create new, poisonous biogeochemical cycles, but instead make sure that new compounds and materials biodegrade and rejoin natural cycles.

1. Principle #1: Maintain the Cyclicality of All Naturally Existing Biogeochemical Cycles

As described above, biogeochemical cycles have "reservoirs" where large amounts of the element or material in question are stored for hundreds of millions of years, without participating in the cycle. For water, the main reservoir is the oceans; for carbon, the primary reservoir is the lithosphere; for nitrogen, the atmosphere. Human intervention in these cycles can be simply described as recreating reservoirs, or the moving of large amounts of one material from one type of "long-term storage medium" into another.[140] The burning of fossil fuels, for example, is often restated as the moving of carbon from underground sinks into the atmosphere.[141] The nitrification of soils and waterways can be redefined as the movement of nitrogen from the atmosphere into the soil and the oceans.[142]

Accordingly, the first principle of an ecological law of property must be to maintain the cycle. In order to do this, we must identify the main reservoir for each cycle and make sure that unused amounts of the material in question are returned to the appropriate reservoir. For carbon, the principal reservoir has to be underground; for nitrogen, the atmosphere. One can nitrify the soil only if one insures the denitrification of runoff and groundwater. One may mine and burn coal (thus placing underground carbon into the atmosphere), but only if one replaces an equivalent amount of carbon in the ground. The freedom of disposing property must be subject to the supreme principle of maintaining the cyclicality of biogeochemical flows. Indeed, with regard to consumable materials, property rights should be redefined as not object-centered, but flow-centered. One does not own a ton of coal, but a ton of carbon or a

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140 *See* Cameron Hepburn et al., *The Technological and Economic Prospects for CO_2 Utilization and Removal*, 575 NATURE 87, 87–90 (2019).

141 *See, e.g.*, MANN & WAINWRIGHT, *supra* note 93, at iv ("what we need to do to tackle climate change [is] stop taking carbon (the "C" in CO_2 and CH_4) from the Earth's crust and pumping it into the atmosphere").

142 *Teacher Background: Nitrogen and Climate Change*, EARTH SYSTEM RESEARCH LABORATORIES, https://perma.cc/5FMN-5XZG (last visited Nov. 6, 2020); *Nitrogen Cycling in the Open Ocean*, CTR. FOR MICROBIAL OCEANOGRAPHY: RES. & EDUC., https://perma.cc/Y55J-LEN3 (last visited Nov. 6, 2020).

percentage of the global carbon cycle. And one cannot freely dispose of their ton of carbon (say, by burning it and simply letting go of the resulting CO_2), but one will continue to own that ton of carbon, even in the form of smoke and CO_2, with attached responsibilities.

In a survey of the technological and economic opportunities of CO_2 (re)usage, Cameron Hepburn and his team found ten potential, economically viable ways of reusing and sequestering carbon.[143] These are creating industrial chemicals such as methanol, urea, or plastics from CO_2 instead of mined carbon sources; converting CO_2 into fuels such as methane or methanol; using CO_2-absorbing microalgae as source materials for biomass, biofuels, or aquaculture feed; creating the carbonates necessary for the production of concrete from CO_2; using different types of underground carbon storage; absorbing CO_2 into the soil through fertilization with biochar and other agricultural techniques, or into woodlands through the planting of forests; and absorbing CO_2 into pulverized silicate rocks, which could then be used to improve agricultural soils.[144] The authors acknowledge that currently, most of the technologies surveyed require subsidies of between $10 and $900 per ton of CO_2 removed from the atmosphere to be profitable.[145] However, this calculation assumes—in line with current property and environmental law—that the alternative, to simply abandon CO_2 into the atmosphere, is legal, acceptable, and supported. If current-day technologies for the creation of fertilizers, fuels, or industrial chemicals had to pay for the CO_2 they released to be recaptured or reused, these calculations would undoubtedly change.

2. Principle #2: Collective Ownership of Biogeochemical Cycles

Because we all participate in biogeochemical cycles—indeed, they flow through our bodies as long as we are alive, and even in death—we all "own" a share of these cycles, whether we like it or not.[146] We own them in a very direct, physical sense that property theorists encounter only in rare cases where the ownership of body parts or genetic materials are

143 Hepburn et al., *supra* note 140.

144 *Id.* at 89–93. Hepburn et al. acknowledge that these methods and techniques are not necessarily beneficial or carbon-neutral, as they may provide perverse incentives or involve heavy fossil fuel use in other parts of the industrial process. *Id.* at 88–90.

145 *Id.* at 92 (calculating the break-even cost of CO_2 utilization in 2015 USD).

146 *Cf.* BRUCE PARDY, ECOLAWGIC: THE LOGIC OF ECOSYSTEMS AND THE RULE OF LAW 15 (2015):

> You may think of your body as a thing. After all, it has a physical existence and identifiable boundaries. . . . Except that it is not a thing in the same way as a chair or a rock. Like chairs and rocks, at this moment your body is made up of a particular collection of atoms and molecules. But unlike these objects, every day some of your atoms and molecules are lost, and others replace them. You consist of different material today than yesterday, last year, and ten years ago.

discussed.[147] We "own" our organs and our genetic materials not in the sense that we can control them or harness them, but in the sense that they *are* us: there is no escape from the genetic and biological conditions that we have, through any of the tools that contract and property law afford to us (exchange or abandonment).[148] We likewise "own" our illnesses and toxins, the lead, mercury, and persistent organic pollutants that accumulate in us, and our children "inherit" them already in the womb, causing developmental problems.

The corollary of this forced ownership should be forced and enduring responsibility. Arguably, the right to abandon is central to any theory of property that places individual freedom as its core value—as James Penner has written, "[o]ne ought not to be saddled with a relationship to a thing that one does not want, and an unbreakable relation to a thing would condemn the owner to having to deal with it."[149] At the same time, collectively, we have an inseverable relationship to the objects of the world, which *some* of us will certainly have to deal with. We also have an unbreakable relationship to our bodies, at least as long as we want to have a self.

3. Principle #3: Chattels Over Realty, Flows Over Boundaries

Property law doctrines focus on real estate over chattels, a characteristic that is widely explained by pointing to the importance of land in pre-industrial societies, where the common law and Roman law developed.[150] Traditional land law promotes and fosters principles of

147 *E.g.*, Moore v. Regents of the Univ. of Cal., 793 P.3d 479, 488–89 (Cal. 1990) (finding that after a person's cells are removed and are not in the person's possession, there is not an ownership interest sufficient to establish a conversion claim); Stephen Ashley Mortinger, *Spleen for Sale:* Moore v. Regents of the University of California *and the Right to Sell Your Body*, 51 OHIO ST. L.J. 499, 500 (1990) (noting *Moore v. Regents of the University of California* was a rare case addressing whether to permit the sale of human body parts and discussing the historical treatment of live bodies, deceased bodies, and materials that were once a part of a body under property law); Newman v. Sathyavaglswaran, 287 F.3d 786, 797–98 (9th Cir. 2002) (finding parents had property rights in their deceased children's bodies and extraction of the children's corneas without the parent's consent was a deprivation of property without due process of law); REBECCA SKLOOT, THE IMMORTAL LIFE OF HENRIETTA LACKS 203 (2010) (noting that although researchers and companies sued one another over ownership of cell lines, Moore was the first person to claim to own his tissue and to sue for profits and damages in *Moore v. Regents of the University of California*).

