RESILIENT CARBON

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SUMMARY

Carbon offsets allow polluters to pay someone else to reduce, avoid, or remove emissions to counterbalance their own emissions. For some, carbon accounting concerns render offsets a necessary evil to be tightly regulated on the path toward decarbonization. For others, moral and political concerns render offsets a dangerous mistake to be thrown out of the climate law toolbox. This Article defends the critical role of carbon offsets in climate law, reframing the problem as the broader challenge of "climate resilience" and explaining why offsets are uniquely suited to integrate decarbonization and adaptation. It calls attention to overlooked adaptive practices like agroforestry and coastal reforestation; unearths the history of carbon offsets as playing the essential collateral role of securing regulatory buy-in from a large, heterogeneous class of polluters; and argues that focusing on resilient carbon begins to address many of the accounting, moral, and political concerns with offsets. Climate adaptation favors the payment-for-services and market-based approach of offsetting on normative and pragmatic grounds, even if the narrower goal of decarbonization does not.

In August 2022, the political comedian John Oliver "debunked" carbon offsets on *Last Week Tonight*, a weekly half-hour talk show that exposes policy issues with humor and satirical moral outrage.[1] He accused "giant corporations" like Disney and Apple of buying offsets to "green things up," even though the funded forest projects did not deliver on the promised carbon benefits and sometimes displaced local communities from their ancestral land. He warned that "[t]he level of carbon dioxide in the atmosphere is now higher than ever in human history," but "we cannot offset our way out of climate change."[2]

Oliver's argument is not new. Legal scholars,[3] moral philosophers,[4] and journalists[5] have been critical of carbon offsets on technical, moral, and political grounds, ever since they originated in international climate agreements

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1. *Last Week Tonight With John Oliver: Carbon Offsets* (HBO television broadcast Aug. 21, 2022).
2. *Id.*
3. For legal scholarship on net zero and offsets, see Shelley Welton, *Neutralizing the Atmosphere*, 132 Yale L.J. 171 (2022); Albert C. Lin, *Making Net Zero Matter*, 79 Wash. & Lee L. Rev. 679 (2022); and Albert C. Lin, *Carbon Dioxide Removal After Paris*, 45 Ecology L.Q. 533 (2019). For legal scholarship on offsets generally, see Michael P. Vandenbergh & Anne C. Steinemann, *The Carbon-Neutral Individual*, 82 N.Y.U. L. Rev. 1673 (2007); Maria Savasta-Kennedy, *The Newest Hybrid: Notes Toward Standardized Certification of Carbon Offsets*, 34 N.C. J. Int'l L. & Com. Regul. 851 (2009); David Takacs, *Carbon Into Gold: Forest Carbon Offsets, Climate Change Adaptation, and International Law*, 15 Hastings W.-Nw. J. Env't L. & Pol'y 39 (2009); Tyler McNish, *Carbon Offsets Are a Bridge Too Far in the Tradable Property Rights Revolution*, 36 Harv. Env't L. Rev. 387 (2012); and Manny Rutinel & Sebastian Quaade, *Reducing Animal Agriculture Emissions: The Viability of a Farm Transition Carbon Offset Protocol*, 52 ELR 10907 (Nov. 2022).
4. *See* Michael J. Sandel, *It's Immoral to Buy the Right to Pollute*, N.Y. Times, Dec. 15, 1997, at A23 (articulating technical, moral, and political critiques of offsets); Robert E. Goodin, *Selling Environmental Indulgences*, 47 Kyklos 573 (1994) (critique of offsets within deontological framework); Note, *Uncommon Goods: On Environmental Virtues and Voluntary Carbon Offsets*, 123 Harv. L. Rev. 2065 (2010) (critique of offsets within a virtue theory framework); Christian Barry & Garrett Cullity, *Offsetting and Risk Imposition*, 132 Ethics 352 (2022) (defending carbon removal offsets within a contractarian framework). Moral critiques are part of a larger debate about market-based regulatory solutions to environmental harms. *See* Section V.C.
5. For prominent media coverage of offset programs, see Lisa Song & James Temple, *The Climate Solution Actually Adding Millions of Tons of CO_2 Into the Atmosphere*, ProPublica (Apr. 29, 2021), https://www.propublica.org/article/the-climate-solution-actually-adding-millions-of-tons-of-co2-into-the-atmosphere (raising concerns about California's compliance offset program). *Cf.* California Air Resources Board (CARB), CARB Responses to Questions From ProPublica on California's Forest Offset Protocol (2021), https://ww2.arb.ca.gov/sites/default/files/2021-04/nc-carb-response-to-propublica-forest-questions.pdf. State and federal legislation considers intervention in offset markets. S. 1251, 117th Cong. (2021) (proposes verification program under the U.S. Department of Agriculture (USDA) to expand the voluntary carbon offset market for the agricultural sector).

in the late 1990s. These concerns reached a fever pitch after international negotiation of the Paris Agreement in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC).[6] Thousands of countries, states, cities, and businesses, covering a breathtaking 91% of the global economy as of 2022, voluntarily pledged to go "net zero" by reducing their emissions and counterbalancing any residual emissions with offsets.[7] Consequently, global carbon markets that sold just under $2 billion of offsets in 2021 are projected to grow anywhere from thirtyfold to 100-fold by mid-century.[8] Billions of public and private dollars will be directed toward carbon-reduction projects, every year, over the multiple decades required to decarbonize the economy.

Should climate change law embrace carbon offsets? And if so, on what terms? This question is salient as international,[9] federal,[10] and state actors[11] are considering legal and policy proposals to intervene in carbon markets and decarbonization schemes. For some legal scholars, technical concerns render offsets a necessary evil to be tightly regulated on the path toward decarbonization. Prof. Albert Lin has advocated for a gradualist approach to reform: accountability and enforcement mechanisms that carve out a more defined and limited role for offsets in decarbonization schemes.[12] For others, moral and political concerns render offsets a dangerous mistake to be thrown out of the climate law toolbox. Prof. Shelley Welton has advocated for sweeping reforms, including redirecting public and private funds dedicated to offsetting toward a public mitigation fund, ultimately eliminating the need for carbon markets altogether.[13]

This Article defends the critical role of offsets in climate law. It begins by reframing the problem of net zero and offsets as the broader challenge of "climate resilience": how can climate change law decarbonize the economy in order to prevent avoidable warming while, at the same time, helping communities adapt to the harmful impacts of unavoidable warming? In doing so, it diagnoses a different underlying problem with carbon offsets: they have been structured and conceptualized solely in service of decarbonization, rarely for adaptation as well.

Scientists agree that reducing greenhouse gas (GHG) emissions everywhere as much and as quickly as possible is needed to limit the damage associated with a warming planet.[14] Yet even with the most ambitious decarbonization efforts, the next three generations at least will need to deal with the impacts of committed warming—including floods, sea-level rise, droughts, heat waves, power outages, longer allergy seasons, lower crop yields, livestock stress, and biodiversity loss—before seeing any global cooling from efforts taken generations earlier.[15] As a result, there is "widespread agreement" among scientists, policymakers, and legal scholars that climate change law must combine decarbonization and adaptation as part of an integrated "climate resilience" framework.[16]

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6. Kyoto Protocol to the UNFCCC art. 12, Dec. 10, 1997, 2303 U.N.T.S. 148 (establishing the Clean Development Mechanism).
7. NewClimate Institute et al., Net Zero Stocktake 2022 (2022). Most notably, the United States and China, the world's two largest emitters, have pledged to go net zero by 2050 and 2060, respectively. *See* Exec. Order No. 14008, 86 Fed. Reg. 7619 (Feb. 1, 2021) (expressing the legally nonbinding intent to "put the United States on a path to achieve net zero emissions, economy-wide, by no later than 2050"). *See* Somini Sengupta, *China, in Pointed Message to U.S., Tightens Its Climate Targets*, N.Y. Times (Sept. 22, 2020), https://www.nytimes.com/2020/09/22/climate/china-emissions.html.
8. Trove Research, Future Demand, Supply, and Prices for Voluntary Carbon Credits—Keeping the Balance (2021); Christopher Blaufelder et al., McKinsey & Company, A Blueprint for Scaling Voluntary Carbon Markets to Meet the Climate Challenge (2021).
9. UNFCCC, *Guidance on the Mechanism Established by Article 6, Paragraph 4 of the Paris Agreement*, Annex I, §IV.A, para. 29(b) (Nov. 19, 2022) (establishing a new type of carbon credit authorized for use toward achievement of national decarbonization goals under the Paris Agreement).
10. *See, e.g.*, The Enhancement and Standardization of Climate-Related Disclosures for Investors, 87 Fed. Reg. 21334 (Apr. 11, 2022) (proposed rule requiring publicly held companies to disclose the role, source, and cost of carbon offsets used in its climate-related business strategy); Press Release, Commodity Futures Trading Commission, CFTC Releases Request for Information on Climate-Related Financial Risk (June 2, 2022) (requesting information on voluntary carbon markets); Press Release, USDA, USDA to Invest $1 Billion in Climate Smart Commodities, Expanding Markets, Strengthening Rural America (Feb. 7, 2022) (announcing subsidies for pilot agricultural offset projects).
11. *See* S.B. 5699, 2023-2024 Leg. (Wash. 2023) (assistance to state for selling carbon offsets); S.B. 48, 33d Leg. (Alaska 2023) (allowing private parties to lease state land to undertake carbon offset programs); H.B. 395, 2020 Reg. Sess. (Va. 2020) (allowing state to participate in marine carbon offset market); S.B. 373, 2021 Sess. (Ind. 2021) (proposing working group to study state role in a voluntary carbon offset market).
12. Lin, *Making Net Zero Matter*, *supra* note 3, at 758-66.
13. Welton, *supra* note 3, at 244; McNish, *supra* note 3, at 391, 433. *See also* Michael Wara, *Measuring the Clean Development Mechanism's Performance and Potential*, 55 UCLA L. Rev. 1759, 1801 (2008). *See generally* Section V.C.
14. *See* Intergovernmental Panel on Climate Change (IPCC), *Summary for Policymakers*, *in* Global Warming of 1.5°C, at 12 (Valérie Masson-Delmotte et al. eds., Cambridge Univ. Press 2018), https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SPM_version_report_LR.pdf (finding that to limit warming to 1.5°C, global carbon dioxide (CO_2) emissions must decline to net zero around 2050).
15. Scientists estimate that CO_2 remains in the atmosphere for anywhere between 200 and 1,000 years. Thus, any climate benefits from decarbonization efforts will be delayed for multiple generations. *See, e.g.*, Alan Buis, NASA Jet Propulsion Laboratory, The Atmosphere: Getting a Handle on Carbon Dioxide (2019); Claudia Tebaldi & Pierre Friedlingstein, *Delayed Detection of Climate Mitigation Benefits Due to Climate Inertia and Variability*, 110 PNAS 17229 (2013); Jochem Marotzke, *Quantifying the Irreducible Uncertainty in Near-Term Climate Projections*, 10 WIREs Climate Change 1 (2018); Bjørn H. Samset et al., *Delayed Emergence of a Global Temperature Response After Emission Mitigation*, 11 Nature Commc'ns 3261 (2020); Mason Inman, *Carbon Is Forever*, 1 Nature Climate Change 156, 156-57 (2008).

    According to a commonly used climate-economy model, the break-even year for mitigation efforts launched in the early 2020s would be only around 2080. Assuming that the average life expectancy is 72 years, the generation born around 2050 would be the first to experience cumulative economic net benefit from mitigation policy. Patrick T. Brown et al., *Break-Even Year: A Concept for Understanding Intergenerational Trade-Offs in Climate Change Mitigation Policy*, 2 Env't Rsch. Commc'ns 95002 (2020).
16. *See* U.S. Global Change Research Program, Global Climate Change Impacts in the United States 11 (2009) ("Mitigation and adaptation are both essential parts of a comprehensive climate change response strategy."). For legal scholarship advocating for integration of adaptation and mitigation, see J.B. Ruhl & Robin Craig, *4°C*, 106 Minn. L. Rev. 191, 196 (2021); Katherine Trisolini, *Holistic Climate Change Governance: Towards Mitigation and Adaptation Synthesis*, 85 U. Colo. L. Rev. 615, 679-86 (2014); James E. Parker-Flynn, *The Intersection of Mitigation and Adaptation in Climate Law and Policy*, 38 Environs Env't L. & Pol'y J. 1 (2014); Lesley MacAllister, *Adaptive Mitigation in the Electric Power Sector*, 2011 B.Y.U. L. Rev. 2115 (2011); Elizabeth Burleson, *A Climate of Extremes: Transboundary Conflict Resolution*, 32 Vt. L. Rev. 477, 496, 501 (2008).

By exploring the climate-resilience potential of carbon offset markets, this Article makes three novel contributions. First, it highlights adaptive carbon removal practices, like coastal and urban reforestation and agroforestry, overlooked in the conversation about net zero and offsets. Mangrove forests protect coastal communities against storms and sea-level rise, reducing billions of dollars in property damage annually while removing more carbon than any terrestrial ecosystem.[17] Agroforestry, the integration of productive trees on farmland, could counterbalance an estimated one-third of domestic fossil fuel emissions annually while protecting livestock and crops from climate impacts.[18] Urban trees on sidewalks, rooftops, and abandoned lots in cities and suburbs can absorb dangerous floodwaters and reduce deaths from heat waves.[19] Studies find that these types of nature-based carbon removal projects help communities adapt to climate impacts better than "hard" interventions like seawalls and levees.[20]

Second, the Article unearths the history of carbon offsets in international, federal, state, and private climate law. While they have been designed for decarbonization, offsets have played a critical collateral function in securing regulatory buy-in from a large and heterogeneous class of polluters. It also shows how carbon markets have evolved over time in response to legitimate technical concerns and public skepticism.

Third, the Article integrates the past and possible futures of carbon markets, arguing for a gradualist approach to market reform that preserves the role of offsetting in the net-zero framework while restructuring offsets for the more holistic goal of climate resilience. To this end, it identifies multiple pathways for public intervention in carbon markets, from public offset certification to aggregation of small-scale projects.[21] Carbon offsets advertised as creating social and environmental co-benefits are already selling for a significant premium in the unregulated marketplace.[22] Federal, state, and local governments should capitalize on this opportunity to steer investments from polluters toward resilient carbon removal practices that address both faces of climate change.

The Article proceeds in six parts. Part I outlines the intergenerational justice argument for integrating mitigation and adaptation within a holistic climate-resilience framework. Part II traces the past and present of carbon markets within decarbonization schemes. Part III builds the argument for climate-resilient carbon offsets by identifying promising nature-based carbon removal practices commodifiable as offsets. Part IV identifies implementation pathways. Part V addresses leading technical, moral, and political objections against carbon offsetting. Part VI concludes.

I. Why Resilience?

This part explains the key differences between mitigation and adaptation as the two dominant legal and policy approaches within climate change law. It then makes the intergenerational equity case for a middle path: climate resilience, which integrates adaptation and mitigation. Finally, it discusses conceptual and regulatory obstacles to climate resilience.

A. Mitigation, Adaptation, and Resilience

When a city experiences a heat wave attributed to climate change, all neighborhoods may be affected by a single impact insofar as nighttime temperatures stay elevated for several days across the city. Low-income neighborhoods with more elderly people living alone might suffer worse health outcomes and lose more lives due to the heat wave than high-income neighborhoods, to the extent that low-income neighborhoods lack access to temperature-regulation infrastructure like tree shade and air-conditioning.

Climate law provides three conceptual frameworks to address this harm.[23] First, mitigation, or decarbonization, focuses on lowering atmospheric concentrations of GHGs to prevent avoidable climate impacts. These impacts include more frequent and intense heat waves, floods, sea-level rise, droughts, power outages, longer allergy seasons, lower crop yields, livestock stress, and biodiversity loss.[24] Second, adaptation focuses on modifying human behavior and the nonhuman environment to reduce death, disease, displacement, and other adverse outcomes in response to unavoidable climate change.[25]

There are key conceptual differences between mitigation and adaptation. Mitigation has one desirable end state: the lowest possible atmospheric concentrations of GHGs as soon as possible. Adaptation "goes with the flow," aiming to preserve life, health, property, and other valuables against an unpredictable current of unavoidable climate impacts.[26]

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17. Daniel M. Alongi, *Carbon Cycling and Storage in Mangrove Forests*, 6 Ann. Rev. Marine Sci. 195, 198 (2014) (mangrove forests store three times more carbon than rain forests). *See* Section III.B.1.
18. Ranjith P. Udawatta & Shibu Jose, *Agroforestry Strategies to Sequester Carbon in Temperate North America*, 86 Agroforestry Sys. 225 (2012). *See* Section III.B.2.
19. *See* Section III.B.3.
20. Mangrove forests can expand following coastlines with sea-level rise. Seawalls are much harder to move. Alexandre Chausson et al., *Mapping the Effectiveness of Nature-Based Solutions for Climate Change Adaptation*, 26 Glob. Change Biology 6134 (2020) (global literature review finding that "most" nature-based interventions designed for decarbonization were reported to have adaptation co-benefits that were "as effective or more so than alternative interventions").
21. *See* Part IV.
22. Jiehong Lou et al., *Integrating Sustainability Into Climate Finance by Quantifying the Co-Benefits and Market Impact of Carbon Projects*, 3 Commc'ns Earth & Env't 1 (2022) (Gold Standard offsets tied to the United Nations Sustainable Development Goals sell for a 30% premium over "basic" offsets).
23. *See* Robin K. Craig, *"Stationarity Is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 Harv. Env't L. Rev. 9, 28 (2010) (describing structural differences between adaptation and mitigation); J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 Env't L. 363, 410 (2010).
24. *See* IPCC, Climate Change 2014: Synthesis Report (Rajendra K. Pachauri et al. eds., 2014), https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf.
25. *Id.* at 19.
26. Ruhl & Craig, *supra* note 16, at 202 (defining "success" in domestic adaptation to a 4°C scenario as, in part, the absence of tribalism or authoritarianism and the presence of some form of democratic governance).