148 This is a Lockean argument, similar to the example of eating an acorn: at the point of consumption, all common property theories fail, and "[n]o Body can deny but the nourishment is his [alone]." JOHN LOCKE, TWO TREATISES OF GOVERNMENT 306 (2d ed. 1967). *But see* J.W. HARRIS, PROPERTY AND JUSTICE 188–96 (1996) (calling into question whether, under Lockean principles, one does, in fact, own one's own body, calling this conclusion "the spectacular non-sequitur").

149 J.E. PENNER, THE IDEA OF PROPERTY IN LAW 79 (1997).

150 *E.g.*, Claire Priest, *Creating an American Property Law: Alienability and Its Limits in American History*, 120 HARV. L. REV. 385, 387–89 (2006) (describing how America shifted away from the English system, where real property was granted preferential treatment in debt satisfaction proceedings, to a system where real and chattel property were treated the same in satisfying personal debts).

efficient use, privacy, self-sufficiency, and excludability that have arguably become the bedrock of liberal constitutionalism.[151] In the biogeochemical cycle-based approach, chattels and flows are primary, and real estate is merely the site for flows to take place. As described above, the biogeochemical cycle-based approach is designed to bypass the entire problem of drawing property boundaries—while of course still relying on the boundaries of both material flows and individual objects.[152]

None of this is to deny the political and moral importance of boundaries for such basic liberal values as privacy, independence, and security. The law of biogeochemical cycles must preserve and maintain as much of these values as possible while preserving and maintaining the preconditions of natural life as well. Possibly, though, the protection of these values will pass even more from property to human rights and constitutional law, as it has already happened with non-discrimination and equality.[153]

4. Principle #4: No New Biogeochemical Cycles

Humanity has not only unbalanced natural biogeochemical cycles, but tragically, has also created new ones. Biogeochemical cycles are interconnected, as alluded to above: for example, the water cycle plays a crucial role in the nitrogen cycle as well as the carbon cycle, with both cycles having important oceanic components. The creation of new materials, or the release of materials that were predominantly underground, can inadvertently create new, toxic, and destructive biogeochemical cycles.

One example is the increase of mercury in the environment, traceable to its use in gold mining, and the burning of coal and municipal waste.[154] Trace amounts of mercury are present in coal and in municipal

151 *See, e.g.*, Carol M. Rose, *Property as the Keystone Right?*, 71 NOTRE DAME L. REV. 329, 330–31 (1996) (discussing the overwhelming economic and privacy interest in securing property); JAMES W. ELY, JR., THE GUARDIAN OF EVERY OTHER RIGHT: A CONSTITUTIONAL HISTORY OF PROPERTY 9 (2008) (discussing the origins of legal protections for property and the historic constitutional status of not separating property and personal rights); Jedediah Purdy & Kimberly Fielding, *Sovereigns, Trustees, Guardians: Private-Law Concepts and the Limits of Legitimate State Power*, 70 L. & CONTEMP. PROBS., Summer 2007, at 165 (delineating the restraints of powers between autonomy and state action regarding territory).

152 On the centrality of easily identifiable property boundaries for the efficient management of a system of property, see Ellickson, *supra* note 43, at 1328–29 and Smith, *supra* note 40, at 1709–14.

153 Joseph William Singer, *No Right to Exclude: Public Accommodations and Private Property*, 90 NW. U. L. REV. 1283, 1448–49, 1458–61 (1996) (advocating for a right of access to places open to the public, in keeping with the values underlying property law and the creation of a "social relations model"); Joseph William Singer, *Property and Sovereignty Imbricated: Why Religion is Not an Excuse to Discriminate in Public Accommodations*, 18 THEORETICAL INQUIRIES L. 519, 521 (2017) (discussing the limits between whether the law should grant people the right of access to public accommodation, or whether the owner can exert his right to exclude people from his property based on religious beliefs).

154 SCI. FOR ENV'T POL'Y, TACKLING MERCURY POLLUTION IN THE EU AND WORLDWIDE: IN-DEPTH REPORT 15, at 17 (Sci. Comm. Unit, U. West of England ed., 2017) (analyzing the

waste and are released into the atmosphere with the smoke of burning both. Large amounts of mercury were also used to dissolve gold contained in ores and sediments, and then evaporated from the gold-mercury amalgam.[155] Mercury in the atmosphere reaches the oceans through the water cycle. Underwater bacteria create organic methylmercury (CH_3Hg^+) from the inorganic forms, and methylmercury is easily ingested by fish.[156] Methylmercury accumulates in fatty tissue, and therefore increases in concentration through the food chain. Large carnivorous fish, such as swordfish or pike, have higher concentrations of mercury in their bodies than small plankton-eating fish.[157] Humans eating large amounts of fish have an even higher chance of accumulating mercury in their bodies. Mercury is, of course, highly toxic and causes significant neurological damage throughout the food chain, including children born to parents who have accumulated a lot of mercury in their bodies.[158]

Similarly, toxic man-made biogeochemical cycles include the polychlorinated biphenyl (PCB)-cycle,[159] the polychlorinated dibenzodioxin (PCDD) or dioxin cycle,[160] the perfluorooctanoic acid (PFOA) cycle,[161] and increasingly, the microplastic cycle. PCBs are organic chlorine compounds with the structure $C_{12}H_XCl_X$, which were widely used as industrial coolant fluids and as transfer agents in carbonless copy papers from the 1880s to the 1970s.[162] PCDDs or dioxins are also complicated organic carbon-hydrogen-chlorine-oxygen molecules that are the byproduct of industrial chemistry, smelting, and the burning of plastics. Both of these materials are bioaccumulative—that is, they accumulate in human and animal tissue, especially fatty tissue—and have severe health effects, including skin diseases, liver failure, neurological damage, and cancers.[163]

A third example of a biogeochemical cycle that is currently being created is the microplastics cycle. Microplastics are defined as pieces of

trend of rising mercury emissions from 1850 to 2008 correlating with the Gold Rush, World Wars I and II, and industrialization around 1950).

155 *Id.*

156 DENNIS A. WENTZ ET AL., U.S. DEP'T OF INTERIOR, U.S. GEOLOGICAL SURV., THE QUALITY OF OUR NATION'S WATER: MERCURY IN THE NATION'S STREAMS—LEVELS, TRENDS, AND IMPLICATIONS 1, 2–3 (2014).

157 *Mercury in Fish*, ST. OF VT. AGENCY OF NAT. RESOURCES, https://perma.cc/C2NY-FQTU (last visited Oct. 13, 2020).

158 Masazumi Harada, *Intrauterine Methylmercury Poisoning—Congenital Minamata Disease*, 33 Kor. J. Env't Health 3 175, 175–79 (2007).

159 Captain Marc W. Trost, USAF, *The Regulation of Polychlorinated Biphenyls Under the Toxic Substances Control Act*, 31 A.F. L. REV. 117, 118 (1989).

160 Wendy E. Wagner, *The Science Charade in Toxic Risk Regulation*, 95 COLUM. L. REV. 1613, 1683, 1683 n.256 (1995).

161 Bruce J. Berger, *The Trouble with PFOA: Testing, Regulation and Science Concerning Perfluorooctanoic Acid and Implications for Future Litigation*, 76 DEF. COUNS. J. 460, 460 (2009).

162 Trost, *supra* note 159, at 117–18.

163 *Id.* at 118.

any type of plastic that are smaller than 5mm in diameter.[164] They originate either from plastic beads used in the manufacture of larger plastic goods, or from the breakdown of used and discarded plastic materials, such as weathered shopping bags, crumbling brittle plastic bottles, or fibers from woven plastic clothing. The microplastic cycle is just being discovered and studied, so its health effects are yet largely unknown. But microplastics are potentially carcinogenic and excellent absorbents for other toxic chemical products.[165] Microplastics have been discovered, in different concentrations, in the oceans, in tap and mineral water, in honey and sugar, in table salts, and, of course, in the flesh of a large variety of seafood.[166] Like the materials above, microplastics have become part of the water cycle and are wreaking havoc on living organisms throughout the food chain.