Mitigation requires doing a few things at most—reduce and remove emissions everywhere as much as possible and as quickly as possible—whereas adaptation requires doing different things in different places that will change over time in unpredictable ways.[27]

Mitigation and adaptation present two different resource allocation strategies. At the local level, a mitigation framework might focus more on reducing energy production emissions (e.g., by replacing coal plants with wind and solar) than toward reducing agricultural emissions, which have a lower carbon footprint.[28] At the global level, it would focus more on reducing emissions from China and the United States, which are jointly responsible for around 40% of global emissions, than toward cutting emissions from Sub-Saharan African countries and small island States, which are responsible for a much smaller portion of the emissions pie.[29] Demand side policies are an overlooked but powerful mitigation strategy in wealthy countries. A 2021 study found that reducing consumer demand for excessively energy-intensive goods like animal-based foods, car transportation, and large dwellings can reduce sectoral emissions by an estimated 40%-80%.[30]

An adaptation framework would allocate more resources to low-income neighborhoods and households to escape from heat waves and compounding impacts like air pollution and contaminated drinking water.[31] As people move out of unbearably hot neighborhoods into cooler ones, resources for critical infrastructure, including housing, energy, transportation, and water, will likely need to relocate with migrating populations to their next destination.[32] A global adaptation strategy would allocate more resources for developing nations south of the equator, which stand to lose the most lives, property, and economic wealth due to the changing climate.[33] With mass human migration from more vulnerable to less vulnerable regions of the world, these resources would move accordingly as well.

The third strategy to deal with climate change coined by the Intergovernmental Panel on Climate Change (IPCC), the body of scientific experts that provides peer-reviewed climate science to inform international negotiations, is "climate-resilient development."[34] Climate resilience involves prioritizing mitigation strategies that (1) reduce the cost of adaptation later on; (2) facilitate multiple adaptation strategies; or (3) directly produce adaptation co-benefits.[35] For example, urban trees sequester carbon while providing flood control, stormwater treatment, air purification, and cooling, contributing up to a 5.4 degrees Celsius (°C) temperature difference within the same city.[36] Buildings retrofitted with improved insulation, triple-paned windows, and rooftop solar panels reduce energy emissions and slow dangerous indoor temperature shifts during weather-related power outages.[37] These resilient technologies became especially salient during the massive grid failures triggered by Hurricane Fiona in 2022 and an unprecedented Texas winter storm in 2021.[38]

Whether mitigation, adaptation, or resilience is a more appropriate response to address our hypothetical heat wave depends on a threshold conceptual question: is the heat wave avoidable or unavoidable? To begin with, the IPCC in 2021 identified five different emission scenarios beginning in 2015, each of which produces a very different climate outcome by 2100.[39] Under all scenarios, temperatures will climb to 1.5°C above pre-industrial levels by 2040 due to "committed warming," or the planet's response to accumulated concentrations of GHG emissions in the

27. Craig, *supra* note 23, at 28-31.
28. U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021 (2023).
29. Tom A. Boden et al., U.S. Department of Energy, National CO_2 Emissions From Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2014 (2014).
30. Felix Creutzig et al., *Demand-Side Solutions to Climate Change Mitigation Consistent With High Levels of Well-Being*, 12 Nature Climate Change 36 (2022).
31. Ruhl & Craig, *supra* note 16, at 200 (identifying migration as a significant adaptation issue given that by 2070 one-third of the world's population would exist in an annual temperature range presently found on the Saharan desert if they were to stay in place).
32. *Id.* at 201, 244 ("redesign" adaptation strategy includes measures needed "to reconfigure and relocate our nation's population distribution, land uses, infrastructure, economic and production networks, natural resource management, and other social, ecological, and technological systems").
33. *See* IPCC, Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems 17 (Priyadarshi R. Shukla et al. eds., 2019) (Asia and Africa are projected to have the highest number of people vulnerable to increased desertification; tropics and subtropics are projected to be most vulnerable to crop yield decline; women, the young, elderly, and poor are most at risk across all populations). *See also* Eliza Pan, *Reimagining the Climate Migration Paradigm: Bridging Conceptual Barriers to Climate Migration Responses*, 50 Env't L. 1173 (2020).
34. *See, e.g.*, Fatima Denton et al., *Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development*, *in* Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 1101, 1106 (C.B. Field et al. eds., Cambridge Univ. Press 2014).
35. Trisolini, *supra* note 16, at 615, 679-86.
36. Robert I. McDonald et al., *The Tree Cover and Temperature Disparity in US Urbanized Areas: Quantifying the Association With Income Across 5,723 Communities*, 16 PLOS One e0249715 (2021).723 communities}, 16 {\\scaps PLoS ONE} e0249715 (2021 *See also* Shannon Lea Watkins & Ed Gerrish, *The Relationship Between Urban Forests and Race: A Meta-Analysis*, 209 J. Env't Mgmt. 152 (2018) (finding race-based inequity in urban forest cover); Josh Foster et al., Center for Clean Air Policy, The Value of Green Infrastructure for Urban Climate Adaptation 6-9, 21-27 (2011); U.S. Environmental Protection Agency (EPA), *Trees and Vegetation*, *in* Reducing Urban Heat Islands: Compendium of Strategies (2008). *See also* Section III.B.3.
37. *See* Part III.
38. Joshua Partlow & Arelis R. Hernandez, *Even Before Fiona, Puerto Rico's Power Grid Was Poised for Failure*, Wash. Post (Sept. 19, 2022), https://www.washingtonpost.com/nation/2022/09/19/puerto-rico-blackout-hurricane-fiona/.
39. *See* IPCC, *Summary for Policymakers*, *in* Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change 3, 14 (Valérie Masson-Delmotte et al. eds., Cambridge Univ. Press 2021). A 2017 *Nature* study narrows the "likely range of global temperature increase" to 2.0-4.9°C. Yet another 2020 climate model further narrows this range to 2.6-3.9°C. J.B. Ruhl and Robin Craig conclude from their comprehensive literature review of climate science that "we will be fortunate to limit temperature increase to 2.6°C, just as likely to reach 3.9°C, and the possibility of reaching 4.0°C or higher cannot be ignored." Steven C. Sherwood et al., *An Assessment of Earth's Climate Sensitivity Using Multiple Lines of Evidence*, 58 Revs. Geophysics e2019RG000678, at 2 (2020). Past 2100, emissions and global warming could both keep increasing.

atmosphere.[40] In the best-case scenario, global surface temperatures decline slightly to 1.4°C around 2080.[41] In the worst-case scenario, emissions increase according to business as usual and temperatures are predicted to climb up to 5.7°C around century's end.[42]

The fact that we are dealing with a mix of avoidable and unavoidable heat waves from now until century's end recommends strongly in favor of climate-resilient strategies. Heat waves due to 1.5°C of average global warming from now until century's end are functionally unavoidable. Moreover, cities experiencing heat waves will feel up to 5.8 degrees Fahrenheit (°F) hotter relative to surrounding areas due to the urban heat island effect, and vulnerable neighborhoods within those cities will suffer the brunt of harms.[43] Of course, decarbonization is also critical because every additional ton of carbon increases (nonlinearly) global warming, which, in turn, increases (nonlinearly) the frequency and intensity of heat waves in the future.[44]

B. *Intergenerational Argument for Resilience*

Beyond the conceptual distinction between avoidable and unavoidable impacts, intergenerational justice considerations also recommend strongly in favor of climate-resilient development. Intergenerational justice deals with questions about present generations' obligations to future generations.[45] To curb our cognitive bias toward present interests, discussions of intergenerational justice obligations tend to prioritize the interests of future generations.[46]

At first, this claim may appear counterintuitive. Like much of environmental protection, aggressive decarbonization is often defended as a first-best strategy for future generations, for three reasons.[47] First, it is necessary to place the world on the lowest emission pathway toward the coolest future, which reduces future adaptation costs relative to a less aggressive decarbonization strategy. Thus, it appears to leave future generations better off than a less aggressive decarbonization strategy.[48] Second, climate adaptation helps present generations respond to unavoidable climate impacts with no apparent benefits for future generations. Third, given limited time and will, adaptation appears to distract the public from meeting the ambitious, long-term demands of mitigation.[49]

However, just because an aggressive decarbonization strategy benefits future generations in principle does not mean that doing so benefits them in practice. Decarbonization pursued in isolation from adaptation may backfire due to loss of political will and unintended health and safety risks.

1. Loss of Political Will

First, pursuing aggressive decarbonization strategies that lack benefits for present generations risks loss of political support for those policies over time. Yet because decarbonization policies must be sustained over multiple decades to be effective, long-term support is necessary for them to yield tangible benefits for future generations. As Prof. Eric Biber warns, public support is fragile when it comes to policies with immediate costs but extremely delayed and dispersed benefits.[50]

Consider the following. In the best-case scenario, aggressive decarbonization efforts taken around 2020 lead to net-zero global emissions by 2050. But even then, global temperatures will only begin to decline, and only slightly, around 2080, when many of those responsible for launching mitigation efforts in 2020 will no longer be alive. The absence of tangible benefits for decades as global temperatures continue to climb reduces the likelihood that decarbonization efforts implemented now will be adequately enforced or extended in order to have the intended effect.[51]

For example, fossil fuel restrictions may be lifted in response to public outcry over rising energy costs—a predictable consequence of a massive energy transition and an unpredictable consequence of economic and geopolitical shocks. Despite its fervent climate commitments, the Joseph Biden Administration dipped into national oil reserves and lifted a seasonal ban on carbon-intensive gasoline in 2021 and 2022 in order to mollify angry consumers.[52] Similarly, state and federal legislatures may decline to

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40. *See* IPCC, *supra* note 39.
41. *Id.*
42. *Id.*
43. *See* Section III.B.3.
44. Nigel W. Arnell et al., *Global and Regional Impacts of Climate Change at Different Levels of Global Temperature Increase*, 155 Climatic Change 377 (2019); IPCC, *supra* note 39, at 15; Timothy M. Lenton et al., *Climate Tipping Points—Too Risky to Bet Against*, 575 Nature 592, 592-95 (2019). *See also* Ruhl & Craig, *supra* note 16, at 193.
45. Stephen M. Gardiner, *A Perfect Moral Storm: Climate Change, Intergenerational Ethics, and the Problem of Moral Corruption*, 15 Env't Values 397 (2006).
46. *Id.* at 404.
47. A. Dan Tarlock, *Takings, Water Rights, and Climate Change*, 36 Vt. L. Rev. 731, 733-34 (2012) (adaptation has emerged as a second-best imperative to mitigation).
48. Shelley Welton, *Decarbonization in Democracy*, 67 UCLA L. Rev. 56, 68 (2020).
49. *See*, *e.g.*, Ruhl, *supra* note 23, at 365-75 ("[T]he challenge of climate change was portrayed as so exceptional, and the need for a new mitigation policy of sweeping dimensions thus so pressing, that talk of adaptation became taboo for fear it might knock the mitigation train off its tracks and lead to complacency."). *See also* E. Lisa Schipper & Ian Burton, *Understanding Adaptation: Origins, Concepts, Practice, and Policy*, *in* The Earthscan Reader on Adaptation to Climate Change 1, 7 (E. Lisa F. Schipper & Ian Burton eds., 2008). In the leading ethical analysis of climate inaction, the philosopher Stephen Gardiner argues that present generations faced with unavoidable climate impacts will "have an incentive to overinvest in adaptation," which risks triggering an intergenerational "arms race" where subsequent generations also choose to invest in adaptation at the exclusion of mitigation. *See* Stephen Gardiner, A Perfect Moral Storm: The Ethical Tragedy of Climate Change 199-203 (2011).
50. Eric Biber, *Climate Change and Backlash*, 17 N.Y.U. Env't L.J. 1295, 1299 (2009).
51. Lin, *Making Net Zero Matter*, *supra* note 3, at 707-08 ("The fact that many net-zero targets are decades away raises additional doubts: in the year 2050, will anyone notice or sanction an entity's failure to achieve a target set in 2021?").
52. Zolan Kanno-Youngs et al., *The United States and Other World Powers Will Tap Oil Reserves*, N.Y. Times (Nov. 23, 2021), https://www.nytimes.com/2021/11/23/business/biden-oil-reserves-gas-prices.html. *See also* Lisa Friedman & Michael D. Shear, *Biden Will Allow Summertime Sales of High-*

extend subsidies and other favorable treatment of solar and wind development if cheap, convenient renewable electricity is not seen for multiple generations.

Loss of political support for decarbonization efforts has knock-on effects. If the world overshoots emission targets (net zero) and temperature targets (2°C) due to insufficient follow-through, this may exacerbate distrust and indifference toward subsequent climate efforts. As Prof. Carol Rose argues, these attitudes are dangerous psychological barriers to solving collective action problems generally.[53] They may undermine subsequent international and domestic negotiations needed to mitigate and respond to a worsening climate.[54]

An integrated climate-resilience strategy can help sustain the political will necessary for decarbonization efforts to bear fruit, in two ways. First, the public is more likely to care about adaptation because its benefits are more local, immediate, and certain.[55] Indeed, a 2016 global study found that when the short-term co-benefits of decarbonization proposals (e.g., economic development) were emphasized, individual support shot up to a similar degree as if the respondents had believed in the importance of climate change.[56] Thus, subsidizing highly adaptive decarbonization technologies like rooftop solar in regions prone to hurricanes and urban trees in areas prone to heat waves could soften public attitudes of distrust and indifference toward climate policies.

Second, climate resilience is compatible with any emission scenario. It presents a flexible, no-regrets option over the next century, whether the world is on track to reach net zero by mid-century or on track to overshoot every target. Contrary to established wisdom, strategically playing to the interest of present generations may ultimately redound to the benefit of future generations.

2. Unintended Risks

The second way in which an aggressive decarbonization strategy might harm future generations is by unintentionally exacerbating health and safety risks in ways even worse than the direct impacts of climate change. For example, replacing a coal power plant with a nuclear plant along a low-lying coastline would drastically reduce emissions,[57] but it also increases the risk of accidents and waste release during storm surges, which will only become stronger and more frequent as the climate warms.[58] Increased biofuel production is virtually required to reduce aviation emissions.[59] But it comes at the cost of displacing valuable farmland and forestland. Indeed, a 2018 study found that stringent mitigation policies like biofuel subsidies would be even more devastating than the direct impacts of climate change on food-insecure and climate-vulnerable regions of Sub-Saharan Africa and Asia.[60] Both risks are eclipsed by the rampant human rights abuses and environmental degradation from cobalt mining currently inflicted upon Congolese communities to support electric vehicle production.[61]

Ecologist Crawford S. Holling observed a similar "pathology" in natural resource management, where interventions designed to achieve a specific, predicted outcome often result in unintended ecological, social, and economic harms.[62] For example, the use of herbicides and pesticides is extremely effective at controlling agricultural pests at first but also results in larger insect outbreaks when spraying stops, as well as air and water pollution and soil erosion. Aggressively seeking to prevent one risk may result in a potentially worse set of unintended risks, especially when dealing with complex, unpredictable natural ecosystems.[63]

To remedy this pathology, Holling recommended more flexible interventions that anticipate and respond to emerging problems.[64] For instance, compared to chemical pesticides, diversifying agricultural ecosystems to enhance natural pest predators may be less effective at controlling certain pest species in the short term. But it also prevents unexpected insect outbreaks and other unintended harms like soil erosion and chemical pollution. Thus, agricultural diversification may be a more sustainable solution to agricultural pests in the long run than pesticides.[65]

Prof. Tim Malloy extends Holling's insight to administrative agency decisionmaking on issues of environmental and safety risk prevention.[66] He argues that when selecting among a suite of safety measures, agencies should select

er-Ethanol Gas, N.Y. Times (Apr. 12, 2022), https://www.nytimes.com/2022/04/12/business/economy/biden-ethanol-gas.html.