PCBs, PCDDs, and (micro)plastics are all materials that have been created in laboratories, adopted by industries, and then finally, by consumers despite their possible degradation and impact on food chains.[167] Regulation of these materials has so far been reactive: after having found out, to our chagrin, that newly created synthetic chemicals have harmful effects on the health of humans and other living beings, their production has been decreased or halted.[168] This, of course, has been inefficient in rounding up the millions of tons of PCBs, dioxins, and microplastics that are already circulating within the food chain and the water cycle.

In the future, we must avoid creating newer biogeochemical cycles by *not* creating new, even only potentially toxic materials that do not break down into non-toxic components and readily integrate into pre-existing, natural biogeochemical cycles. Instead of controlling polluting outputs, pollution must be prevented at the source.[169]

B. The Principle of Responsibility in Ownership

The obligation to ensure the cyclicality of biogeochemical cycles, by making sure the chemical components of every item we own and throw out rejoin the appropriate cycle and reservoir, surely raises as many

164 Samaneh Karbalaei et al., *Occurrence, Sources, Human Health Impacts and Mitigation of Microplastic Pollution,* 25 ENV'T SCI. & POLLUTION RES. 36046, 36047 (2018).

165 *Id.* at 36054.

166 *Id.* at 36052.

167 *The History of Wellington Laboratories*, WELLINGTON LABORATORIES, https://perma.cc/22DG-25JF (last visited Oct. 16, 2020).

168 *See generally* Stockholm Convention on Persistent Organic Pollutants, May 22, 2001, S. Treaty Doc. No. 107-5, 2256 U.N.T.S. 40214; *Basel* Convention on the Control of Transboundary Wastes and Their Disposal, Mar. 22, 1989, S. Treaty Doc. No. 102-5, 1673 U.N.T.S. 28911.

169 This principle is similar to David Driesen and Amy Sinden's proposal of "dirty input limits." *See* David M. Driesen & Amy Sinden, *The Missing Instrument: Dirty Input Limits*, 33 HARV. ENV'T L. REV. 65, 66 (2009) (discussing regulation that limits inputs that cause pollution).

questions as it answers. Going back to the cup of coffee, how much of that would be my personal responsibility, and how could I fulfill it or make sure that others fulfill it?

Would I have to mulch my used coffee cup personally and make sure it becomes carbon in the soil, or living tree wood in my backyard? And, if I did so, would it be acceptable for me to do so in my backyard in North America if the wood pulp for the cup came from, say, Indonesia? Or could I entrust it to BioCycle™ Corp., which promises to capture and store CO_2 underground in pore spaces, or to plant new forests in Northwest Bolivia? What if BioCycle™ Corp. becomes bankrupt, turns out to engage in false accounting or fraudulent practices, or is otherwise frustrated in its efforts to return carbon into plants or underground? How far am I responsible, and if not me, then who?

Related questions arise regarding the waste materials created by the shipping companies, the coffee growers, or the café where I bought the coffee itself. Would I be responsible only for the carbon content of the paper cup, or also the CO_2 generated by the use of the espresso machine, the heating of the café premises, the trucks' and ships' exhausts, and so forth? And if not me, who would be responsible for returning the tons of CO_2 created through heating, transportation, agriculture, and so forth—how would these costs be distributed between the primary producer, the initial buyer, the end-consumer and other participants?

Some of these problems could safely be entrusted to markets similar to current-day markets. Let us depart from the university café for a moment to take the example of a coal mine. Biogeochemical cycle-based ownership of a coal mine would not differ much from current-day ownership, whether the subsurface owner is the same as the surface owner or not; whether the government has exclusive ownership of minerals or not; et cetera. All it would require is that any excavation, sale, or use of the coal must be accompanied by the return of an equal amount of carbon, trace sulphur, trace mercury, and any other ingredients into the Earth, or perhaps, arguably, into living forests which could one day become coal again. That is, roughly speaking, a tree must be planted for every twenty-two kilograms of coal brought up from the mine.[170] Alternative modes of carbon sequestration could be done, of course, if they are possible and more profitable.[171] If the planting of enough trees is still impossible or still unprofitable, then the exchange should not take place—an exchange that does not honor the cycle is a form of theft from the collective cycle-owners. The buyer of the coal must therefore pay the price of the mining as well as the price of returning an equivalent amount

[170] *Tree Facts*, TREES OF STRENGTH, https://perma.cc/SB6W-F38C (last visited Oct. 17, 2020) ("A tree can absorb as much as 48 pounds of carbon dioxide per year.").

[171] *See, e.g.*, Alberta Mines and Minerals Act, R.S.A. 2000, c M-17 § 15.1 (Can.) (declaring Crown ownership over "pore space," that is the empty, underground cavities where oil and gas used to exist, which can plausibly become the site of long-term carbon storage). *See* Owen L. Anderson, *Geologic CO_2 Sequestration: Who Owns the Pore Space?*, 9 WYO. L. REV. 97, 97–98 (2009) (discussing the plausibility of CO_2 sequestration in pore space).

of carbon to the appropriate reservoir. At that point, the buyer of the coal has the right to burn the coal (converting it into atmospheric carbon), or to use it in some other way. If the miners plan to use the coal themselves, they must be the ones to return the equivalent carbon into the ground—or arguably, carbon return must be a precondition of mining the coal itself.

More significant problems arise when dealing with negative value objects (economic bads),[172] that have no use or exchange value and are uniformly unpleasant or dangerous. Property law is geared almost exclusively toward objects that have positive value, which many people will try to claim. With regular goods, the bankruptcy, death, or destruction of any one owner will reliably trigger actions by others to obtain the goods left behind. When dealing with bads, on the other hand, ownership has to be imposed by the law, as rational actors will try to get rid of the objects or foist them onto someone else. Accordingly, another important principle of Ecological Property must be limited alienability: I am stuck with the paper cup until, and unless, I can return it to the appropriate biogeochemical cycle, and I could only transfer my trash to others if it is absolutely certain that they will do so for me. As with the paper cup, so with the tons of coal: no sale until the corresponding amount of carbon is returned underground.

1. Principle #5: Limited Alienability and Cyclical Trade

Limited alienability is the corollary to the abolishment of the right to abandon. Without limiting alienability, non-abandonment would be easily circumvented by "selling" waste products to a desperate individual or to a shell company, who could then illegally abandon or dump these materials. It would also be easy to designate shell companies to act as literal "holding companies," reinstating dumping and non-cyclical material flows through a corporate back door. To avoid this outcome, one should not be able to give or sell unwanted products to anybody at will, but only to those who would either directly use the products or materials at hand, or those who would return them, without pollution, to the appropriate biogeochemical reservoir.

This type of limited alienability would be different from other types of inalienability that have been discussed in property law literature, such as goods that can be gifted, but not sold (e.g., human organs), or goods that are absolutely inalienable (e.g., human beings, political votes, or fundamental human rights).[173] It would be more similar to Calabresi & Melamed's paternalistic inalienability, which limits certain actors from purchasing goods that would be dangerous to themselves or others (such as bans on minors purchasing tobacco, alcohol, or fireworks or citizens, in

172 VARIAN, *supra* note 72, at 41.

173 For typologies of inalienability, see Susan Rose-Ackerman, *Inalienability and the Theory of Property Rights*, 85 COLUM. L. REV. 931, 933–48 (1985); Margaret Jane Radin, *Market-Inalienability*, 100 HARV. L. REV. 1849, 1849–58 (1987).

general, from purchasing military hardware).[174] It would also be close to de facto administrative limits on alienability that are quite common in today's market economy, such as licenses, tax registration, age limits, permits, and so forth.[175]

Limited alienability would make people more mindful of the responsibility and stewardship involved in ownership and would lead consumers to care about packaging and the costs of limitless consumption. It would, in turn, encourage producers to create goods and services that either do not produce waste, or where the waste is easily directed into the appropriate biogeochemical cycle. The limited (in)alienability of almost all materials would act to ensure that environmentally harmful materials do not get traded, consumed, and ultimately, created.

The alternative, in a world of Ecological Property, would be to live with piles of inalienable waste, as in Antoine Repressé's cycle of photographs, "365 Unpacked."[176] In this cycle, the artists asked his boundlessly patient subjects to save up recyclable packaging materials for four years, and then photographed the subjects in domestic scenes, surrounded by the trash that they created and consumed over the last four years. We see a person sitting on a toilet, almost engulfed by the cardboard cores of toilet paper rolls; a couple sitting at dinner in a sea of microwave dinner boxes, egg cartons, and other food packaging; and a washing machine among hills of detergent and fabric softener bottles.

This "less is more" attitude is somewhat similar to the view that Coasean transaction costs are not an impediment to efficiency, which should be lowered or eliminated by all means possible, but in fact, the guarantee of the efficiency of transactions; they preclude inefficient transactions from taking place.[177] Likewise, alienability only within a biogeochemical cycle ensures sustainable production and long-term prosperity, instead of destroying the resources we will be reliant on in the future.

From the perspective of property law itself, limited alienability would be a fulfillment of the promises of Extended Producer Liability (EPR): a set of mostly European legislative initiatives that mandate

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174 Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1111–15 (1972).

175 Rose-Ackerman, *supra* note 173, at 951–52.

176 *365 Unpacked*, ANTOINE REPRESSÉ, https://perma.cc/ZQ9V-NCZ9 (last visited Nov. 4, 2020).

177 Lee Anne Fennell, *The Problem of Resource Access*, 126 HARV. L. REV. 1472, 1473 (2013) ("Because making transactions cheaper or less necessary consumes resources that might be better deployed elsewhere, we cannot infer inefficiency from high transaction costs alone."). *See also* David M. Driesen & Shubha Ghosh, *The Functions of Transaction Costs: Rethinking Transaction Cost Minimization in a World of Friction*, 47 ARIZ. L. REV. 61, 65 (2005); Pierre Schlag, *The Problem of Transaction Costs*, 62 S. CAL. L. REV. 1661, 1665 (1989); Harold Demsetz, *The Problem of Social Cost: What Problem? A Critique of the Reasoning of R.H. Coase*, 7 REV. L. & ECON. 1, 10 (2011).

producer take-backs of packaging and sometimes broken goods as well.[178] "If broadly extended . . . [EPR] laws will effectively transform the consumer product market into a *leasing* economy. In practical terms, there is little difference between leasing a car and mandating the manufacturer through EPR to reclaim the car at the end of its life."[179] The common thread in leasing, EPR and Ecological Property is a type of cyclicality: "the manufacturer knows it must take back its product upon disposal."[180]

There are, of course, several other legal forms in which cyclicality and limited transmissibility may be enforced. It could be made to function through a system of leases and bailments, or through outright joint ownership, or through a government-mandated last-ditch or backup mechanism of ownership and cost dispersal.

C. Violations and Enforcement

What about violations of the cycle? What if I flaunt my obligation to make sure the paper cup gets recycled, reused, mulched, or otherwise disposed of in an ecologically sustainable way? It is, after all, too easy to toss a cup on the roadside: few people will notice, and even fewer have any legal means of holding me responsible. It is even easier to abuse opportunities to release invisible and odorless pollutants such as CO_2 or nitrous oxides.

I can, and should, be held responsible for littering, of course, by paying a fine or receiving some other punishment in accordance with local administrative regulations.[181] But that in itself does not help maintain biogeochemical cycles and the circulation of property. Rather, additionally, even if I had burned the cup, lost it, or disposed of it in some other irretrievable way, my responsibility for the materials contained therein should not disappear. I should be forced to pay a carbon capture and storage facility to replace the amount of carbon within the cup underground or pay to plant a tree or shrub that would trap an equivalent amount of carbon. This is a corollary of the principle of limited alienability and non-abandonment. If I cannot "get rid of" (or rather, foist onto someone else) the carbon that I have stewardship over by sale, gift, or abandonment, then there is no reason for me to be able to do so through loss or dereliction.

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178 Salzman, *Sustainable Consumption*, *supra* note 19, at 1270–80. For more discussion of Extended Producer Liability as a concept and as a model and precursor for Ecological Property, see *infra* notes 222–232 and accompanying text.

179 Salzman, *Sustainable Consumption*, *supra* note 19, at 1277.

180 *Id.*

181 Anti-littering laws are the major exception to the general rule of permissive abandonment, which mandate the owners of unwanted materials to dispose of them only in certain ways and certain places (e.g., curbside, trash cans, etc.). Peñalver, *supra* note 71, at 204, 218–19; Strahilevitz, *supra* note 67, at 363–64.

Rather, once I am the owner of a certain amount of carbon (nitrogen, oxygen, etc.), I should remain the owner unless I can prove the carbon has been returned to the appropriate reservoir. The principle of common ownership of biogeochemical cycles (outlined above as Principle No. 2)[182] and the principle of limited alienability (Principle No. 5 above)[183] together should direct such an outcome.

Litterers, of course, are rarely caught. What if someone finds the coffee cup on the wayside, without any clues as to who threw it away? Likewise, what if the global increase of CO_2 in the atmosphere can be measured, but it is unclear who is responsible for the release of carbon into the atmosphere? Collective ownership requires collective responsibility—and indeed, the functioning of global biogeochemical cycles ensures some kind of collective responsibility. A *just* and hopefully effective collective responsibility, however, would go up the chain of production and sale, and locate the person responsible for the materials in the vendor or producer. Thus, if a coffee cup is found by the wayside, the person responsible would be the café or the manufacturer of the cup. If an increase in global CO_2 levels is found that is not accounted for, the entities responsible would be oil and gas companies, who have the sole power to extract and refine petroleum.

I call this mechanism to establish responsibility on the basis of previous possession and control, *the principle of staggered collective ownership*. It is a form of collective ownership, but quite different from joint tenancy or tenancy-in-common. Collective ownership on a global scale certainly cannot be a global version of joint tenancy or tenancy-in-common, complete with the right of survivorship, the possibility of severance, or the existence of separate and distinct shares in a cycle.[184] It also cannot mean joint, global management of resources: an oxymoron if one ever existed. The fact that every person has a stake in the global water cycle and carbon cycle cannot mean that every person has veto rights over the use of a lake, or survivorship inheritance rights to every lump of coal. Conversely, neither can it be similar to today's "global commons" or "open access" regimes, which are better described as "anarchy or no law . . . [or] a 'scheme of universally distributed, all-encompassing' privilege."[185] Instead, the collective ownership of biogeochemical cycles should be modeled on "gatekeeper responsibility,"

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182 *Supra* notes 146–149 and accompanying text.

183 *Supra* notes 173–180 and accompanying text.