53. Carol Rose, *Commons, Cognition, and Climate Change*, 32 J. Land Use & Env't L. 297, 302 (2017).
54. *See also* Barton H. Thompson Jr., *Tragically Difficult: The Obstacles to Governing the Commons*, 30 Env't L. 241, 245-46 (2000) (people are more likely to cooperate when they think others are bound to do so too).
55. Biber, *supra* note 50, at 1300; Robert R.M. Verchick, *Culture, Cognition, and Climate*, 2016 U. Ill. L. Rev. 969, 1007-10 (2016) (arguing that local adaptation efforts could loosen political partisanship on climate mitigation).
56. Paul G. Bain et al., *Co-Benefits of Addressing Climate Change Can Motivate Action Around the World*, 6 Nature Climate Change 154 (2016).
57. Vaclav Smil, Energy at the Crossroads: Global Perspectives and Uncertainties 313 (2005) (estimating nine grams of CO_2 per kilowatt hour of electricity generated by nuclear power).
58. Trisolini, *supra* note 16, at 668-72.
59. Candelaria Bergero et al., *Pathways to Net-Zero Emissions From Aviation*, 6 Nature Sustainability 404 (2023) respectively, of projected business-as-usual aviation emissions in 2050. However, further reductions will depend on replacing fossil jet fuel with large quantities of net-zero emissions biofuels or synthetic fuels (that is, 2.5–19.8 EJ of sustainable aviation fuels (estimating that biofuel production must increase fivefold for aviation sector to become carbon-neutral).
60. Tomoko Hasegawa et al., *Risk of Increased Food Insecurity Under Stringent Global Climate Change Mitigation Policy*, 8 Nature Climate Change 699 (2018).
61. Siddharth Kara, Cobalt Red: How the Blood of the Congo Powers Our Lives (2023).
62. *See* Crawford S. Holling & Gary K. Meffe, *Command and Control and the Pathology of Natural Resource Management*, 10 Conservation Biology 328 (1996). *See also* Timothy Malloy, *Re-Imagining Risk: The Role of Resilience and Prevention*, 22 Nev. L.J. 145 (2021).
63. *See also* Jonathan Baert Wiener, *Managing the Iatrogenic Risk of Risk Management*, 9 Risk: Health Safety & Env't 39, 40 (1998).
64. Holling & Meffe, *supra* note 62, at 334-35.
65. Studies of rice-fish aquacultures have shown this effect. J. Stephen Lansing & James Kremer, *Rice, Fish, and the Planet*, 108 PNAS 19841 (2011); Fengbo Li et al., *Impact of Rice-Fish/Shrimp Co-Culture on the N_2O Emission and NH_3 Volatilization in Intensive Aquaculture Ponds*, 655 Sci. Total Env't 284 (2019); Jian Xie et al., *Ecological Mechanisms Underlying the Sustainability of the Agricultural Heritage Rice-Fish Coculture System*, 108 PNAS E1381 (2011).
66. Malloy, *supra* note 62, at 202-07.

the measure that performs well across a *set* of important criteria, like risk mitigation and adaptation.[67] This type of "multi-criteria decision analysis" is preferable to pursuing those criteria in separate areas of decisionmaking, especially when dealing with situations marked by complexity and uncertainty.[68]

More broadly, it is standard practice for regulatory agencies to treat the secondary co-harms and co-benefits of a regulatory proposal on par with its targeted benefits.[69] For example, the 1990 Clean Air Act Amendments regulated power plant sulfur dioxide emissions to reduce risks posed by acid rain, but most of the monetized benefits from the regulation resulted from reducing human exposure to fine particulate matter, which contributes to premature mortality.[70] This type of comprehensive accounting of a regulation's costs and benefits promises more rational decisionmaking, by avoiding welfare-reducing under-regulation and over-regulation.[71] It also promises more meaningful public participation, by providing more accurate information about the effects of governmental acts.[72]

What does this mean for climate law? Like natural ecosystems, climate change interacts with socioecological systems in complex, unpredictable ways. Decarbonization efforts must at least be cognizant of adaptation challenges to avoid undesirable trade offs like nuclear disasters and worsened food insecurity.[73] That means subsidizing low-emissions technologies that will not generally exacerbate health and safety risks in a changing climate. It also means siting those technologies and regulating their operation in ways that will not exacerbate local adaptation challenges and environmental justice concerns.[74]

Ideally, we should pursue integrated climate-resilient policies when possible. Doing so makes the most out of limited attention, will, and resources to minimize and respond to a continuously evolving risk with many immediate and future victims. A siloed decarbonization policy, even if it does not worsen adaptation challenges, comes at the opportunity cost of adaptation co-benefits, and vice versa.[75]

To illustrate, suppose that a storm-prone municipality is considering whether to use a federal grant to invest in rooftop solar panels, diesel backup generators, or utility-scale solar (a large field with solar panels).[76] All else equal (e.g., identical installation and operational costs), rooftop solar is likely the best choice. Utility-scale solar is not as adaptive to hurricanes because it relies on a large, storm-vulnerable grid to deliver electricity to customers. Diesel-powered generators continue to work after storms but are significantly more carbon-intensive than solar panels. In short, a climate-resilient strategy can protect future generations from the unintended harms of overzealous decarbonization, while optimizing limited resources to respond to a continuously evolving risk.

C. *The Regulatory Challenge of Resilience*

Despite "widespread agreement" among scholars and policymakers that mitigation and adaptation are "complementary" approaches to the climate crisis that should be pursued in a concurrent and integrated manner, there is a lack of scholarship identifying concrete legal, regulatory, or policy proposals for climate resilience.[77] Scholarship on climate resilience tends to catalog specific technologies, like urban forestry and building insulation, or identify extremely broad governance principles, like cooperation between different levels of government and the civil society.[78] These recommendations bear little resemblance to the familiar and well-tested suite of regulatory instruments available for climate mitigation.

Indeed, climate mitigation is essentially a classic pollution problem. It can be achieved with command-and-control regulations that mandate specific low-emissions technologies, emission fees, market-based regulations like cap and trade, and subsidies to incentivize low-emissions technologies.[79] U.S. federal environmental law has used these regulatory instruments for decades to clean up conventional pollutants from the air and water. Theoretically, the more stringent these controls (e.g., higher fees), the more effective the mitigation outcomes are. And because GHG emissions mix in the global atmosphere to produce global climate change, it is always more effective to implement mitigation strategies at higher levels of governance (e.g., international rather than local).

67. *Id.*
68. *Id.* at 203.
69. Office of Management and Budget, Circular A-4: Regulatory Analysis 26 (2003), https://obamawhitehouse.archives.gov/sites/default/files/omb/assets/omb/circulars/a004/a-4.pdf (agencies should "look beyond the direct benefits and direct costs . . . and consider any important ancillary benefits and countervailing risks"). U.S. EPA, Guidelines for Preparing Economic Analyses 11-2 (2014), https://www.epa.gov/sites/production/files/2017-08/documents/ee-0568-50.pdf (instructing EPA to assess "all identifiable costs and benefits" in its analysis of regulation). *See also* Samuel J. Rascoff & Richard L. Revesz, *The Biases of Risk Tradeoff Analysis: Towards Parity in Environmental and Health-and-Safety Regulation*, 69 U. Chi. L. Rev. 1763 (2002); Kimberly M. Castle & Richard L. Revesz, *Environmental Standards, Thresholds, and the Next Battleground of Climate Change Regulations*, 74 Minn. L. Rev. 1349 (2019).
70. Joseph E. Aldy et al., *Co-Benefits and Regulatory Impact Analysis: Theory and Evidence From Federal Air Quality Regulations* 6 (National Bureau of Economic Research, Working Paper No. 27603, 2020), https://www.nber.org/system/files/working_papers/w27603/w27603.pdf.
71. Rascoff & Revesz, *supra* note 69, at 1818.
72. Castle & Revesz, *supra* note 69, at 1437.
73. Ruhl & Craig, *supra* note 16, at 196.
74. Joel B. Eisen & Shelley Welton, *Clean Energy Justice: Charting an Emerging Agenda*, 43 Harv. Env't L. Rev. 307, 360-62 (2019) (large-scale wind and solar may disproportionately burden rural populations and Native American tribes).
75. Aldy et al., *supra* note 70.
76. Prabir Barooah, *With Rooftop Solar, It's Not Just About the Carbon Reduction*, Hill (Oct. 8, 2021), https://thehill.com/opinion/energy-environment/575937-with-rooftop-solar-its-not-just-about-the-carbon-reduction/.
77. Ruhl & Craig, *supra* note 16, at 196.
78. IPCC, *supra* note 39, at 29 (identifying "enabling condition[s]" of climate-resilient development to include "international cooperation" and "governments at all levels working with communities, civil society, educational bodies, scientific and other institutions, media, investors and businesses" and "developing partnerships with traditionally marginalized groups, including women, youth, Indigenous Peoples, local communities and ethnic minorities").
79. Craig, *supra* note 23, at 28. *See* Part II.

By contrast, adaptation strategies run the gamut from purely technological (e.g., seawalls) to behavioral (e.g., altered development patterns) to managerial (e.g., altered farm practices). These strategies must be tailored to a diverse array of climate impacts, from drought to flood to heat waves to longer allergy seasons. There is substantial uncertainty about how effective various options are at fully reducing risks at higher levels of warming.[80] And the ideal governance level for climate adaptation depends on the scale and location of the climate impact. For example, heat waves will impact mostly southern U.S. states, but their adverse health impacts will be concentrated in cities. Adaptation law is therefore a work in progress and will, as Prof. Robin Craig writes, "require both a new way of thinking about what regulation is supposed to accomplish and different kinds of legal frameworks for accomplishing those new goals."[81]

In light of basic conceptual differences between mitigation and adaptation and significant uncertainty about effective adaptation governance, it is no wonder regulatory strategies and legal frameworks for climate resilience have been underexplored. The next part begins to address this challenge by discussing the history of carbon offsets, a controversial regulatory instrument rooted in climate mitigation law.

II. Mitigation-Centric Carbon Offsets

Carbon offsets allow polluters to pay someone else to reduce, avoid, or remove emissions in order to negate or "neutralize" their own net-positive emissions. It follows the empirical assumption that, for carbon reductions, "a ton of emissions here is a ton there" because, to the extent that GHGs mix in the global atmosphere, it does not matter whether an entity curtails their own emissions or causes an equivalent emission-reducing activity somewhere else in the world.

This part traces the evolution of carbon offsets from the late 1990s to the early 2020s. It demonstrates how offsets have been structured primarily as a pollution control instrument in service of ambitious decarbonization goals, while playing collateral political, economic, and psychological functions. It also shows how offsets have persisted throughout the history of climate law, from top-down international climate agreements to bottom-up private climate pledges, evolving to address legitimate concerns.

A. Kyoto Protocol

Carbon offsets began as a political compromise within an international climate agreement governed by the explicit goal of reducing carbon emissions from the biggest polluters. Under the "common but differentiated" approach taken by the UNFCCC,[82] Party nations negotiating the Kyoto Protocol sought to implement binding emissions-reduction targets for industrialized countries and to exempt developing countries.[83] This framework created conflicts between industrialized countries like the United States, which were concerned about losing economic competitiveness to developing countries exempted from the targets, and less fossil fuel-dependent countries within the European Union, which pushed for more ambitious targets for developed countries.[84]

In the final moments of negotiations, the U.S. and Brazilian negotiators successfully lobbied for a compromise called the "Clean Development Mechanism" (CDM) despite significant opposition from European Union countries and environmental organizations.[85] Under the CDM, developed countries subject to mandatory emissions targets under Kyoto could buy carbon credits generated by developing countries to meet their targets in lieu of domestic emission reductions.[86] Developing countries could generate CDM credits by growing trees, implementing electrification projects to replace less energy-efficient processes, and other carbon removal and reduction projects.[87]

The CDM had a straightforward economic rationale: because carbon emissions are well-mixed in the atmosphere, where emission reductions occur should not matter. Therefore, if it is cheaper for developed countries to pay for reductions in other countries, then they should be allowed to do so. The CDM also had a clear political purpose: to induce the United States and other major developed nations to agree to binding emissions-reduction targets. It offered the financial carrot of lower compliance costs and removed the reputational stick associated with not directly meeting these targets through domestic reductions.[88] It also helped assuage U.S. concerns that China and other future economic competitors exempted from binding emission targets under Kyoto were involved in the international climate effort in some manner.

The CDM ultimately failed to persuade U.S. legislators to ratify the Kyoto Protocol.[89] However, it persists as the first global carbon market to use a standardized emission currency to transfer funds from wealthy polluters

80. IPCC, *Summary for Policymakers*, *in* Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change 7, 19 (Martin L. Parry et al. eds., Cambridge Univ. Press 2007).
81. Craig, *supra* note 23, at 30.
82. UNFCCC arts. 4(1) and 4(2)(A), May 9, 1992, S. Treaty Doc. No. 102-38, 1771 U.N.T.S. 107.
83. UNFCCC, *Berlin Mandate*, U.N. Doc. FCC/CP/1995/7/Add.1, art II.2(a) (June 6, 1995).
84. Daniel Bodansky, *The History of the Global Climate Change Regime*, *in* International Relations and Global Climate Change 23 (Urs Luterbacher & Detlef F. Sprintz eds., MIT Press 2001).
85. Franck Lecocq & Philippe Ambrosi, *The Clean Development Mechanism: History, Status, and Prospects*, 1 Rev. Env't Econ. & Pol'y 134 (2007).
86. Kyoto Protocol to the UNFCCC art. 12, Dec. 10, 1997, 2303 U.N.T.S. 148. Use of the CDM and other trading mechanisms under the Kyoto Protocol must be "supplementary" to domestic reductions. *Id*. arts. 6, 17.
87. The United Nations Executive Board would oversee project approval. *Id*. art. 12.4.
88. Lecocq & Ambrosi, *supra* note 85, at 135.
89. Byrd-Hagel Resolution, S. Res. 98, 105th Cong. (1997) (expressing the U.S. Senate's sense that the United States should not sign any protocol that did not include binding targets for both developed and developing countries).

toward decarbonization projects in developing countries. As the CDM market grew, it began attracting significant public criticism regarding the technical dubiousness of offset credits and the moral and political implications of market-based climate schemes.[90] Some of these concerns were predictable, given the United Nations' (U.N.'s) lack of experience overseeing a global security trading operation. Subsequent climate mitigation schemes incorporated offsets to attract polluter buy-in, but they were forced to grapple with these criticisms, which began to erode the public reputation of carbon offsets.

B. *Waxman-Markey*

A political compromise also led to the inclusion of carbon offsets within the United States' first federal climate proposal: the American Clean Energy and Security Act of 2009 (commonly known as "Waxman-Markey").[91] Like the Kyoto Protocol, Waxman-Markey aimed to reduce carbon emissions within a specific time frame. Unlike Kyoto, Waxman-Markey targeted major domestic polluters like power plants and fuel producers instead of major polluting countries.

Most importantly, the Kyoto Protocol was primarily a command-and-control scheme that mandated specific reduction targets for each polluter, supplemented with cost-containment mechanisms like the CDM. Waxman-Markey, on the other hand, relied on a comprehensive cap-and-trade mechanism whose explicit purpose was to reduce emissions at lowest cost. Cost was a major concern for U.S. House of Representatives Republicans as well as the American public, given that Waxman-Markey was proposed during the worst economic downturn in the United States since the Great Depression.[92]

Under cap and trade, the government puts a cap on total emissions within a regulated sector and then gives or auctions off emission permits ("allowances") to polluters. Like allowances, offsets are tradable rights to emit a certain volume of emissions over a certain period.[93] But whereas allowances are supplied by the government in fixed quantities, offsets are voluntarily supplied by entities not covered under the cap. Polluters can buy or sell unused allowances with each other.[94] At the end of a pre-specified period, polluters "pay" for their emissions by submitting an equivalent number of permits to the state. The "cap" is effectively lowered over time by reducing the total number of allowances issued. "Capping" and "trading" allowances reduces total emissions over time in a cost-effective fashion.