184 WILLIAM BLACKSTONE, COMMENTARIES ON THE LAWS OF ENGLAND: BOOK THE SECOND 180–82 (William S. Hein & Co., 1st ed. 1992) (1766)); Speck (Re), 1983 CanLII 667 (Can. B.C. S.C.).

185 Hanoch Dagan & Michael A. Heller, *The Liberal Commons*, 110 YALE L.J. 549, 557 (2001). An even stronger formulation is from Daniel H. Cole, *Clearing the Air: Four Propositions About Property Rights and Environmental Protection*, 10 DUKE ENV'T L. & POL'Y F. 103, 107 n.19 (1999) ("A resource cannot be at once 'open access' (nonproperty) and the subject of property 'rights.'").

well known in corporate law and Internet law.[186] Instead of directly dealing with consumers or corporations, the state empowers, but also holds responsible, those actors who have considerable leverage over the mass of consumers or companies (such as accountants or Internet Service Providers).[187]

1. Principle #6: Staggered Collective Ownership

Ecological Property would have to be staggered, having a principal "current" or "present" owner, and a secondary "background," "potential," or "exigency" owner, who would inherit the materials and the responsibility for them if the principal owner no longer exists or is unable to be found. Forms of divided, unequal control are not rare in property law: trusts[188] and leases[189] are obvious models; so are the ancient common law rules on waste in life estates and fee tails, where successive generations had an interest and say in land management practices.[190] Gregory Alexander calls these types of property "governance property": forms of co-property with vertical power structures and non-concurrent possession and use rights.[191] Professor Alexander argues that governance property exists in many contexts and at many scales, including marital and family property, common interest communities, leaseholds, partnerships, and close corporations.[192] The model for staggered ownership in particular could be the doctrine of waste in leases, trusts, and life estates, but in reverse. Instead of the landlord or remainderman having rights against waste so as to preserve the property for after the passing of the beneficiary, lessee, or life estate-holder, the "background owner" would have the *responsibility* to return the appropriate material to the flow/reservoir, if the current owner is unable (or unable to be located). Another model for Ecological Property is Extended Producer Responsibility, mentioned above and further discussed below.[193]

In the context of littering, this would mean holding Coca-Cola or the local aluminium can producer responsible for each can that is found strewn on the roadside. In the context of CO_2 pollution, this would mean holding oil and gas producers or refiners responsible for every measurable

186 Reiner H. Kraakman, *Gatekeepers: The Anatomy of a Third-Party Enforcement Strategy*, 2 J.L. ECON. & ORG. 53, 53 (1986); JOHN C. COFFEE, JR., GATEKEEPERS: THE PROFESSIONS AND CORPORATE GOVERNANCE 1–3 (2006); JACK GOLDSMITH & TIM WU, WHO CONTROLS THE INTERNET? ILLUSIONS OF A BORDERLESS WORLD 68–73 (2006).

187 JONATHAN L. ZITTRAIN, THE FUTURE OF THE INTERNET AND HOW TO STOP IT 196–97 (2008); Ethan Zuckerman, *Intermediary Censorship*, *in* ACCESS CONTROLLED: THE SHAPING OF POWER, RIGHTS, AND RULE IN CYBERSPACE 71, 71 (Ronald Deibert et al. eds., 2010).

188 GEORGE T. BOGERT, HORNBOOK SERIES: TRUSTS 1 (6th ed. 1987).

189 Robert H. Kelley, *Any Reports of the Death of the Property Law Paradigm for Leases Have Been Greatly Exaggerated*, 41 WAYNE L. REV. 1563, 1565–67 (1995).

190 Jedidiah Purdy, *The American Transformation of Waste Doctrine: A Pluralist Interpretation*, 91 CORNELL L. REV. 653, 658 (2006).

191 Gregory Alexander, *Governance Property*, 160 U. PENN. L. REV. 1853, 1865–66 (2010).

192 *Id.* at 1860–63.

193 *See supra* notes 178–180; *infra* notes 222–232 and accompanying text.

increase in atmospheric CO_2 levels. Who exactly should be the secondary or staggered owner depends on which actor is in the best position to ensure cyclicality within each industry and each biogeochemical cycle. These are questions where the ingenuity of financiers and policymakers will hopefully devise the most efficient solution.

Realizing a global system of secondary or background ownership may well require the global traceability of all industrial and consumer goods and their ingredients—something that has also already been implemented regarding global food supply chains[194] and is an important element of financial law, property law, and occasionally, criminal law.[195] Global traceability is therefore neither impossible nor utopian (nor dystopian, unless subverted). A helpful, possibly even necessary, precondition for global traceability would be identifying on the product both the ingredients and the origin of the ingredients of every industrial product. In the example of the coffee cup, every coffee cup produced should have an ingredient list on its side: how much cellulose, water, bleach, etc. was used for the production of the cup and where these ingredients originated.

2. Principle #7: Universal Ingredient Labeling (and the Codex Alimentarius)

The global regulation of flows, especially flows in economic bads that nobody wants, requires precise information on what products contain, and how and where they can be made to rejoin the appropriate biogeochemical flows. A model for creating and standardizing this information might be the Codex Alimentarius.[196] The Codex Alimentarius is a soft-law instrument, created and regularly updated by an eponymous commission, which was itself created jointly by the U.N. Food and Agricultural Organization and the U.N. World Health Organization.[197] The aim of the Codex Alimentarius is to set global standards for safe food products and safe food production. By necessity, this includes an (open and expanding) list of safe ingredients, prescribing what can be put into "mango chutney,"[198] "instant noodles,"[199] "soy protein products"[200] and

194 *See infra* notes 197–208 and accompanying text (discussing the Codex Alimentarius).

195 *See* LIONEL SMITH, THE LAW OF TRACING (1997).

196 David E. Winickoff & Douglas M. Bushey, *Science and Power in Global Food Regulation: The Rise of the Codex Alimentarius*, 35 SCI., TECH., & HUM. VALUES 356–58 (2010).

197 *Id.* at 357.

198 Food & Agric. Org. of the U.N. [FAO] & World Health Org. [WHO], *Standard for Mango Chutney: CXS 160-1987*, at 2 (2019), https://perma.cc/4QFX-Z2CG (search in search bar for "160-1987") [hereinafter *Standard for Mango Chutney*].

199 Food & Agric. Org. of the U.N. [FAO] & World Health Org. [WHO], *Standard for Instant Noodles: CXS 249-2006*, at 2 (2019), https://perma.cc/36RP-6ULR (search in search bar for "249-2006").

200 Food & Agric. Org. of the U.N. [FAO] & World Health Org. [WHO], *General Standard for Soy Protein Products: CXS 175-1989*, at 2 (2019), https://perma.cc/MGX7-749E (search in search bar for "175-1989").

hundreds of other food products.[201] Some standards are simple to the point of self-explanatory;[202] others are complex and hotly debated.[203]

Codex Alimentarius standards derive their legal force from their inclusion within the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). The SPS Agreement directs parties to respect the Codex Alimentarius as the authoritative common standard "relating to food additives, veterinary drug and pesticide residues, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice."[204] This means that in any trade dispute, national food standards that do not conform to the Codex Alimentarius could be judged to constitute non-tariff trade barriers by the WTO's dispute settlement mechanisms.[205]

In the model of the Codex Alimentarius, an international standard-setter for industrial and consumer products could be set up. This standard-setter would have a role very similar to the Codex Alimentarius, but instead of food safety, it would address ecological safety. Like the Codex Alimentarius,[206] it could require the manufacturers of all goods to include a list of (chemical) ingredients and suggested decomposition methods for end-of-useful-life processing. This would allow waste workers to efficiently cycle ingredients of goods back into the environment and would compel producers to design goods and materials with decomposition already in mind. Methods for the calculation of biogeochemical ingredients have, in fact, been developed and are in use by private industrial certification agencies such as the Carbon Trust, which offer to calculate and certify the amount of greenhouse gas emissions and/or water used in the creation of household products.[207]

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201 See the full list at *International Food Standards*, Food &Agric. Org. of the U.N. [FAO] & World Health Org. [WHO]: CODEX ALIMENTARIUS, https://perma.cc/N8FT-HXN9 (last visited Oct. 18, 2020).