As Prof. Ann Carlson wrote upon introduction of Waxman-Markey, "political reality suggests that any successful climate bill is going to include offsets."[95] Indeed, the cost savings and reputational function of offsets carried over from the Kyoto Protocol to Waxman-Markey. The U.S. Environmental Protection Agency (EPA) predicted that allowing polluters to use offsets would cut allowance prices by half.[96] Unsurprisingly, polluters were allowed to buy a generous volume of domestic and international carbon offsets to meet their emission obligations under the final draft of Waxman-Markey.[97]

However, Waxman-Markey imposed two key guardrails on the use of offsets absent in the Kyoto Protocol: (1) a cap on the total volume of offsets that regulated polluters could use and (2) a discount ratio for foreign-produced offsets.[98] This effectively raised compliance costs for polluters and boosted prices for domestic offsets, which would theoretically be easier to regulate. The inclusion of offsets may have pushed Waxman-Markey through the House by narrow margins. However, the landmark climate bill ultimately lost out to other domestic political priorities like health care, and so was never brought to the U.S. Senate for a vote.[99]

C. *State Cap and Trade*

While the United States did not adopt legally binding GHG emission-reduction targets after the Kyoto Protocol and Waxman-Markey at the federal level (and has yet to do so[100]), carbon offsets persisted within state cap-and-trade regulations. The earliest was the Regional Greenhouse Gas Initiative (RGGI), an agreement signed in 2005 by

90. *See also* Part V.
91. *See* American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009).
92. Daniel J. Weiss, *Anatomy of a Senate Climate Bill Death*, Ctr. for Am. Progress (Oct. 12, 2010), https://www.americanprogress.org/article/anatomy-of-a-senate-climate-bill-death/.
93. One allowance or offset represents the right to emit one metric ton of CO_2 equivalent over the course of a year.
94. For legal scholarship discussing emissions cap-and-trade programs and predecessors, see Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 Harv. Env't L. Rev. 293 (2008); Jonathan Baert Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 Yale L.J. 677, 791 (1999); and Bruce Ackerman & Richard Stewart, *Reforming Environmental Law*, 37 Stan. L. Rev. 1333, 1341 (1985). For discussion of environmental credit trading schemes, see James Salzman et al., *Payments for Ecosystems Services: Past, Present, and Future*, 6 Tex. A&M L. Rev. 199, 216-19 (2018); and Carol Rose, *The Several Futures of Property: Of Cyberspace and Folk Tales, Emission Trades, and Ecosystems*, 83 Minn. L. Rev. 129, 165-67 (1998).
95. Ann Carlson, *Offsets and Waxman-Markey*, Legal Planet (July 31, 2009), https://legal-planet.org/2009/07/31/offsets-and-waxman-markey/.
96. U.S. EPA, EPA Analysis of the Waxman-Markey Discussion Draft: The American Clean Energy and Security Act of 2009—Executive Summary (2009).
97. Other provisions included a federal renewable electricity and efficiency standard and performance standards for new coal power plants. *See* Congressional Budget Office, Cost Estimate: H.R. 2454 American Clean Energy and Security Act of 2009, at 4 (2009), https://www.cbo.gov/sites/default/files/111th-congress-2009-2010/costestimate/hr24541.pdf.
98. The original draft of Waxman-Markey imposed even stricter guardrails. It discounted the value of all offsets by 80% of the value of an allowance. This provision was eliminated likely to gain political support for the overall proposal. U.S. EPA, Ways in Which Revisions to the American Clean Energy and Security Act Change the Projected Economic Impacts of the Bill (2009).
99. *See* Ryan Lizza, *As the World Burns*, New Yorker (Oct. 3, 2010), https://www.newyorker.com/magazine/2010/10/11/as-the-world-burns (documenting political horse-trading that led to the exclusion of Waxman-Markey in the Senate).
100. The latest legislative effort is the Climate Leadership and Environmental Action for Our Nation's (CLEAN) Future Act, H.R. 1512, 117th Cong. (2021).

seven eastern states (12 as of 2022),[101] and then California's Assembly Bill 32, the Global Warming Solutions Act, passed in 2006.[102] Washington and Oregon followed suit in 2021, adopting statewide cap-and-trade legislation.[103]

Under each program, polluters are permitted to submit state-approved or "compliance offsets" to meet a marginal portion of their legal emission-reduction obligations. While the CDM market crashed after the Kyoto Protocol's first compliance period expired in 2012, state cap-and-trade programs have generally been renewed until at least 2030.[104] Compliance offset markets are expected to be active and undergo various reforms until then.[105]

Like their international and federal predecessors, state offset programs primarily function to contain costs for polluters within a broader pollution control regulation. In service of this goal, states have adopted a sophisticated suite of accounting rules to ensure that offset trading does not result in a net *increase* in emissions. At a basic level, offsets are always required to represent "additional" and "permanent" emission reductions that are "quantifiable, verifiable, and enforceable."[106]

Additionality asks whether the carbon-reduction activity would have occurred anyway without financial incentive from the offset credit. If carbon benefits represented by an offset credit are not additional—because the activity is legally mandated or otherwise commercially profitable—then the purchase would effectively allow for a net increase in emissions from the buyer without a corresponding net decrease in emissions from the seller. Permanence requires carbon reductions in an offset project to last for a specified period.[107] If carbon reductions are reversed, then re-release of sequestered carbon may raise atmospheric carbon to higher levels than they would have been had transaction never occurred, thus also resulting in a net emissions increase.

State compliance offset programs went beyond their international and federal predecessors by placing substantial guardrails on sellers and buyers. First, they placed a strict ceiling on the number of offsets polluters can use to meet their obligations, typically no more than 8%.[108] This was to mitigate the risk that the carbon-reduction benefits represented by offsets are not equivalent to emission reductions by the polluter.

Second, state agencies administering compliance offset trading only approve a small handful of carbon-reduction projects in order to ensure additionality and permanence. For example, California has approved six types of offsets under its cap-and-trade program: forestry-based practices, urban forestry, rice field cultivation, ozone-depleting substance destruction, coal methane capture, and anaerobic digester installation on dairy farms.[109] In order to receive compliance offset credits from the state to sell to polluters, sellers must comply with a long list of regulatory protocols for quantifying and monitoring carbon reductions. Sellers must also incur specific liabilities in case of unintentional carbon reversal (e.g., release of forest carbon by wildfires) or noncompliance.[110]

On the upside, higher standards associated with compliance offsets bolstered consumer confidence and ensured a price premium over unregulated offsets. On the downside, higher standards increased transaction costs associated with producing offsets, setting up onerous environmental reviews, strict evidentiary requirements, and long commitment periods for proving additionality and permanence. This favors large-scale offset developers and biases against small-scale developers.[111] Indeed, no urban forestry offsets have been sold under California's cap-and-trade program as of this writing.[112] Compared to large-scale forestry projects implemented on thousands of acres of land, small-scale carbon removal practices are not cost effective given the extent and length of regulatory obligations.[113]

101. Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont signed the RGGI Memorandum of Understanding (MOU) in 2005. Five additional states have since joined. Regional Greenhouse Gas Initiative Memorandum of Understanding 2 (2005), https://www.rggi.org/sites/default/files/Uploads/Design-Archive/MOU/MOU_12_20_05.pdf.
102. Global Warming Solutions Act, ch. 488, 2006 Cal. Stat. 3419 (codified at Cal. Health & Safety Code §§38500-38599 (2012)).
103. S.B. 5126, 2021 Reg. Sess. (Wash. 2021); Or. Admin. R. 340-271-0920 (2021).
104. *See, e.g.*, A.B. 398, 2017-2018 Reg. Sess. (Cal. 2017) (renewing cap-and-trade program until 2030).
105. While offset trading in the RGGI states never got off the ground, California, Oregon, and Washington have embraced offsets in their cap-and-trade programs. *See*, *e.g.*, Cal. Health & Safety Code §38591.1 (establishing a Compliance Offsets Protocol Task Force to provide guidance in establishing new offset protocols).
106. *See* Cal. Code Regs. tit. 17, §95802(a); RGGI Model Statute 10.1 (2017); S.B. 5126, §(2)(b)(i), 2021 Reg. Sess. (Wash. 2021).
107. Abigail Stecker, *Creating a Carbon Sequestration Right: A Legal Tool to Enhance the Use of Forest-Based Carbon Offsets*, 18 Hastings Env't L.J. 292, 310-11 (2012) (discussing permanence requirements for carbon forest offsets and resulting challenges of project design).
108. California's cap-and-trade program caps the use of offsets at 6%. Cal. Health & Safety Code §38562(b)(2)(E). Washington's cap-and-trade program caps the use of offsets at 5%, which lowers to 4% by 2027. S.B. 5126, §19(3), 2021 Reg. Sess. (Wash. 2021). Sweden places an 8% limit on the use of offsets to meet its 2030 target of 63% emission reduction and a 2% limit for the 2040 target of 75% reduction. Naturvardsverket (Swedish EPA), *Sweden's Climate Act and Climate Policy Framework*, https://www.naturvardsverket.se/en/topics/climate-transition/sveriges-klimatarbete/swedens-climate-act-and-climate-policy-framework/ (last visited May 12, 2023).
109. *See* Cal. Health & Safety Code §38562; Cal. Code Regs. tit. 17, §§95100 et seq. *See also* CARB, *Compliance Offset Program*, https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program (last visited Apr. 10, 2023) (providing overview of the various protocols and project types). Although RGGI has approved three categories of offsets—landfill methane capture, forestry practices, and anaerobic digesters—member states are not required under the MOU to accept offsets from regulated entities. RGGI Model Statute 10.3 (rev'd 2018).
110. *See*, *e.g.*, CARB, Compliance Offset Protocol Urban Forest Projects (2011).
111. McNish, *supra* note 3, at 391.
112. CARB, *ARB Offset Credit Issuance Table*, https://ww3.arb.ca.gov/cc/capandtrade/offsets/issuance/arboc_issuance.xlsx (last visited Apr. 10, 2023).
113. Costs for producing one urban forestry carbon offset dwarfed 2021 offset prices fourteenfold. *See* CARB, *supra* note 110, at 16; E. Gregory McPherson, *Urban Forestry and Carbon: What the Reporting Protocol Means to You*, 17 Arborist News 31, 33 (2008) (estimated cost per urban forest offset is $250); Jodi Shafto, *December 2020 Calif. Carbon Allowance Price Extends Gains Into Year's End*, S&P Glob. Mkt. Intel. (Jan. 5, 2021), https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/december-2020-calif-carbon-allowance-price-extends-gains-into-year-s-end-61975760; Jane Braxton Little, *The Future of Urban Forests in California's Cap & Trade Market*, Cal. ReLeaf, Summer 2012, at 1.

D. Carbon Neutrality

In the decade after the United States declined to ratify the Kyoto Protocol, voluntary carbon offset markets emerged outside of the regulatory environment in response to rapid demand from individuals and organizations across the political, economic, and cultural spectrum. Several prominent businesses began advertising their operations and products as "carbon neutral," including the Dave Matthews Band in 2002 and Google in 2007.[114] Governments, religious congregations, and nonprofit organizations also announced their intention to become carbon-neutral.[115] With the help of personal carbon footprint calculators, individual consumers began to neutralize ordinary decisions like flights and laundry.[116] An estimated $6 million in voluntary offsets sold in 2006 grew to $110 million in just two years.[117]

While cost containment was the clear motivator for including offsets in international, federal, and state climate schemes, it is less clear what drove the demand for voluntary offsets. No regulation threatened to impose new costs on personal or business activities, for which carbon offsets presented a cheaper compliance option. Any personal gains from neutralizing emissions—especially for ordinary household activities—were speculative and uncertain. Possible explanations range from desire for reputational gains, to calculated preparation for future regulation, to altruistic concern for those impacted by a warming climate, to alleviation of moral guilt.[118]

Regardless of its precise causes, the increasing demand for carbon offsets from individuals, businesses, nonprofits, governments, universities, and religious congregations created a thriving voluntary carbon market completely unregulated by governmental actors. Offset exchange platforms, third-party certifiers (who verify the claimed attributes of the carbon offset), retailers and wholesalers, and project developers proliferated almost overnight. The U.S. Government Accountability Office (GAO) began to sound consumer protection concerns about the quality and claims of carbon offsets.[119] In contrast with the tightly controlled, centralized approach of compliance offsets, the patchwork nature of voluntary offsets engendered consumer confusion.[120] Carbon "cowboy" sellers peddling blatantly fraudulent offsets, and corporate buyers making extravagant climate neutrality claims, further engendered public distrust.[121]

Yet, governmental actors declined to regulate voluntary carbon markets.[122] Attempts to bolster consumer confidence came, instead, from the private sector itself. Some voluntary offset exchanges tried to distinguish "quality" from "basic" offsets, by tying offsets sold on their market to various social co-benefits. In 2003, a coalition of international nongovernmental organizations, including the World Wildlife Fund, established the "Gold Standard," an offset certification scheme that advertises "the highest levels of environmental integrity" while "contributing to sustainable development."[123]

Major offset exchange platforms also incorporated quasi-democratic internal procedures for adopting, revising, and abandoning offset protocols, including public consultation and scientific review.[124] Perhaps the most notable effort was the Chicago Climate Exchange, which became the largest voluntary cap-and-trade program in North America and Brazil—covering approximately 350 sources at its peak.[125] Despite attempts to self-regulate, the voluntary carbon market was subject to significant public skepticism.

E. Net Zero

These public and private climate mitigation efforts merged in 2015, when nation signatories to the UNFCCC Paris Agreement, including the United States and China, committed to "achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century."[126] Hundreds of subnational governments, corporations, and organizations followed by pledging to reach "net-zero" emissions, typically by mid-century.[127] Net-zero pledges have achieved a much

114. Urs Hoelzle, *Carbon Neutrality by End of 2007*, Google: Keyword Blog (June 19, 2007), https://blog.google/outreach-initiatives/sustainability/carbon-neutrality-by-end-of-2007/; Matthew L. Wald, *What's Kind to Nature Can Be Kind to Profits*, N.Y. Times, May 17, 2006, at G1 (discussing widespread corporate interest in carbon neutrality in 2006). *See generally* Vandenbergh & Steinemann, *supra* note 3, at 1717-20 (cataloging carbon-neutral pledges from nonprofits, governments, and corporations).

115. *See*, *e.g.*, U.N., *American College & University Presidents' Climate Commitment*, https://sdgs.un.org/partnerships/american-college-university-presidents-climate-commitment (last visited Apr. 10, 2023); Elisabeth Rosenthal, *Vatican's Tree Penance: Forgive Us Our CO_2*, N.Y. Times, Sept. 17, 2007, at A4.

116. U.S. EPA, *Carbon Footprint Calculator*, https://www3.epa.gov/carbon-footprint-calculator/ (last updated July 14, 2016).

117. James Kanter, *Guilt-Free Pollution. Or Is It?*, N.Y. Times, Feb. 20, 2007, at C1.

118. Savasta-Kennedy, *supra* note 3, at 863.

119. *See*, *e.g.*, GAO, GAO-08-1048, Carbon Offsets: The U.S. Voluntary Market Is Growing, But Quality Assurance Poses Challenges for Market Participants app. VII, at 56-57 (2008) ("The proliferation of standards has caused confusion in the market, and the existence of multiple quality assurance mechanisms with different requirements raises questions about the quality of offsets available on the voluntary market."). *See* Part V.

120. Savasta-Kennedy, *supra* note 3, at 867-70.

121. *See*, *e.g.*, Terry Macalister, *Offsetting Chief Warns of Carbon Cowboys*, Guardian (June 18, 2007), https://www.theguardian.com/business/2007/jun/18/consumernews.money. *See also* Savasta-Kennedy, *supra* note 3, at 854-55 (noting that Dell had announced achievement of "carbon neutrality" without counting any emissions from its supply chain or its consumers' use of computers). *See* Section IV.A.

122. However, USDA was authorized under the 2008 Farm Bill to help facilitate farmer, rancher, and forest landowner participation in "environmental services markets." H.R. 2419, 110th Cong. §2709 (2008).

123. Gold Standard, Guidance for the Identification of Impacts and Indicators for Activity Level SDG Impact Reporting Version 1.0, at 12 (2019). *See also* Matthew Paterson & Johannes Stripple, *Virtuous Carbon*, 21 Env't Pol. 563, 570 (2012).

124. *See*, *e.g.*, American Carbon Registry, The American Carbon Registry Standard Requirements and Specifications for the Quantification, Monitoring, Reporting, Verification, and Registration of Project-Based GHG Emissions Reductions and Removals 45-48 (2020).

125. Savasta-Kennedy, *supra* note 3, at 861-62.

126. *Paris Agreement to the UNFCCC, Dec. 13, 2015*, *in* Report of the Conference of the Parties on the Twenty-First Session, U.N. Doc. FCCC/CP/2015/10/Add.1, art. 4 annex (2016), https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

127. NewClimate Institute et al., *supra* note 7, at 4.

larger footprint than carbon neutrality: as of late 2022, net-zero pledges covered an estimated 83% of global emissions and 91% of global gross domestic product (GDP).[128]

Despite differences in terminology and impact, carbon neutrality and net zero are functionally identical decarbonization frameworks along four dimensions. First, neither is generally legally binding. For example, nationally determined contributions (NDCs) that signatory Parties under the Paris Agreement are required to submit every five years to demonstrate progress cannot be substantively enforced by other Member countries.[129] However, a small number of national governments and subnational governments, including the cap-and-trade states, have adopted emission-reduction regulation in line with their NDCs.

Second, the scope of emissions that entities intend to cover with their net-zero and carbon neutrality pledges varies widely.[130] Firms within hard-to-decarbonize industries like aviation and cement manufacturing exclude significant emissions throughout their value chain. As a result, their net-zero pledges may achieve very little change in emissions in practice. Third, a mix of public and private actors have adopted net-zero pledges and carbon neutrality claims.

Fourth, and most importantly, carbon offsets play a key role in both net-zero and carbon neutrality frameworks. However, there remains significant lack of transparency and disagreement regarding (1) to what extent entities will rely on carbon offsets versus internal emission reductions to meet their pledges, and (2) which of the many offsets available entities intend to use to meet their pledges. Oxford University's Net Zero project reports that the majority of governmental pledges are unclear on whether they intend to use carbon offsets. Of those that do, a small minority have set caps and other conditions on their use.[131] Despite confusion about the role of offsets on net-zero claims, there will be a baseline demand for carbon offsets due to significant residual emissions from hard-to-decarbonize sectors like aviation, steel, and concrete.[132] While each of these factors will impact the trajectory of carbon markets, initial trends indicate rapid growth: the global carbon market grew approximately thirteenfold in the five years after the Paris Agreement.[133]

Legal scholars have called for regulation of carbon markets and net-zero claims in light of these rapid changes.[134] So far, there have primarily been informal attempts to self-regulate from voluntary carbon markets and private-sector initiatives.[135] Think-tanks, universities, and climate advocacy organizations have begun to informally police net zero by gathering and publicizing information about their implementation.[136] Federal agencies and states have begun to convene working groups and fund pilot projects to solicit information about whether and how to intervene in the voluntary carbon market.[137] There remains substantial normative, legal, and policy uncertainty about how the public and private sectors should respond to this rapidly evolving climate regime.

III. Resilient Carbon Offsets

As the previous part discussed, carbon offsets have been conceptualized and implemented primarily in the service of mitigation in line with the evolution of climate law. This part questions that tradition. It shows that carbon offsets have enormous potential to be restructured for both mitigation and adaptation, goals that, as Part I argued, should be pursued in an integrated manner within climate law for considerations of intergenerational justice.

This part builds the argument for climate-resilient carbon markets by discussing highly adaptive, nature-based carbon removal practices that have been overlooked in the conversation about carbon offsets and vastly underexploited within current carbon markets. Part IV explores obstacles and possible public and private interventions to redirect carbon markets in the direction of climate resilience.

A. *The Case for Trees*

While all carbon offsets represent net emission reductions, some offsets have much higher adaptation co-benefits. Others are maladaptive because they are structured narrowly to maximize carbon removal in disregard of unintended risks. To illustrate this distinction, this section contrasts forestry-based offsets,[138] which represent roughly half of all carbon offsets generally globally, with carbon capture and storage (CCS), an engineered carbon removal system.[139] Due to accounting errors and other market implementation issues, forestry offsets have been the primary target of public and academic criticism against carbon offsets.[140] Scholars writing about net zero and offsets have highlighted CCS as an alternative, given its capacity to avoid some of these accounting issues.

128. *Id*.
129. *See* Welton, *supra* note 3, at 189; NewClimate Institute et al., *supra* note 7, at 20.
130. Direct GHG emissions are "scope 1 emissions"; indirect emissions from purchased electricity and other forms of energy are "scope 2 emissions"; and upstream and downstream emissions in their value chain are "scope 3 emissions." NewClimate Institute et al., *supra* note 7, at 30 ("virtually all" companies intend to cover scope 1 and 2 emissions, but less than 40% intend to cover scope 3 emissions).
131. *Id*. at 22.
132. Bergero et al., *supra* note 59. *See also* Steven J. Davis et al., *Net-Zero Emissions Energy Systems*, 360 Science 9793, at 1 (2018).
133. Stephen Donofrio et al., Ecosystem Marketplace, The Art of Integrity: State of the Voluntary Carbon Markets 2022 Q3 Insights Briefing (2022).
134. *See supra* note 3.
135. Integrity Council for the Voluntary Carbon Market, *About Us*, http://icvcm.org/about-the-integrity-council (last visited Apr. 10, 2023).
136. Two prominent examples are Oxford's Net Zero Project and Berkeley's Carbon Trading Project.
137. *See supra* note 10.
138. Forestry offsets constituted 44.3% of carbon offsets generated globally and 55.5% of offsets generated in the United States, as of April 2022. Berkeley Carbon Trading Project, *Voluntary Registry Offsets Database*, https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database (last visited May 12, 2023).
139. Minh Ha-Duong & David W. Keith, *Carbon Storage: The Economic Efficiency of Storing CO_2 in Leaky Reservoirs*, 5 Clean Techs. & Env't Pol'y 181, 182 (2003).
140. *See* Part V.

To start, forestry-based offsets cover a range of forest management activities, including afforestation, reforestation, improved forest management, and avoided deforestation.[141] Forests mitigate climate change in essentially the same way as CCS systems: by moving carbon from the atmosphere to various sinks below. Trees convert carbon into plant tissue, some of which eventually decays into humus, a highly stable form of soil carbon.[142] CCS systems physically capture carbon emitted from industrial sources and then compress, transport, and finally inject the carbon into unused underground spaces for storage (e.g., saline aquifers and abandoned oil reservoirs). Here, the carbon remains ideally for hundreds to thousands of years to achieve the intended mitigation benefit.[143]

Despite similarities in mitigation, forests demonstrate much higher climate adaptation potential throughout their life cycle than CCS systems. This can be attributed to differences in biophysical properties, production costs, technological maturity, distribution of technical knowledge among potential sellers, and ability to reduce various climate vulnerabilities between these technologies.

First, trees and CCS systems have very different biogeochemical properties.[144] Living trees provide shade- and transpiration-based temperature moderation, flood absorption, air purification, water filtration, and other passive climate regulation services. Trees also produce valuable material resources like food, medicine, and fibers that are used in everything from clothing to houses, which continue to operate as carbon sinks even after they are discarded.[145] Decayed trees continue to enhance biodiversity and ecosystem productivity by returning organic nutrients into the soil for use by offspring and other organisms.[146]

By contrast, CCS systems produce few known adaptation benefits during operation because they are engineered solely to remove carbon. Injection sites, however, leave behind significant environmental risks long after the industrial emission source has ceased operation, including groundwater contamination, seismic activity, and emission leaks and explosions.[147]

Second, forestry-based practices can be deployed faster and more cheaply by more potential sellers around the globe than can CCS systems, because forest management is a more mature and well-distributed technology. As of this writing, forestry offsets outnumber CCS offsets by 10 to one in the United States and 30 to one globally.[148] From a mitigation-centric perspective, low production costs associated with forestry-based offsets present a disadvantage because it lowers the price of carbon pollution for buyers, thus lowering incentives for carbon reduction.[149] From an adaptation perspective, however, low production costs are an advantage because it lowers the cost of securing adaptation benefits for developers.

Indeed, forest management predates CCS technology by literally thousands if not millions of years, tracing back to early hominids who exploited tropical forests in Africa and Asia for food and habitat.[150] Trees are extremely diverse, grow in every continent except for Antarctica, and remain useful for many purposes.[151] Technical knowledge related to resilient forest management is more evenly distributed across sectors and populations. This translates to better potential distribution of carbon revenue.

By contrast, the first CCS project was implemented in 1996 in Norway and CCS has only featured in fewer than 50 projects globally as of this writing.[152] Because CCS technology is highly industry-specific and capital-intensive, it will evolve to be proprietary to a few carbon-intensive industries.[153] Novel financial incentives for CCS like offset payments and subsidies will likely follow this highly unequal distribution of proprietary knowledge.

Indigenous groups could play an important role in the development and sale of resilient forestry-based offsets. Due to extended periods of reliance on forest ecosystems for multiple dimensions of livelihood—food, water, medicine, habitat—and cultural beliefs tying human welfare to forest ecosystem health, Indigenous groups around the world have significant expertise in managing forests for resilience.[154] This is especially valuable in the European-colonized Americas, where political and economic control was achieved via forced migration of Indigenous populations and systematic clearing of native-managed forest

141. Afforestation involves establishing tree cover to previously non-forested land. Reforestation involves restoring tree cover to recently deforested land. Avoided conversion projects prevent deforestation of existing forestland. Improved forest management projects generally involve land management activities like prescribed burns and selective timber harvest that increase or maintain a baseline level of carbon.
142. Humus can last up to an estimated 5,000 years if left alone. Ray Weil & Nyle C. Brady, The Nature and Properties of Soils 543 (15th ed. 2017).
143. Ha-Duong & Keith, *supra* note 139, at 182.
144. Chausson et al., *supra* note 20.
145. Jeffrey P. Prestemon et al., *Housing Starts and the Associated Wood Products Carbon Storage by County by Shared Socioeconomic Pathway in the United States*, 17 PLOS One e0270025 (2022) (finding that wood products in the United States in 2020 sequestered an amount of carbon roughly equivalent to total global emissions in 2010).
146. Bruce G. Marcot, USDA, Research Note: Ecosystem Processes Related to Wood Decay (2017) (summarizing research on wood decay's contribution to biodiversity and nutrient recycling).
147. Lin, *Making Net Zero Matter*, *supra* note 3, at 752 n.406. *See also* IPCC, IPCC Special Report on Carbon Dioxide Capture and Storage, Prepared by Working Group III of the Intergovernmental Panel on Climate Change 9-15 (Bert Metz et al. eds., 2005) (discussing environmental risks of CCS).
148. CCS projects generated 5.5% of carbon offsets from the United States and 1.4% globally as of April 2022. *See* Berkeley Carbon Trading Project, *supra* note 138.
149. Maxine Burkett, *Root and Branch: Climate Catastrophe, Racial Crises, and the History and Future of Climate Justice*, 134 Harv. L. Rev. 326, 326-27 (2021).
150. Eleanor M.L. Scerri et al., *Tropical Forests in the Deep Human Past*, 377 Phil. Transactions Royal Soc'y B 20200500 (2022).
151. Roberto Cazzolla Gatti et al., *The Number of Tree Species on Earth*, 119 PNAS e2115329119 (2022) (estimating 73,000 tree species globally).
152. Many of these projects are still under construction. Jan C. Minx et al., *Negative Emissions—Part 1: Research Landscape and Synthesis*, 13 Env't. Rsch. Letters 063001, at 17 (2018).
153. IPCC, *supra* note 147, at 9-15 (CCS technology "opens doors" for proprietary rights).
154. Charles M. Peters, Managing the Wild: Stories of People and Plants and Tropical Forests (2018).

ecosystems for agricultural commodity production and human settlement.[155]

While the energy transition from wood to fossil fuels and reforestation efforts in the early 20th century have recovered forest cover to an estimated 75% of precolonial levels, Native groups still play a key role in improving forest resiliency.[156] Studies find that North American forests managed by Native American tribes demonstrate higher carbon sequestration levels and lower vulnerability to pests and other disturbances than neighboring forests managed by non-native foresters.[157] Carbon markets offer a promising new incentive structure for resilient forestry practices.

B. Resilient Forest-Based Offsets

Forestry practices are generally more climate-resilient than CCS systems, but must be carefully selected, sited, and scaled to address local climate vulnerabilities. The majority of forestry offsets are currently generated on vast acres of unbroken forestland. However, small-scale, diversified afforestation projects offer large but underexploited adaptation benefits where people and food are concentrated: coasts, farmland, and cities. Carbon markets could provide critical financial incentives for these resilient forms of land use against countervailing economic and social pressures for maladaptive land use.

In contrast with small-scale and diversified forestry projects, large-scale monoculture forestry projects are maladaptive across a range of different landscapes. Like CCS systems, they are largely designed to maximize carbon removal in complete disregard of environmental interactions. For example, large-scale state-funded plantings of non-native, fast-growing trees in arid and semi-arid regions of China and Chile resulted in extremely high tree fatality rates and exacerbated drought issues.[158] The problem is not tree planting, but implementation of that technology in the narrow service of decarbonization. The following discusses three examples of overlooked climate-resilient forestry practices.

1. Coastal Mangroves

Approximately 40% of people in the United States and globally live along coastlines, given their capacity to provide food, recreation, transportation, and other services.[159] For many of these coastal communities, mangroves—tough trees that thrive in shallow, warm saltwater marked by a tangled morass of aerial roots—offer a powerful and relatively inexpensive form of protection against sea-level rise and storms.[160] One model estimates that mangrove forests along Florida's southern coastline prevented $1.5 billion in property damage during Hurricane Irma in 2017.[161] Mangroves also bring large economic benefits to coastal industries (e.g., tourism, aquaculture, and wetland agriculture) by functioning as a nutrient source for neighboring plants[162] and a nursery and breeding ground for aquatic animals.[163] While mangroves' mitigation benefits are largely overlooked relative to more charismatic flora like rain forests, they sequester three times more carbon per acre than rain forests.[164]

Despite the substantial climate resiliency benefits of mangroves, more than 50% of pre-industrial mangrove cover and other coastal ecosystems have been lost in the past century, and an estimated 1%-2% continues to be lost annually due to urbanization and farmland conversion.[165] This has concentrated harms on climate-vulnerable communities dependent on coastal ecosystems year-round for multiple dimensions of their livelihood. As rising sea levels and warmer temperatures drive people and mangrove habitats poleward and inland,[166] carbon markets can cre-

155. Justin Farrell et al., *Effects of Land Dispossession and Forced Migration on Indigenous Peoples in North America*, 374 Science 4943 (2021).
156. Greater efficiency in agricultural productivity due to subsidized technological developments in irrigation, fertilizers and pesticides, and farm machinery also shrank farmland acreage, leaving more room for forest cover. Douglas MacCleery, USDA, American Forests: A History of Resiliency and Recovery (1992).
157. *See, e.g.*, Donald M. Waller & Nicholas J. Reo, *First Stewards: Ecological Outcomes of Forest and Wildlife Stewardship by Indigenous Peoples of Wisconsin, USA*, 23 Ecology & Soc'y 45 (2018).
158. Shixiong Cao, *Why Large-Scale Afforestation Efforts in China Have Failed to Solve the Desertification Problem*, 42 Env't Sci. & Tech. 1826 (2008); Christian Little et al., *Revealing the Impact of Forest Exotic Plantations on Water Yield in Large Scale Watersheds in South-Central Chile*, 374 J. Hydrology 162 (2009). *See also* Kristen Lyons & Peter Westoby, *Carbon Colonialism and the New Land Grab: Plantation Forestry in Uganda and Its Livelihood Impacts*, 36 J. Rural Stud. 13 (2014) (to make way for plantation-based offsets in Uganda, offset developers confiscated stray livestock, destroyed burial sites, and excluded communities from harvesting food crops, medicinal crops, and firewood).
159. National Oceanic and Atmospheric Administration, National Ocean Service, *What Percentage of the American Population Lives Near the Coast?*, https://oceanservice.noaa.gov/facts/population.html (last updated Jan. 20, 2023); Barbara Neumann et al., *Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding—A Global Assessment*, 10 PLOS One e0118571 (2015) (projecting growth of coastal populations with urbanization).
160. Nathaniel L. Bindoff et al., *Changing Ocean, Marine Ecosystems, and Dependent Communities*, *in* IPCC Special Report on the Ocean and Cryosphere in a Changing Climate 447, 508, 531-36 (H.-O. Pörtner et al. eds., Cambridge Univ. Press 2019), https://www.ipcc.ch/site/assets/uploads/sites/3/2022/03/07_SROCC_Ch05_FINAL.pdf (discussing the importance of integrating "hard" engineered coastal protection systems with "soft" nature-based systems like mangrove afforestation).
161. *See* Alongi, *supra* note 17; Siddharth Narayan et al., Nature Conservancy, Valuing the Flood Risk Reduction Benefits of Florida's Mangroves (2019).
162. Mangroves are especially efficient at nutrient recycling and carbon sequestration because ocean currents "outwell" organic nutrients away from decaying trees into the deep sea, whereas terrestrial trees bury nutrients where the tree is located. Gurmeet Singh et al., *Nutrient Cycling in Mangrove Ecosystem: A Brief Overview*, 30 Int'l J. Ecology & Env't Sci. 231 (2005).
163. One Senegalese mangrove afforestation project led to substantial increases in fish, shrimp, and oyster production and desalinated adjacent rice fields. Livelihoods Fund, Mangrove Restoration: Impacts After 10 Years of the Largest Mangrove Restoration Project of the Livelihoods Carbon Fund in Senegal With Océanium Summary Report 13, 15 (2020).
164. Bindoff et al., *supra* note 160, at 454.
165. *Id.* at 495-96.
166. *Id.* at 451, 495. Ken W. Krauss et al., *How Mangrove Forests Adjust to Rising Sea Level*, 202 New Phytologist 19 (2013).

ate novel financial incentives for mangrove afforestation in coastal communities in the United States and abroad.[167]

2. Agroforestry

Approximately 50% of the U.S. land base and 40% of the global land surface is used to grow crops or graze livestock animals.[168] Agroforestry—the integration of fruit, nut, and other productive trees on farm and grazing land—promises a large range of climate regulation benefits for this vast expanse of land, including protection against heat waves, cold snaps, droughts, soil erosion, and pest infestations.[169] It also reduces climate-related financial risks by diversifying farm revenue, which is especially beneficial for breadbasket regions dominated by annual monocultures like the corn- and soy-heavy Midwest.[170] Due to agriculture's extensive land coverage in the United States, agroforestry also promises large mitigation benefits: incorporating trees on just 10% of farmland could counterbalance an estimated 33% of fossil fuel emissions annually.[171]

Agroforestry is rooted in Indigenous agricultural practices around the world. Yet it was almost completely abandoned by U.S. farmers around the early 20th century, with the widespread adoption of industrial technologies (e.g., field machines, irrigators, agrochemical pesticides, and fertilizers) and agronomic practices that maximize calorie production at the expense of nutritional diversity and environmental sustainability.[172]

Federal subsidies created around the same time have generously funded this type of monoculture-based agriculture.[173] Corporate consolidation and regulatory capture of the legislative process beginning in the late 20th century have effectively ossified the renewal of those federal programs in substantially the same form every five years.[174] In this maladaptive social, policy, and economic environment, carbon markets offer a promising new incentive structure for farmers to invest in climate-resilient agroforestry practices that would otherwise be too financially risky to undertake.[175]

3. Urban Forestry

Cities and suburbs contain approximately 80% of the U.S. population and more than 50% of the global population, even though they make up a relatively small portion of land use.[176] For these growing communities, urban forestry—small-scale tree plantations on rooftops, sidewalks, yards, and other unused land surfaces—can provide critical flood protection, stormwater treatment, water conservation, air purification, and cooling services.