202 *E.g.*, Food & Agric. Org. of the U.N. [FAO] & World Health Org. [WHO], *Standard for Quick Frozen Peaches, CXS. 75-1981*, at 2 (2019), https://perma.cc/FYK3-JSX6 (search in search bar for "75-1981") ("Quick frozen peaches is the product prepared from fresh, sound, properly ripened fruit conforming to the characteristics of *Prunus persica L.*, but excluding nectarine varieties, which fruit is packed with or without a dry sugar of a syrup and is packaged.").

203 *E.g.*, *Standard for Mango Chutney*, *supra* note 198 (mango chutney contains a number of food additives).

204 Agreement on the Application of Sanitary and Phytosanitary Measures, Annex A, 3. (a), https://perma.cc/V5ES-PHSD.

205 *See* Michael A. Livermore, *Authority and Legitimacy in Global Governance: Deliberation, Institutional Differentiation, and the Codex Alimentarius*, 81 N.Y.U. L. REV. 766, 775–76 (2006) (discussing the role of the Codex in the context of international trade agreements and regulation).

206 *Cf.* Food & Agric. Org. of the U.N. [FAO] & World Health Org. [WHO], *General Standard for the Labeling of Prepackaged Foods*, *CXS-1-1985*, at 2–8 (2018), https://perma.cc/D64V-L8AJ (setting international standards for food and agriculture products that require detailed ingredient information to be listed on product labels and packaging).

207 *Footprint Measurement and Analysis*, CARBON TR., https://perma.cc/EQ77-ZU56 (last visited Jan. 28, 2021).

Such standards could not, of course, be completely "neutral" and "impartial": many different political and economic interests may be served by different compositions of ecologically friendly ingredients and standards.[208] But, it would certainly be a start in creating a circular economy.

VI. ANALOGIES, MODELS, AND PRECURSORS OF ECOLOGICAL PROPERTY

How far would be the above-listed principles take us from common-law property, with its systems of estates, separate but parallel legal and equitable title, and the rest? Hopefully, far enough to end pollution and environmental destruction but not so far as to make trade and industry impossibly hard or complicated. This Part will argue "*nihil novi sub sole*":[209] radical as Ecological Property may seem, there is much in currently existing property law and environmental law that is very similar to what this Article proposes.

A. Analogy #1: Property in Water and Other Flows

Property law is no stranger to flows: the ownership of biogeochemical cycles should seem much less far-fetched if we consider that property rights concerning flowing water (for riparian owners) or petroleum and natural gas reserves (for concessionaries or owners of the land above the field) are straightforward and have been accepted for a long time. Oil and water law present an example both for "background property" before capture, and for property over material flows instead of graspable "things."[210]

This is a simplification, of course: the "background property" is a rather peculiar mix of public access rights[211] and state property that is managed and distributed by administrative boards.[212] There is significant confusion over not only whether governments can own and dispose of

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208 *See generally* Winickoff & Bushey, *supra* note 196 (discussing the political nature of the procedures and processes that produced the regulations in the Codex Alimentarius).

209 *Ecclesiastes* 1:9 (King James) (translating to "there is nothing new under the sun").

210 *Cf.* Smith, *supra* note 40, at 1711 (discussing the difficulty of applying property law concepts such as alienability and violations of property rights to resources, like water or information, that cannot be spatially separated or easily classified as "things," as the word is commonly used).

211 *See generally* Joseph L. Sax, *The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention*, 68 MICH. L. REV. 471, 475–88 (1970) (describing the nature of the public trust doctrine by discussing its historical background, and the public trust as a public right, including the concept of property owned by the citizen and the conceptual support for the public trust doctrine). *See, e.g.*, Sarah E. Hamill, *The Public Right to Fish and the Triumph of Colonial Dispossession in Ireland and Canada*, 50 U.B.C. L. REV. 53, 62–63, 76 (2017) (discussing public fishing rights in Ireland and Canada).

212 *See, e.g.*, Dale Gibson, *The Constitutional Context of Canadian Water Planning*, 7 ALTA. L. REV. 71, 86, 91–92 (1969) (arguing for the creation of provincial administrative bodies to manage water resources in Canada).

watercourses under the public trust doctrine,[213] but also whether those who have legal access to, and even possession of, water have any property rights in the water.[214] Courts have held that "[a] right to appropriate surface water however, is not an ownership of property,"[215] but also that "a deprivation of water amounts to a physical taking [under the Fifth Amendment]."[216] Nevertheless, it is hard to sustain that the consumer of water did not acquire property rights over the water, at least at the moment of consumption;[217] and household consumption by riparian owners, at the very least, is often exempt from administrative permit procedures in North American jurisdictions.[218]

Water law is also noteworthy in that there is some attention paid to the negative aspects of the flow: may a landowner get rid of unwanted water flow on their land by diverting the flow to their neighbors? The traditional English "common enemy" doctrine holds that all landowners may divert surface water flow on their lands in any way they wish; the "civil law" doctrine holds to the contrary, that neighbors have an absolute right to keep their land free of intrusions by water drainage flows; while the "reasonable use" doctrine grants freedom to the courts to determine the question according to circumstances.[219]

These doctrines show there is no holistic view of water as a flow that is connected in all of its states and locations and indeed, there is no background property, or any sort of property, in water vapor, fog, clouds,

213 *See generally* Sax, *supra* note 211.

214 *Compare* FLA. STAT. § 253.141(1) (2020) ("Riparian rights are those incident to land bordering upon navigable waters. They are rights of ingress, egress, boating, bathing, and fishing and such others as may be or have been defined by law. Such rights are not of a proprietary nature."), *with* FRANK E. MALONEY ET AL., WATER LAW AND ADMINISTRATION: THE FLORIDA EXPERIENCE 31 (1968) ("It seems clear that in Florida, as in most eastern jurisdictions, riparian rights are property, a lawful taking of which necessitates compliance with the requirements of constitutional due process."). Both quotations are cited in Daniel P. Fernandez, *Riparian Rights in a Polluted World: Property Right or Tort*, 22 BARRY L. REV. 131, 132–33 (2017). *See also* Sandra B. Zellmer & Jessica Harder, *Unbundling Property in Water*, 59 ALA. L. REV. 679, 681–82 (2008) (discussing the unsettled nature of the dispute in contemporary natural resource law over whether interests in water are legally recognized as property).

215 Spear T. Ranch, Inc. v. Knaub, 691 N.W.2d 116, 127 (Neb. 2005).

216 Tulare Lake Basin Water Storage Dist. v. U.S., 49 Fed. Cl. 313, 320 (2001).

217 Echoing, again, see LOCKE, *supra* note 148, 318–19 (explaining generally that use created a property right and that consumption gave rise to possession). *See also* Vill. of Tequesta v. Jupiter Inlet Corp., 371 So.2d 663, 667 (Fla. 1979) (discussing ownership rights of percolating waters as it relates to capture, control, and possession).