Tree cover is notoriously unequally distributed within cities along wealth and racial lines. A 2021 study of U.S. cities found that low-income neighborhood blocks have on average 15% less tree cover than high-income blocks. A 2018 study found significant race-based inequity in urban tree cover, likely due to historical redlining and other intentionally and unintentionally discriminatory land use policies.[177] As cities become dangerously hotter and wetter, urban tree cover will become an increasingly important climate adaptation strategy, especially for poorer neighborhoods with lower access to air-conditioning, travel, and other expensive engineered technologies to escape adverse weather conditions.

While urban forestry programs are primarily funded by municipal general funds, special tax levies, and state and federal grants, these funding sources are vulnerable to shifting political leadership, competing funding priorities, and natural disasters.[178] Carbon markets could serve as a critical gap-filler for urban forestry in this uncertain fiscal environment.

For example, the city of Minneapolis chose to sell carbon offsets to local corporations as an alternative funding source for its urban forestry program in 2019, after a special property tax expired and a pest infestation decimated its ash tree population.[179] By concentrating its offset-funded afforestation efforts in low-income areas with less tree canopy, Minneapolis effectively shifted climate adaptation costs from local taxpayers to local corporations.[180] Local governments and nongovernmental organizations facing similar shortfalls can use carbon markets in similarly innovative ways to secure funding for urban afforestation projects.

IV. Implementation

This part turns to the "what if" question—what would carbon markets and the surrounding legal and policy environment look like if offsets embraced climate resilience? To

167. Mangrove ecosystems are currently concentrated in Africa and Southeast Asia but could expand into the U.S. Gulf Coast region and along the southeastern coast with global warming and sea-level rise. Bindoff et al., *supra* note 160, at 503.
168. *Land Use in Agriculture by the Numbers*, Food & Agric. Org. U.N. (May 7, 2020), https://www.fao.org/sustainability/news/detail/en/c/1274219; Daniel P. Bigelow & Allison Borchers, USDA, Major Uses of Land in the United States, 2012 (2017).
169. My co-authors and I have discussed federal agricultural policy as it pertains to agroforestry in previous work. Lingxi Chenyang et al., *Farming With Trees: Reforming U.S. Farm Policy to Expand Agroforestry and Mitigate Climate Change*, 48 Ecology L.Q. 1, 1-19 (2021) (climate resiliency benefits of agroforestry).
170. *Id.* at 11-19.
171. Udawatta & Jose, *supra* note 18.
172. Chenyang et al., *supra* note 169, at 14, 20-21. *See also* Vaclav Smil, Energy and Civilization 306-13 (2017).
173. Chenyang et al., *supra* note 169, at 20-34.
174. Nathan A. Rosenberg & Bryce Wilson Stucki, *The Butz Stops Here: Why the Food Movement Needs to Rethink Agricultural History*, 13 J. Food L. & Pol'y 12, 17-25 (2017).
175. Chenyang et al., *supra* note 169, at 20-34 (discussing barriers to agroforestry adoption).
176. U.S. Census Bureau, *Urban Area Facts*, https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/ua-facts.html (last revised Oct. 8, 2021).
177. *See* Watkins & Gerrish, *supra* note 36.
178. The Inflation Reduction Act and Bipartisan Infrastructure Bill allocated approximately $2.5 billion for urban forestry programs. *See* Inflation Reduction Act of 2022, Pub. L. No. 117-169, 136 Stat. 1818.
179. Green Minneapolis, *Urban Tree Carbon Offset Program*, https://www.greenminneapolis.org/projects/climate-resiliency-initiative/carbon-offset-program/ (last visited Apr. 10, 2023). Previously, the program was funded by a term-limited property tax.
180. *Id.*

answer that question, it begins with a general discussion of pricing mitigation versus adaptation services. It then turns to possible ways in which governmental actors might intervene in carbon markets to steer investments from lower-value offsets like monoculture tree plantations toward higher-value offsets like coastal mangrove forests.

A. Pricing Resilience

Markets are capable of pricing multiple attributes of goods and services. Organic apples cost more than nonorganic apples, even though they look and taste the same to the buyer. The organic premium reflects not just consumers' willingness to pay more for organic products due to environmental, health, and reputational concerns, but also the additional cost of producing organic foods. Similarly, a ton of carbon that helps reduce local heat-related harms should cost more than a ton that does not. Goods and services produced by companies that offset their unavoidable emissions with resilient offsets should be more valuable to consumers than those that counterbalance all of their emissions with fraudulent or harmful offsets.

To the extent that the market fails to accurately price the resiliency benefits offsets or their consumption, it suffers from what economists call a "market failure"—a failure to allocate resources toward their socially optimal uses. To correct for this problem, we might first ask: what is the optimal price for the resilience premium? While market prices are determined by buyers and sellers in a distributed fashion, governmental actors use cost-benefit analysis to price the aggregate social impacts of regulations and policies when considering their implementation. Importantly, cost-benefit analysis seeks to price public goods, like climate adaptation, not currently captured in market transactions. If a proposed regulation's benefits exceed its costs, then it moves forward.[181] Thus, cost-benefit analysis presents a helpful tool to conceptualize the optimal price for the resilience premium.

Under a cost-benefit framework, adaptation should yield more certain and less contested prices than mitigation. Consider the social cost of carbon (SCC), the most widely used carbon pricing framework in the United States. It is a model-derived estimate of the marginal social damage (e.g., deaths attributed to flooding and heat waves), inflicted by an additional ton of GHG emissions at a certain point in time, over a specified time period.

Governmental actors have used variants of the SCC to guide their decisionmaking since the mid-2000s.[182] But because the SCC is an estimate of the *global* and *multi-century* impacts of carbon emissions, it depends on uncertain empirical predictions about very long-term economic, demographic, and climactic changes, as well as contested normative judgments about intergenerational discount rates.[183] As a result, the SCC has varied widely between different jurisdictions and political administrations, from $1 per metric ton of carbon dioxide (CO_2)-equivalent under the Donald Trump Administration to $776 under Germany's federal government.[184]

In theory, estimates of adaptation co-benefits should fall within smaller margins because they are evaluated locally, over shorter time horizons.[185] Indeed urban forests, according to a 2008 EPA estimate, yield a net economic benefit of $21 to $38 per year per tree in the United States.[186] This price includes flood protection, stormwater treatment, water conservation, air purification, and cooling services.[187]

181. *See* Richard L. Revesz & Michael A. Livermore, *The Case for Cost-Benefit Analysis*, *in* Retaking Rationality: How Cost-Benefit Analysis Can Better Protect the Environment and Our Health 10 (2008).

182. Federal agencies began incorporating SCC estimates in cost-benefit analyses in 2008, following a court ruling ordering an agency to consider the value of reducing GHG emissions in a rulemaking process. Cost-benefit analysis is a systematic aggregation of all anticipated or realized impacts of a proposed regulation, revision, or rollback. *See* Center for Biological Diversity v. National Highway Traffic Safety Admin., 538 F.3d 1172, 1200, 38 ELR 20214 (9th Cir. 2008). *See also* Exec. Order No. 12866, 58 Fed. Reg. 51735 (Oct. 4, 1993).

In 2021, the Biden Administration set an interim SCC at $51 per ton and directed the Interagency Working Group on the Social Cost of Carbon to update the SCC to reflect intergenerational equity and environmental justice concerns. *See* Exec. Order No. 13990, 86 Fed. Reg. 7037 (Jan 25, 2021). *See also* Heather Boushey, *A Return to Science: Evidence-Based Estimates of the Benefits of Reducing Climate Pollution*, White House (Feb. 26, 2021), https://www.whitehouse.gov/cea/written-materials/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/; Interagency Working Group on the Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide (2021). New York and other subnational jurisdictions have adopted significantly higher GHG cost estimates than the federal SCC for state agency decisionmaking. *See*, *e.g.*, New York State Department of Environmental Conservation, Establishing a Value of Carbon: Guidelines for Use by State Agencies (rev'd 2022), https://www.dec.ny.gov/docs/administration_pdf/vocguid22.pdf (setting "value of carbon guidance" at a central value of $121 per ton). A 2022 *Nature* study estimates that the SCC should be valued at $185, more than triple the Biden Administration's 2021 interim figure. *See* Kevin Rennert et al., *Comprehensive Evidence Implies a Higher Social Cost of CO_2*, 610 Nature 687 (2022).

183. More specifically, the SCC is based on social damages of marginal carbon emissions until 2300. Under the Barack Obama and Biden Administrations, the SCC was an estimate of *global* damages with a 3% discount rate. Under the Donald Trump Administration, however, the SCC used a 7% discount rate and only factored future damage to the United States. There is a large volume of literature that points out inherent limitations of the SCC due to empirical uncertainties and normative controversies.

An even larger volume of literature points out the limitations inherent in environmental cost-benefit analysis generally, such as the difficulty of accounting for nonmonetary values and selecting a discount rate. *See*, *e.g.*, Douglas A. Kysar, Regulating From Nowhere: Environmental Law and the Search for Objectivity 100-01 (2010); Frank Ackerman & Lisa Heinzerling, *Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection*, 150 U. Pa. L. Rev. 1553, 1578 (2002); David M. Driesen, *Is Cost-Benefit Analysis Neutral?*, 77 U. Colo. L. Rev. 335, 339-42 (2006) (noting that benefits can be "extraordinarily difficult" to quantify and monetize); Frank Ackerman & Lisa Heinzerling, Priceless: On Knowing the Price of Everything and the Value of Nothing 37-40 (2004). *See also* Alexander Volokh, *Rationality of Rationalism—The Positive and Normative Flaws of Cost-Benefit Analysis*, 48 Hous. L. Rev. 79 (2011).

184. GAO, GAO-20-254, Social Cost of Carbon: Identifying a Federal Entity to Address the National Academies' Recommendations Could Strengthen Regulatory Analysis (2020).

185. Muyeye Chambwera et al., *Economics of Adaptation*, *in* Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 945, 960-63 (C.B. Field et al. eds., Cambridge Univ. Press 2014).

186. *See* U.S. EPA, *supra* note 36.

187. U.S. EPA, *supra* note 36, at 12. *See also* Foster et al., *supra* note 36, at 21-27.

Unlike carbon pricing, adaptation pricing should also be sensitive to local vulnerabilities and other distributional concerns. More climate-vulnerable communities (e.g., those dealing with hotter temperatures and lower access to alternative forms of heat adaptation) experience higher net benefits from urban trees than dispersed, wealthier communities living in more moderate climates.[188] Thus, urban forestry offsets sited in climate-vulnerable communities should be more valuable than those sited in less vulnerable communities.

In theory, project-specific analyses—where an offset developer submits a proposal to a carbon registry or certifier that reviews and evaluates the project's resiliency benefits—is the most accurate and flexible way to price the resilience premium. However, this may increase the cost of producing offsets if certifiers had to conduct expensive and lengthy project-specific cost-benefit analysis for every offset credit. Indeed, the CDM under the Kyoto Protocol took a project-specific approval process to assess additionality of offset projects, and a 2008 study reported that CDM credits were issued at a rate of 2.5%-5% of what is needed.[189] Project-specific analysis may also place further obstacles on small-scale offset sellers, even though small-scale carbon removal projects often yield the highest climate resiliency benefits.

B. Public Certification

While the largest carbon registries sell a myriad of offsets sited across the globe, a few "boutique" registries certify and sell offsets from specific geographic regions or offsets with specific co-benefits. For example, the Gold Standard ties its offsets to the U.N. Sustainable Development Goals (SDGs), which include climate adaptation.[190] One approved offset project is the replacement of indoor wood cookstoves with energy-efficient cookstoves, which reportedly reduces exposure to dangerous indoor air pollution, a health harm that burdens primarily women in developing countries.[191] Other carbon registries specializing in urban forest offsets,[192] agricultural offsets,[193] and region-specific offsets[194] have emerged in the wake of the net-zero movement. Their use of a non-decarbonization metric to filter "quality" from "basic" offsets represents a key departure from early carbon markets' narrow focus on carbon reduction.

Selective certification responds to market failure by correcting for information asymmetry between buyers and sellers. However, there are three problems with relying solely on private carbon registries to accurately price climate resiliency. First, standards used to filter quality offset projects are often undefined and inconsistent. For example, a wide range of projects that do not yield veritable co-benefits could be interpreted to meet the Gold Standard's certification standard because the SDGs are numerous and ambiguously phrased.[195] Second, the absence of external checks on the crediting process creates conflicts of interest. Because carbon registries, certifiers, and project developers are ultimately interested in selling more offset credits, there is insufficient incentive to veto projects that fall short of the higher standards marketed by private registries.[196] Third, inadequate data disclosure standards and performance metrics prevent consumers from assessing the existence and magnitude of co-benefits promised by carbon registries.[197]

To ameliorate these problems, governmental actors should intervene as a secondary certifier for the voluntary offset market. First, by setting minimum enforceable standards for offsets, a public offset certification program would mitigate consumer confusion and market integrity concerns. As mentioned, California for its compliance offset program selects protocols from the voluntary carbon market that meet strict state-level cap-and-trade standards. While cap-and-trade offset standards (e.g., additionality and permanence) are largely tied to decarbonization goals, a climate-resilient offset certification program would be tied to region-specific adaptation goals as well (e.g., flood mitigation in eastern states and storm protection in coastal states).

Second, a public certification program reduces conflicts of interest in a wholly private carbon market. State and local government participation in the certification process is especially valuable: they are often underfunded and thus have vested interests in leveraging private funding for regional and local adaptation needs.[198] Corporate offset buyers, by contrast, often have little incentive to verify marketing claims for purchased offsets, as long as they can

188. Weiqi Zhou et al., *Urban Tree Canopy Has Greater Cooling Effects in Socially Vulnerable Communities in the U.S.*, 4 One Earth 1764 (2021) (finding that tree planting in socially vulnerable neighborhoods achieved greater cooling benefits per unit increase in canopy).

189. *See* Michael W. Wara & David G. Victor, *A Realistic Policy on International Carbon Offsets* 14 (Stanford University Program on Energy and Sustainable Development, Working Paper No. 74, 2008). *See also* Karen Bennett, *Additionality: The Next Step* for *Ecosystem Service Markets*, 20 Duke Env't L. & Pol'y F. 417, 425-28 (2010).

190. Gold Standard, Gold Standard for the Global Goals: Principles and Requirements Version 1.2, at 8 (2019), https://globalgoals.goldstandard.org/101-par-principles-requirements/.

191. These benefits are described as accruing primarily to women in the developing countries in which clean cookstove offsets are sold. Gold Standard, Gold Standard Improved Cookstove Activities Guidebook 8, 38, 48 (2016), https://www.goldstandard.org/sites/default/files/documents/gs_ics_report.pdf. *See also* Megha Thakur et al., *Impact of Improved Cookstoves on Women's and Child Health in Low and Middle Income Countries: A Systematic Review and Meta-Analysis*, 73 Thorax 1026 (2018) (finding improved cookstoves are associated with "significant reduction" in lung disease and adverse respiratory symptoms for women users).

192. City Forest Credits, *Home Page*, https://www.cityforestcredits.org/ (last visited Apr. 10, 2023).

193. Indigo Ag, *About Indigo Ag*, https://www.indigoag.com/about (last visited Apr. 10, 2023).

194. Vi Agroforestry, *About Us*, https://viagroforestry.org/about-us/ (last visited Apr. 10, 2023).

195. They include "sustainable cities and communities" and "responsible consumption and production." *See* U.N. Department of Economic and Social Affairs, *The 17 Goals*, https://sdgs.un.org/#goal_section (last visited Apr. 10, 2023).

196. Savasta-Kennedy, *supra* note 3, at 887-88.

197. Elizabeth Lewis et al., *Navigating the Sustainable Investment Landscape* (World Resources Institute, Working Paper, 2016).

198. *See* Section III.B.3.

claim that their purchase has allowed them to meet their climate goals.

Third, public certification injects needed democratic accountability and governmental oversight into the carbon market. For example, California's compliance offset protocols are state regulations subject to the state Administrative Procedure Act, and so proposed offset protocols must survive public notice-and-comment and environmental analysis prior to approval,[199] and specific projects are subject to public data disclosure requirements.[200] Some protocols are subject to reform via consultation with local offset suppliers like tribal groups.[201]

However, state and local government certification may exhibit a bias for offsets with geographically concentrated adaptation co-benefits. A federal certification program that sets a nationwide minimum standard for resilient offsets could help correct for any geographic bias. A wide range of consumer products are covered by federal environmental labeling programs, from organic food (National Organic Program) to energy-efficient buildings and appliances (Energy Star) to water-efficient lawn irrigation systems (WaterSense). These labeling programs provide important models for a federal carbon offset certification program.[202]

C. Demand Side Intervention

Other demand side interventions that shift market demand toward resilient carbon offsets are a critical supplement to public certification programs. To this end, governmental procurement policy has proven to be an impactful and politically bipartisan demand side tool for decarbonization.[203] The federal government as the owner and operator of thousands of road vehicles, aircraft, and buildings is the nation's largest energy consumer, while state and local governments are also significant energy consumers.[204] Procurement rules typically require governmental actors to purchase low-emissions technologies, like renewable electricity and electric vehicles, as well as government-certified high-efficiency products, like Energy Star appliances.[205] Since 1975, federal procurement policy established via presidential executive order has helped reduce the energy intensity of federal facilities and operations by almost half.[206]

Likewise, federal, state, and local governments should adopt aggressive carbon offset acquisition rules as part of their climate goals. To the extent that the federal government and many states and cities have adopted net-zero goals and will need to offset their unavoidable emissions to meet those goals, it presents a significant opportunity to steer public investments toward high-quality climate-resilient carbon offsets. At minimum, offset procurement rules could require that any offsets purchased to meet net-zero goals be certified by some governmental entity, like California or Washington do under their compliance offset programs.

Procurement rules could also be tailored to the unique climate vulnerabilities of the governmental entity's operations or jurisdiction. For example, major federal coastal facilities like naval bases could commit to purchasing mangrove afforestation and coastal ecosystem restoration offsets. Agriculture-dominated states like Minnesota and Michigan could commit to purchasing some percentage of agroforestry-based offsets. Major city governments like New York City and Atlanta, highly vulnerable to summer heat waves, could commit to purchasing urban forestry offsets sited in vulnerable communities. A locally tailored procurement policy would further reduce conflicts of interest inherent in a wholly privatized carbon market.

D. Supply Side Intervention

Supply side interventions aim to increase the supply of resilient offsets on the market by lowering barriers to entry. The biggest barrier is the significant transaction cost associated with registering, measuring, monitoring, enforcing, and aggregating offset projects. Up to 30% of carbon offset funding under the CDM program went toward market intermediaries, according to one estimate.[207] In effect, these costs filter out small-scale offset projects, like urban forestry, with the largest resilience potential. Carbon payments alone do not cover the significant fixed costs associated with developing, registering, and monitoring these projects.

To reduce transaction costs, governmental actors can intervene in two ways. First, they can subsidize initial development and registration costs for small-scale offset developers. California, recognizing that offset revenue from its cap-and-trade program has been concentrated in the hands of large forestland owners, is currently exploring carbon financing assistance for "disadvantaged communities, Native American or tribal lands, and rural and

199. CARB, California Air Resources Board's Process for the Review and Approval of Compliance Offset Protocols in Support of the Cap-and-Trade Regulation 5-7 (2013).
200. Cal. Code Regs. tit. 17, §95973(b).
201. Beth Rose Middleton Manning & Kaitlin Reed, *Returning the Yurok Forest to the Yurok Tribe: California's First Tribal Carbon Credit Project*, 39 Stan. Env't L.J. 71, 117-20 (2019).
202. Prof. Alexandra Klass has proposed several mechanisms for tailoring federal energy-efficiency standards to local needs, including waivers for states that petition to set a uniform, multistate standard. These proposals could be applied to carbon offsets as well. Alexandra B. Klass, *State Standards for Nationwide Products Revisited: Federalism, Green Building Codes, and Appliance Efficiency Standards*, 34 Harv. Env't L. Rev. 335, 359-61 (2010).
203. John C. Dernbach, *The Dozen Types of Legal Tools in the Deep Decarbonization Toolbox*, 39 Energy L.J. 339 (2018).
204. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Government Energy Management*, https://www.energy.gov/eere/efficiency/government-energy-management (last visited Apr. 10, 2023).
205. Federal agencies are required to purchase higher-efficiency energy-consuming products, like Energy Star. 42 U.S.C. §8259(b).
206. Exec. Order No. 13423, Strengthening Federal Environmental, Energy, and Transportation Management, 72 Fed. Reg. 3919 (Jan. 26, 2007); Exec. Order No. 13514, Federal Leadership in Environmental, Energy, and Economic Performance, 74 Fed. Reg. 52117 (Oct. 9, 2009); Exec. Order No. 13963, Planning for Federal Sustainability in the Next Decade, 80 Fed. Reg. 15871 (Mar. 15, 2015); Exec. Order No. 14057, Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, 86 Fed. Reg. 70935 (Dec. 21, 2021).
207. McNish, *supra* note 3, at 409-16.

agricultural regions."[208] The state of Washington offers financial assistance for offsets developed on tribal land.[209] A federal carbon financing program would further remove barriers to access for under-resourced but high-impact developers like tribal and Indigenous communities, aquaculture-based coastal communities, and climate-vulnerable urban communities.[210]

Second, governmental actors can consolidate registration, monitoring, and reporting costs for distributed offset projects by acting as carbon offset aggregators. Prof. Hannah Wiseman has proposed several governance structures and procedures to reduce transaction costs associated with wind and solar development across property, municipal, and state lines.[211] These proposals apply to carbon offset development as well. State-level carbon aggregators would be especially useful to consolidate agroforestry projects across private farm properties and urban forestry projects across local government jurisdictions.

Regional carbon aggregators would be useful for large-scale offset projects that cross state lines. Suppose that mangrove afforestation would have the highest resilience potential sited across tidal lands in Florida and Georgia. An interstate carbon board composed of representatives from both states would be especially useful in consolidating environmental review processes; holding fora for local government and landowner concerns; identifying public access conditions on development; and consolidating measurement, monitoring, and reporting requirements. Interested offset developers would no longer have to identify and deal separately with each other or public and private stakeholders. Instead, the interstate carbon board could provide a "one-stop shop" for developers and relevant stakeholders.

V. Concerns and Responses

Three critiques of carbon offsets have been articulated by scholars, policymakers, and journalists since the CDM was negotiated into the Kyoto Protocol.[212] Accounting concerns target the production of offsets. Moral concerns target the purchase of offsets. Political concerns target the market structure used to finance offsets. These critiques have acquired renewed significance as offset demand has soared from the proliferation of net-zero pledges.

This part argues that restructuring carbon offset markets for climate resiliency diminishes the force of these familiar normative criticisms. Adaptation favors the payment-for-services and market-based approach of offsetting on normative and pragmatic grounds, even if mitigation does not. While critics have assumed that these are irresolvable problems with carbon markets, they may simply be bugs when markets are narrowly structured for climate mitigation.

A. Accounting Concerns

Perhaps the most common critique of carbon offsets is that they do not do what they say: reduce, avoid, or remove carbon emissions in quantities *physically* equivalent to the buyer's net increase in emissions. Accounting difficulties have been covered extensively by journalists throughout the evolution of carbon markets. Their intractability has resulted in "a long-standing, vociferous debate" among environmentalists about the inclusion of offsets in international, federal, state, and voluntary climate regimes.[213]

Consider two stubborn issues of nonequivalence.[214] First, accurately quantifying the carbon benefits of different offset projects has proven to be elusive. Natural carbon removal rates vary significantly based on environmental factors, land management practices, and unpredictable natural and anthropogenic disturbances.[215] Developments in monitoring technologies and models may narrow this accounting gap in the future.[216] But, as long as accounting rules do not accurately represent the carbon removed in particular projects, sellers have perverse incentives to exaggerate carbon benefits to sell more credits.[217]

Second, ensuring that carbon benefits produced by offsets are additional to a "business-as-usual" counterfactual state has proven to be similarly elusive.[218] When sellers have better information about what they would do under various counterfactual scenarios than market intermediaries and buyers, they face perverse incentives to overclaim additionality.[219]

Whistleblowers exposed particularly egregious cases of non-additional offsets in the earliest carbon markets. The *Wall Street Journal* reported in 2008 that landfills across the country were selling offsets within the Chicago Climate Exchange for methane capture projects that had already been ongoing for years.[220] As one landfill operator

208. Compliance Offsets Protocol Task Force, Final Recommendations (2021), https://ww2.arb.ca.gov/sites/default/files/2021-03/offsets_task_force_final_report_030221.pdf.
209. S.B. 5126, §§19(e), 20(1)-(2), 2021 Reg. Sess. (Wash. 2021).
210. These climate-vulnerable communities can be identified using the EPA EJScreen tool. *See* https://www.epa.gov/ejscreen (last updated Jan. 30, 2023).
211. Hannah J. Wiseman, *Expanding Regional Renewable Governance*, 35 Harv. Env't L. Rev. 477, 528-38 (2011).
212. *See supra* notes 3-5.
213. *See* Welton, *supra* note 3, n.172.
214. James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 Stan. L. Rev. 607 (2000).
215. *See* Lin, *Making Net Zero Matter*, *supra* note 3, at 746-47.
216. Kim A. Novick et al., *Informing Nature-Based Climate Solutions for the United States With the Best Available Science*, 28 Glob. Change Biology 3778 (2022) (discussing advantages and limitations of novel technologies and models for quantifying the carbon benefits of nature-based carbon removal efforts).
217. The Berkeley Carbon Trading Project published a highly impactful study in 2021 finding that improved forest management offsets issued under California's cap-and-trade program were over-credited by almost 30% due to inaccurate carbon quantification methods and adverse selection issues. The problem is that estimates of carbon removal rates for specific offset projects were based on unrepresentative regional averages of forest carbon stocks. The study concluded that sellers were "systematically" gaming California's rules to gain more offset revenue than warranted by choosing sites for projects that were particularly unrepresented by these averages. Grayson Badgley et al., *Systematic Over-Crediting in California's Forest Carbon Offsets Program*, 28 Glob. Change Biology 1433 (2021).
218. *See* Section II.C.
219. *Id.*
220. Jeffrey Ball, *Pollution Credits Let Dumps Double Dip*, Wall St. J. (Oct. 20, 2008), https://www.wsj.com/articles/SB122445473939348323.

admitted, "It seemed a little suspicious that we could get money for doing nothing."[221]

Other prominent studies concluded that the world's first major carbon offset programs had led to significant over-crediting from projects that made suspect additionality claims.[222] Offset standards were generally tightened in the aftermath of these reports to prevent similar types of abuse, yet the reputation of carbon offset markets as fraudulent persisted.[223]

Accounting concerns most clearly rest on the assumption that decarbonization should be a primary standard for evaluating carbon markets. Carbon accounting gaps—differences between represented carbon benefits and what an offset project actually achieves due to non-additionality and other accounting errors—are objectionable to the extent that they result in a net emission increase (due to over-crediting) rather than a net emission decrease (due to under-crediting).

Restructuring carbon markets for climate resilience presents two responses to accounting concerns. First, while a net emission increase is always worse than a carbon-neutral outcome under a decarbonization framework, it may not be under a climate-resilience framework, where equivalent weight is assigned to adaptation co-benefits. Under this holistic cost-benefit analysis, an offset purchase could be warranted even if the project does not produce the carbon benefits represented, as long as its adaptation co-benefits make up for any costs attributed to the carbon accounting gap. For example, in the case of CCS-based offsets, carbon shortfalls due to the risk of non-additionality are not counterbalanced by any discernible adaptation co-benefits. Yet, the same cost-benefit analysis may tip the scale in the favor of coastal afforestation, which promises significant adaptation co-benefits even though projects suffer from pervasive carbon accounting errors common to land-based carbon removal practices.

Second, resilient offsets have important downstream co-benefits not accounted for under a strict decarbonization framework. For example, the Yurok Tribe of northern California used carbon revenue to purchase more than 50,000 acres of ancestral land from private forestland owners.[224] Selling carbon has presented the cheapest and quickest option to land reclamation.[225] It has also allowed Yurok tribal members to implement climate-resilient traditional management techniques like prescribed burns, which boost biodiversity, enhance watershed restoration, and increase cultivation of food and medicinal plants that thrive in a fully functioning forest ecosystem.[226] While studies have found that securing Indigenous land tenure is one of the best long-term strategies for climate resilience,[227] the environmental and ethical benefits of social-institutional changes like land reclamation remain extremely difficult to account for in a strict decarbonization framework.[228]

B. *Moral Concerns*

Moral concerns target the purchase of carbon offsets. Even if offsets reduce, avoid, or remove emissions in quantities physically equivalent to the buyer's emissions, moral concerns point out that buying offsets is wrong—either categorically wrong or wrong in virtue of its harmful consequences. On the deontological version, fairness and equity concerns prohibit "buying one's way" out of strict obligations to cut emissions.[229] Carbon emissions, like murder and lying, is simply not the type of wrongful act that people should be able to buy the right to do.

On the consequentialist version, buying offsets leads to worse climate outcomes by displacing more powerful psychological incentives to reduce emissions, like stigma and shame,[230] insofar as "knowing you can always buy your way out of trouble tempts you to do it again."[231] Similarly, allowing polluters to purchase offsets as part of an institutional policy might displace more powerful institutional incentives to reduce emissions. For example, a corporate policy to offset employees' work-related flights may send market signals to expand the airline industry, encouraging further flight-related emissions. A cap-and-trade regulation that allows industrial polluters to meet a portion of their emis-

221. Two years later, European watchdog groups reported that Chinese and Indian companies were building refrigerant factories just to destroy its by-product emissions in order to generate CDM credits for sale. The problem was that the refrigerants themselves are a particularly potent GHG. Thus, the whole offset scheme likely led to significant emission increases for both buyers and sellers. *Id*.

222. Martin Cames et al., Oeko Institute, How Additional Is the Clean Development Mechanism? (2016); Michael Wara, *Is the Global Carbon Market Working?*, 445 Nature 595 (2007).

223. In the aftermath of the refrigerant destruction scandal, the CDM restricted new plants from selling CDM credits and capped the sale of credits to historic levels of refrigerant production. Nathanial Gronewold, *Greenhouse Gas Emission Offsets May Be Fraudulent*, Sci. Am. (June 14, 2010), https://www.scientificamerican.com/article/greenhouse-gas-emission-offsets-may-be-fraudulent/.

224. Song & Temple, *supra* note 5; Carolyn Kormann, *How Carbon Trading Became a Way of Life for California's Yurok Tribe*, New Yorker (Oct. 10, 2018), https://www.newyorker.com/news/dispatch/how-carbon-trading-became-a-way-of-life-for-californias-yurok-tribe.

225. Manning & Reed, *supra* note 201.

226. Kormann, *supra* note 224.

227. IPCC, *supra* note 33, at 51, 70, 104.

228. *But see* Helen Ding et al., World Resources Institute, Climate Benefits, Tenure Costs: The Economic Case for Securing Indigenous Land Rights in the Amazon (2016) (estimating that CCS is up to 42 times more expensive than securing Indigenous forestlands tenure in producing equivalent climate mitigation benefits).