218 *E.g.*, Alberta Water Act 2017, R.S.A. 2000, c. W-3, § 21–27 (Can.).

219 Darin L. Whitmer, *Common Enemy or Unilateral Threat: Why Jurisdictions Need to Become Reasonable in Regards to Diffuse Surface Waters*, 41 CREIGHTON L. REV. 423 (2008); Gwenn R. Rinkenberger, *Landowner's Right to Fight Surface Water: The Application of the Common Enemy Doctrine in Indiana*, 18 VAL. U.L. REV. 481, 481 (1983); Wendy B. Davis, *Reasonable Use Has Become the Common Enemy: An Overview of the Standards Applied to Diffused Surface Water and the Resulting Depletion of Aquifers*, 9 ALB. L. ENV'T OUTLOOK J. 1, 8–9 (2004).

or the oceans.[220] But all the elements necessary for Ecological Property are present in water law, stemming from the recognition that water is always in movement. And there is already a movement afoot to extend these principles to wind energy: a resource flow that is almost intangible, mostly ignored in history, but becoming contentious and disputed.[221]

B. Analogy #2: Extended Producer Responsibility

There is already one functioning example of a secondary or background ownership regime: Extended Producer Responsibility (EPR), also known as take-back liability or take-back regulations. These mandate the producers of certain goods (mostly small electronic goods, automobile tires and batteries, and sometimes packaging, lightbulbs, and other materials such as paints[222]) to accept worn-out, broken, and malfunctioning products that were manufactured by the producers, and require the producers to dispose of the trash end-products that their goods became.[223] These measures were instituted starting from the 1980s, so as to "shift the burden of managing certain end-of-life products from municipalities and taxpayers to producers."[224] "To date, the most aggressive EPR initiative has been product take-back measures which mandate that the producer take back its product or packaging at the time of disposal and valorize it by recycling, re-use, or incineration with energy recovery."[225] Essentially, this is a form of secondary ownership, of responsibility that can amount to property, *after* the sale of the product.[226]

Examples of existing EPR regulations include the E.U. Directive on Waste Electrical and Electronic Equipment;[227] the E.U. Directive on Packaging;[228] the National Television and Computer Recycling Scheme in

220 *Cf.* UN Convention on the Law of the Sea art. 87, Dec.10, 1982, 1833 U.N.T.S. 397. ("The high seas are open to all States, whether coastal or land-locked."). There is no mention of what states or individuals may do with seawater as such, though Art. 210 bans the dumping of waste materials.

221 Yael R. Lifshitz, *Winds of Change: Drawing on Water Law Doctrines to Establish Wind Law*, 23 N.Y.U. ENV'T L.J. 434 (2015). *See also* Yael R. Lifshitz, *Gone with the Wind? The Potential Tragedy of the Common Wind*, 28 UCLA J. ENV'T L. & POL'Y 434, 434–36 (2010).

222 ORG. FOR ECON. COOP. AND DEV. REPORT (OECD), EXTENDED PRODUCER RESPONSIBILITY: UPDATED GUIDANCE FOR EFFICIENT WASTE MANAGEMENT 24 (2016), https://perma.cc/J455-8UXP [hereinafter OECD Report].

223 Salzman, *Sustainable Consumption*, *supra* note 19, at 1270–77. *See also* Megan Short, *Taking Back the Trash: Comparing European Extended Producer Responsibility and Take-Back Liability to U.S. Environmental Policy and Attitudes*, 37 VAND. J. TRANSNAT'L L. 1217 (2004) (referring to how the E.U. has developed waste management schemes that require manufacturers to take back products at the end of their useful life).

224 OECD Report, *supra* note 222, at 10.

225 Salzman, *Sustainable Consumption*, *supra* note 19, at 1271.

226 Thomas Lindhqvist, *Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product Systems* 150–51 (2000) (Ph.D. dissertation, Lund University), https://perma.cc/JC2Z-SEFD.

227 European Parliament & Council Directive 2012/19/EU, 2012 O.J. (L 197/38) 6.

228 European Parliament & Council Directive 94/62/EC, 1994 O.J. (L 365).

Australia;[229] a take-back scheme for used car tires in Flanders, Belgium;[230] and one for used rechargeable batteries in Japan.[231] Less ambitious schemes that only collect fees for environmental treatment and waste disposal costs, but do not necessarily involve return of materials or property rights, are active in Canada, China, and some U.S. states, among other jurisdictions.[232]

While EPR is a prime example of secondary or background ownership, it is unfortunately single instance: once the producer has (re)acquired the waste product, they may be bound by recycling target figures, but whoever then acquires the waste or recycled materials, has no secondary property rights or obligations. Also, instead of a general rule of property, it is exceptional both in its material scope and in the number of jurisdictions that implement it.

C. Analogy #3: "Rights by Property": Legal Subjecthood Granted to Nature and Ecosystems

The analogy that is, at first glance, the "greenest" and ideologically most related to Ecological Property—the recognition of the rights of nature or specific ecosystems—turns out to be the least similar legal institution. There is a rising global trend to grant or acknowledge the legal subjecthood of Nature and natural systems: the Te Urewera Forest,[233] the Whanganui River[234] and Mount Taranaki[235] by New Zealand legislature; the Ganges and Yanuma Rivers by the High Court of Uttarakhand in India;[236] the Atrato River by the Constitutional Court of Columbia;[237] the Yarra River by the Victoria state legislature in Australia;[238] and Lake Erie by the city of Toledo in Ohio, U.S.A.[239] Nature and Mother Earth have also received personhood, and "the right to exist, persist, maintain and regenerate its vital cycles, structure, functions and

229 *Product Stewardship (Televisions and Computers) Regulations 2011* (Cth) pt 3 div 3.3 (Austl.), https://perma.cc/S8GH-D2HF; OECD Report, *supra* note 222, at 217–21.

230 OECD Report, *supra* note 222, at 223–28.

231 *Id.* at 257–61.

232 *Id.* at 229–42; Travis P. Wagner, *Shared Responsibility for Managing Electronic Waste: A Case Study of Maine, USA*, 29 WASTE MANAGEMENT 3014, 3014 (2009).

233 Te Urewera Act 2014, s 4 (N.Z.).

234 Te Awa Tupua (Whanganui Claims Settlement) Act 2017, s 14 (N.Z.).

235 Te Anga Putakerongo Record of Understanding between New Zealand and Nga Iwi o Taranaki, sec. 5.5, (signed on 20 December 2017).

236 Mohammed Salim v. State of Uttarakhand & Others, (2017) Uttarakhand HC 126 (India).

237 Corte Constituciónal, noviembre 10, 2016, Sentecia T-622/16 (Colom.).

238 Yarra River Protection (Wilip-gin Birrarung murron) Act 2017 (Vic) s 5(b) (Austl.).

239 Lake Erie Bill of Rights, Toledo Mun. Code ch. XVII, § 254(a) (2020), *invalidated by* Drewes Farms P'ship v. City of Toledo, 441 F.Supp.3d 551, 557 (N.D. Ohio 2020).

its processes in evolution"[240] in the Ecuadorean, and later in the Bolivian, constitution.[241]

The recognition of Nature and specific ecosystems as legal persons echo and is often inspired by indigenous legal traditions about the spirits and personalities of non-human entities and the respect owed to them.[242] They are clearly motivated by a desire to rebalance rights between humans and non-human entities;[243] though what the recognition means in practice remains to be seen. Certainly, in the United States, there have been both judicial[244] and legislative measures[245] that are aimed at blocking the personhood of Nature or specific ecosystems. And clearly, even if personhood and rights are uncontested, "Nature, the environment, or even single complex ecosystems are seldom easily quantifiable as bounded entities with geographically clear borders."[246] It is therefore unclear what activities, and within what range, the declaration of personhood is intended to prevent. But the recognition of the legal personhood of rivers and other ecosystems certainly entails a type of co-ownership or use rights in the property and self of the ecosystem in question (if these ecosystems do not become unperturbed wilderness areas but continue to be used by humans in some way).

VII. CONCLUSION

As far back as the 1992 Rio Earth Summit, political legislative reactions to climate change and global pollution issues have followed a predominantly top–down approach, with the negotiation of international legal instruments: the 1992 U.N. Framework Convention on Climate Change, the 1997 Kyoto Protocol, the 2012 Doha Amendment, the 2015 Paris Agreement, and so forth.[247] And as far back as the United States'

[240] Constitution de 2008, Oct. 20, 2008, Ch. 7, art. 71 (Ecuador), *translated at* https://perma.cc/U8GV-VMRT.

[241] Constitucion del Estado Plurinacional de Bolivia, 2009, art. 33–34. *See also* Ley de Derechos de La Madre Tierra, Ley N 71, 21 Diciembre, 2010 (Bol.); Ley Marco de La Madre Tierra y Desarrollo Integral Para Vivir Bien, Ley N 300, 15 Octubre, 2012 (Bol.).

[242] Cristy Clark et al., *Can You Hear the Rivers Sing: Legal Personhood, Ontology, and the Nitty-Gritty of Governance*, 45 ECOLOGY L.Q. 787, 838–42 (2018).

[243] *See* STONE, *supra* note 69, at 165.

[244] *See* Unopposed Motion to Dismiss Amended Complaint with Prejudice, Deep Green Resistance v. Colorado, 2017 WL 9472427 (D. Colo. 2017) (No. 1:17-cv-02316-NYW) (seeking to dismiss a complaint intending to declare the personhood and rights of the Colorado River); Deep Green Resistance v. Colorado, 2017 WL 9472427 (No. 1:17-cv-02316-NYW) (D. Colo. 2017*)* (dismissing complaint intending to declare the personhood and rights of the Colorado River). *See also Drewes Farms P'ship*, 441 F. Supp. 3d at 558 (invalidating the Lake Erie Bill of Rights, Toledo Mun. Code ch. XVII, § 254).

[245] "Nature or any ecosystem does not have standing to participate in or bring an action in any court of common pleas. No person, on behalf of or representing nature or an ecosystem, shall bring an action in any court of common pleas." Ohio Rev. Code § 2305.01 (2019).

[246] Clark et al., *supra* note 242, at 791. *Cf. supra* notes 57, 92–98, 136–137 and accompanying text.

[247] *See supra* notes 33–37 and accompanying text.

decision not to ratify the Kyoto Protocol in 2000, this strategy has produced failure after failure. Concerned people have instead turned to local and regional governments to act in opposition to climate change: a strategy with limited possibilities and mixed results as well.[248] Other environmental crises, such as the loss of habitat and the pollution of the oceans, have seen even less global intervention.

The opposition to globally mandated carbon targets, with the attendant debates on historical responsibility and injustice, has led us nowhere thus far.[249] Maintaining hope about multilateral diplomacy, it is time to turn to a bottom–up approach: create an ecological property regime. An ecological property regime is not just about creating property rights in carbon (a proposition that has been raised and failed several times),[250] but is, instead, based in creating an in-depth regime in all material flows.

Ecological Property is premised on the need to create a zero-waste cyclical economy. The two principal difficulties in creating a legal regime that serves a zero-waste world are 1) certain property law doctrines that allow or encourage the creation of pollution, and 2) a system of property boundaries that is wholly divorced from the boundaries of nature: ecosystems and biogeochemical cycles.

Ecological Property can—and must—be created by revising these two basic elements of contemporary property. Ecological Property must focus on material flows that are necessarily tied to the biogeochemical cycles that sustain life on Earth. The right to abandon, the right to destroy, and the right to alienate completely and freely must be purged from the property lexicon, to be replaced by the overarching obligation to maintain the cyclicality of material flows (i.e., do not convert and displace materials, such as carbon, without making sure such materials can be converted back to their original state and location) and the obligation not to create new, disruptive biogeochemical cycles. Maintenance of a cycle is possible through a system of staggered ownership and overarching, background collective ownership, in which materials have one or several background or secondary owners, who can be compelled to return "owner-less" materials to the appropriate biogeochemical cycles. The obligation to return materials to the proper biogeochemical cycles can be facilitated by a universal labeling of chemical ingredients for all products, and the limiting of alienability to subjects who are capable and willing to return the products in question to the appropriate biogeochemical cycles.

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248 Jason MacLean, *Rethinking the Role of Nonstate Actors in International Climate Governance*, 16 LOY. U. CHI. INT'L L. REV. 21, 27–28, 30 (2020).

249 *See, e.g.*, Amy Sinden, *Allocating the Costs of the Climate Crisis: Efficiency Versus Justice*, 85 WASH. L. REV. 293, 295–96 (2010) (discussing the breakdown in communication between the developed and the developing world and explaining that "[t]he developed world is speaking the language of efficiency, while the developing world speaks the language of justice").

250 *Id.* at 319–23 (outlining the benefits and difficulties in applying a model that creates property rights in carbon).

Models and analogies for such a system of Ecological Property already exist in many diverse places. Secondary ownership is a feature of leases, trusts, and life estates, as well as more newfangled legal regimes such as extended producer liability.[251] Property in flows, even if these are not cyclical flows, is recognized in water law as well as oil and gas law. And the universal labeling of product ingredients is a basic element of food law, even if rare outside of food regulations.

It remains that even a strict law of biogeochemical cycles may not be nearly enough to save human civilization. The proposed principles in this Article attempt to establish a middle ground between complete non-intervention in the natural world (a Chimerical proposition, if any) and the current "the world is our oyster" approach which has led us to gravely harming, if not destroying, the biospheric support system that allows human life on Earth. Yet, even meticulously following all of the above principles allows for, say, the chopping down of all forests on Earth, so long as a corresponding amount of carbon is kept in the ground. To prevent habitat loss and biodiversity loss—which are also dire problems and may also cause ecological collapse and the loss of irreplaceable ecological services—the framework for ecological property must be supplemented by a recognition of wild animals, or wild ecosystems, owning their own habitats in private law as well.[252]

These proposals may well be rejected as utopian, too abstract, or too hard to implement. In that case, they may stand for a prime example of post-apocalyptic legal theory: if civilization and extractive industrial economies will ever be rebuilt after the (nigh-)inevitable collapse, they had better respect the circularity of global material flows if they aim to last for more than a couple of centuries.

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251 *See supra* notes 188–189 and accompanying text.

252 *See, e.g.*, CORMAC CULLINAN, WILD LAW: A MANIFESTO FOR EARTH JUSTICE 31 (Chelsea Green Pub., 2d ed. 2002) ("Wild laws are laws that regulate humans in a manner that creates the freedom for all the members of the Earth Community [i.e., animals and plants] to play a role in the continuing co-evolution of the planet."). *See also* LAW AS IF EARTH REALLY MATTERED: THE WILD LAW JUDGMENT PROJECT (Nicole Rogers & Michelle Maloney eds., 2017) (a collection of papers critiquing judgments from the perspective of wild law and suggesting judgments and cases in favor of animal species).