229. Jonathan Remy Nash, *Framing Effects and Regulatory Choice*, 82 Notre Dame L. Rev. 313, 326 (2006) (articulating this argument); John P. Dwyer, *The Use of Market Incentives in Controlling Air Pollution: California's Marketable Permits Program*, 20 Ecology L.Q. 103, 111 (1993) (some environmental groups and regulators express moral objection to "creating property rights in pollution").

230. Steven Kelman, What Price Incentives?: Economists and the Environment 49 (1981) ("The 'license to pollute' that an economic incentives policy implies may influence citizen preferences in a direction that gives achievement of a clean environment less weight . . . ."); Bruno S. Frey, *Motivation as a Limit to Pricing*, 14 J. Econ. Psych. 635, 652 (1993) (carbon pricing may "weaken" or "completely destroy" guiding environmental ethic, in turn eroding political support for environmental policies); Cass R. Sunstein, *On the Expressive Function of Law*, 144 U. Pa. L. Rev. 2021, 2045-46 (1996) ("Critics claim that emissions trading has damaging effects on social norms by making environmental amenities seem like any other commodity . . . .").

231. *See* Sandel, *supra* note 4 ("[T]urning pollution into a commodity to be bought and sold removes the moral stigma that is properly associated with it.").

sion-reduction obligations by buying offsets may displace the passage and implementation of more effective pollution control restrictions, like command-and-control regulations mandating specific reductions for each polluter.

Moral objections have played a lesser role in legal and policy discussions about the proper role of offsets in climate law than accounting issues have. However, they have strongly influenced public opinion on carbon offsets, explaining, perhaps, the overwhelming number of op-eds and television segments dedicated to critiquing carbon offsets relative to other environmental regulatory instruments.[232]

Like accounting issues, moral objections center on a static idea of what offsets do and why polluters intend to buy them: to neutralize emissions in order to avoid avoidable global warming. Restructuring carbon offsets for resiliency renders these objections somewhat moot. Climate law has long embraced the idea that polluters have strict obligations to help vulnerable parties adapt to climate change. But payment for services by third parties has been the default method for discharging these obligations, not personal action. To the extent that offset projects like urban forestry and coastal afforestation have local adaptation co-benefits, buying offsets would allow polluters to meet a portion of their moral obligations to provide adaptation assistance, even if it does not count at all toward their moral obligations to reduce emissions.

First, polluters are obligated to contribute to climate adaptation for the same fairness and equity rationales that undergird polluters' obligations to reduce emissions. Indeed, unlike murder and other conventional wrongs, climate change is a fundamentally two-pronged normative problem. Individuals and institutions are faced not simply with the choice of harming or not harming, but with the dual and concurrent imperatives to avoid harming and remedy ongoing climate harms.

Climate law from the beginning has embraced the idea that polluters have dual obligations to mitigate and adapt—obligations commensurate with each polluter's historical emissions. The UNFCCC commits all nation Members to implement domestic mitigation and adaptation measures, but it additionally commits developed countries to assist "particularly vulnerable" developing countries with their adaptation costs.[233] Broad adaptation commitments were subsequently codified into specific funding mechanisms in the Kyoto Protocol,[234] the Copenhagen Accord,[235] and the Paris Agreement.[236]

Similarly, U.S. climate tort litigation has brought arguments linking polluters' historical and present contributions to climate change to strict legal responsibilities to fund the adaptation costs of vulnerable individuals and groups. In these lawsuits, private-property owners, tribal groups, and subnational governments argue that oil and gas companies that have contributed disproportionately to climate change through their business activities are liable for the costs of adapting to sea-level rise and other climate harms that would otherwise fall entirely on the plaintiffs.[237] While U.S. tort law has yet to yield any favorable outcomes for climate victims, the moral demand underlying their claims to relief endures: polluters have an affirmative obligation to help victims cope with the ongoing harms of climate change.[238]

Second, even if reducing emissions is not the type of obligation that polluters can "buy their way out of," adaptation assistance certainly is, given the highly technical nature of adaptation measures and the important autonomy values at stake in decisions about where, when, and how to adapt. Polluters typically lack the knowledge and expertise to identify and address highly local climate vulnerabilities. No good, for instance, comes from requiring frequent fliers on a major commercial airline to *personally* design, implement, or oversee a massive reforestation initiative off of the Florida coastline, a rooftop solar panel installation in a blackout-prone neighborhood in Texas,

232. Welton, *supra* note 3, n.172.

233. UNFCCC art. 4 §§1(b), 4, May 9, 1992, S. Treaty Doc. No. 102-38, 1771 U.N.T.S. 107.

234. *See supra* note 86.

235. UNFCCC, *Copenhagen Accord*, art. 3, U.N. Doc. FCCC/CP/2009/L.7 (Dec. 18, 2009). In upholding the Copenhagen Accord, the Obama Administration issued a series of Executive Orders that mandated coordination between federal agencies and with states, localities, and tribes to consider both adaptation and mitigation prospects in their formal and informal actions. *See* Exec. Order No. 13563, 78 C.F.R. 66819 (2013) (requiring federal agencies to coordinate on resilience plans promoting "dual goals" of mitigation and adaptation); Exec. Order No. 13693, 80 C.F.R. 15871 (2013) (forming federal interagency working group to coordinate resilience planning with different levels of government and stakeholders).

236. Paris Agreement to the UNFCCC art. 9 §§1, 4, Dec. 12, 2015, T.I.A.S. No. 16-1104. While the Obama-era climate resiliency mandates were subsequently revoked under the Trump Administration, states from Hawaii to Maine created interagency councils delegated with designing climate response plans that include both mitigation and adaptation measures. *See*, *e.g.*, Haw. Rev. Stat. Ann. §225P-3 (2021); N.J. Admin. Code Exec. Order No. 89 (2019) (similar); Me. Rev. Stat. Ann. tit. 38, §577 (2019) (similar); D.C. Code Ann. §8-181.02 (2017) (similar).

237. *See* Native Vill. of Kivalina v. ExxonMobil Corp., 663 F. Supp. 2d 863, 39 ELR 20236 (N.D. Cal. 2009), *aff'd*, 696 F.3d 849 (9th Cir. 2012) (Alaska Inupiat village suing energy corporations seeking as damages relocation costs for village threatened by rising seas); Comer v. Murphy Oil USA, Inc., 607 F.3d 1049, 1055, 40 ELR 20147 (5th Cir. 2010) (Mississippi coastal landowners suing energy corporations seeking recovery of insurance costs from flood risk and cleanup costs due to Hurricane Katrina); City of Oakland v. BP PLC, 969 F.3d 895, 50 ELR 20124 (9th Cir. 2020) (cities of Oakland and San Francisco suing five oil and gas companies, seeking contribution to an "abatement fund" for climate change adaptation programs). For commentary, see Albert C. Lin & Michael Burger, *State Public Nuisance Claims and Climate Change Adaptation,* 36 Pace Env't L. Rev. 49, 50-51 (2018).

238. R. Henry Weaver & Douglas Kysar, *Courting Disaster: Climate Change and the Adjudication of Catastrophe*, 93 Notre Dame L. Rev. 295 (2017) (discussing "norm articulation" function of courts). *See also* Robert M. Cover, Foreword: *Nomos and Narrative*, 97 Harv. L. Rev. 4, 4 (1983) (observing that law constitutes and situates itself within "a world of right and wrong").

or a prescribed burn on tribal forestland in northern California. If anything, the do-it-yourself "voluntourism" approach inculcates character vices like arrogance and foolhardiness.[239] Financing the efforts of foresters and electricians to implement adaptation measures in their respective sectors and geographies of expertise is in the far better interest of intended beneficiaries.

A second reason that payment-for-services trumps more interventionist forms of adaptation assistance is that it is necessary to build long-term adaptation capacity. This is especially salient for Indigenous groups forced to relocate due to climate change. External funding can protect tribal agency in decisions about where and how to resettle.[240]

In 2009, Kivalina, a village of Inupiat Native Alaskans living on a barrier reef island, broke with a preceding string of climate tort claims by seeking an estimated $95-$400 million in relocation costs for their village in a public-nuisance lawsuit against 24 energy corporations,[241] rather than a court injunction to limit the defendants' carbon emissions.[242] A monetary award would have allowed Kivalina to implement their chosen relocation plan, the product of decades of internal referenda.[243] Voluntary community-driven relocation has subsequently served as a key element of the Biden Administration's climate adaptation policy.[244] Resilient carbon markets responsive to local adaptation needs fall in line with this community-driven approach to adaptation assistance.

What about the consequentialist objection that buying offsets "tempts" buyers away from reducing their own emissions? No empirical evidence directly supports the charge.[245] Buying offsets could instead *enhance* emissions-reduction behavior and support for climate measures by educating polluters about the carbon footprint of specific behaviors and investment decisions, thus combating ignorance about climate change.[246] Buying offsets may also trigger the norm of reciprocity by inducing polluters to sacrifice *something* in the service of remedying their harmful behavior, rather than ignoring or denying the harm altogether.[247] As Profs. Michael Vandenbergh and Anne Steinemann point out:

> Studies demonstrate that when individuals take affirmative steps to reduce their contributions to social harms, *they expect reciprocity from others*—in this case, industry, government, agriculture, and others. . . . Offsets that involve public commitments by individuals to reduce their carbon footprint thus may induce direct emissions reductions and may build public support for traditional regulatory measures.[248]

Pairing carbon offset markets with information disclosure mechanisms is critical to maintaining voluntary incentives to reduce emissions. Information disclosure has been a cornerstone strategy of U.S. environmental law. For example, the National Environmental Policy Act (NEPA) has been used by activists to force governmental disclosure of the environmental impacts of major infrastructure projects since its passage in 1970.[249]

To preserve company and government motivations to mitigate, mandated disclosure of actual emissions and details about their net-zero targets is the first-best option.[250] As Professor Lin argues, information about "planned pathway[s] to net zero, emissions reduction measures, actual emissions, and reliance on offsets and carbon removals" will allow the public to distinguish between "genuine

239. Pippa Biddle, Ours to Explore: Privilege, Power, and the Paradox of Voluntourism (2021) (criticizing the service-based travel industry of serving the emotional, reputational, and empowerment needs of wealthy Western volunteers to the detriment of poor non-Western beneficiaries).

240. *Id.* at 534 ("[D]ecisions on land use, development, and resource management continue to have limited input from Indigenous peoples, limiting agency to alter settlement patterns, resource management, and land use in response to environmental change.").

241. Complaint ¶¶ 1-4, Native Vill. of Kivalina v. ExxonMobil Corp., 663 F. Supp. 2d 863 (N.D. Cal. 2009) (No. cv-08-1138).

242. *See, e.g.*, American Elec. Power Co. v. Connecticut, 564 U.S. 410, 41 ELR 20210 (2011) (eight states and the city of New York sued five large private utilities, seeking court-enforced limits on CO_2 emissions from domestic power plants).

243. City of Kivalina, *Relocation*, http://www.kivalinacity.com/kivalinarelocation.html [https://web.archive.org/web/20120713030803/http://www.kivalinacity.com/kivalinarelocation.html].

244. Press Release, U.S. Department of the Interior, Biden-Harris Administration Makes $135 Million Commitment to Support Relocation of Tribal Communities Affected by Climate Change (Nov. 30, 2022), https://www.doi.gov/pressreleases/biden-harris-administration-makes-135-million-commitment-support-relocation-tribal (announcing $115 million for Voluntary Community-Driven Relocation Program to assist tribal communities severely impacted by climate-related environmental threats).

245. Defenders of the "crowding out" effect frequently cite a 2001 study finding that parents, when presented with a fine for being late to pick up their children at an Israeli day care center, tend to pick up their children later rather than earlier. *See* Bruno S. Frey & Reto Jegen, *Motivation Crowding Theory*, 15 J. Econ. Survs. 589, 603-04 (2001). This type of behavioral research purports to show that motivation to do the morally superior act may generally be "crowded out" when a previously nonmonetary relationship is transformed into an explicitly monetary one. *See generally* Yochai Benkler, *Sharing Nicely: On Shareable Goods and the Emergence of Sharing as a Modality of Economic Production*, 114 Yale L.J. 273, 321-28 (2004) (overview of literature on "crowding out" effect).

246. Rose, *supra* note 53, at 302-12 (describing ignorance, distrust, and insouciance as structural cognitive impediments to solving "tragedy of commons" problems).

247. *Id.*

248. Vandenbergh & Steinemann, *supra* note 3, at 1723 (emphasis added). People may also respond in morally worse ways to a less permissive, command-and-control alternative. Carol M. Rose, *The Moral Subject of Property*, 48 Wm. & Mary L. Rev. 1924 (2007); Lior Jacob Strahilevitz, *How Changes in Property Regimes Influence Social Norms: Commodifying California's Carpool Lanes*, 75 Ind. L.J. 1231 (2000) (finding drop in rampant cheating when California highway express lanes gave access to single-passenger cars that paid a use fee).

249. 42 U.S.C. §§4321-4370h, ELR Stat. NEPA §§2-209; Wyatt G. Sassman, *Community Empowerment in Decarbonization: NEPA's Role*, 96 Wash. L. Rev. 1511 (2021).

250. Under a 2022 proposed Securities and Exchange Commission (SEC) rule, publicly held companies must disclose information about their scope 1 and scope 2 emissions. Scope 3 emissions must be disclosed if material to shareholders or if the company has set an emissions goal that includes those emissions. The Enhancement and Standardization of Climate-Related Disclosures for Investors, 87 Fed. Reg. 21334 (Apr. 11, 2022). California has proposed legislation requiring large companies doing business in the state to report their scope 1, 2, and 3 emissions annually. S.B. 260, 2021-2022 Reg. Sess. (Cal. 2021), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB260. As a signatory to the UNFCCC, the United States is required to develop and submit annual national GHG emission inventories. UNFCCC art. 4(1)(a), May 9, 1992, S. Treaty Doc. No. 102-38, 1771 U.N.T.S. 107. EPA further requires annual reporting of GHG data from large GHG emissions sources in the United States. 40 C.F.R. pt. 98 (2009).

progress toward net zero and mere greenwashing."[251] Given the negative reputation of carbon offsets among the general public, disclosure of *distinct* targets for internal emissions-reduction and offset purchases are critical to "safeguard the primacy of conventional mitigation measures" as well as reliance on higher-quality offsets in reaching net zero.[252]

C. Political Concerns

Political concerns take issue with the fact that carbon markets allow buyers and sellers to choose how to neutralize emissions in ways seemingly unconstrained by the broader community implicated in and impacted by climate change.[253] Climate change is the exemplar of a collective action problem because its causes and effects are both global and intergenerational.[254] Therefore, resources dedicated to neutralizing emissions should be allocated at broader levels of governance, rather than at the atomistic level of individuals.[255]

Behind political critiques of offsetting lies a suspicion of private forms of environmental governance and what they represent: a shift of authority away from public bodies traditionally understood as managers of environmental protection (legislatures, administrative agencies, and courts), and toward private actors (individuals, households, and corporations) traditionally understood as its subjects.[256] Public bodies have adopted democratic procedures over time to ensure that their decisions are responsive to the many affected (e.g., notice-and-comment rulemaking, judicial appeals process, etc.). Private actors seem to make self-interested decisions accountable only to the invisible hand of the market. Due to this "democratic deficit" within private environmental governance, skeptics worry that the expanded role of carbon markets within the net-zero framework will result in distributional consequences detrimental to the broader normative aims of climate law.[257]

Indeed, private carbon markets unchecked by public bodies threaten to harm groups not only historically disadvantaged by law, but especially vulnerable to the impacts of climate change. On the buyer side, carbon markets appear complicit in continued environmental injustice against disadvantaged groups. Large industrial polluters notoriously choose to site heavily polluting infrastructure (e.g., extraction sites, factories, power plants, and airports) adjacent to poor, minority communities.[258] When polluters buy carbon offsets, they appear to buy societal permission to continue to emit harmful co-pollutants as well.

On the seller side, there have been multiple documented instances of nonconsensual land transfers from Indigenous groups to large-scale forest-based offset sellers, primarily in developing countries.[259] Because Indigenous peoples depend on land for livelihood and cultural resources more directly than urban populations, land expropriation for offset production uniquely exacerbates their climate vulnerability.[260] Critics have attributed both types of distributional harm to the market structure used to coordinate the production and consumption of offsets.

To avoid these distributive harms, legal scholars have proposed variants of a "public option" for offsetting, where polluters contribute to a mitigation fund run by a national or international body to meet their net-zero pledges in lieu of buying offsets from unregulated third-party certifiers.[261] Disbursement of a public mitigation fund would, ideally, be overseen by groups potentially impacted by both the buying and production of offsets. A public fund is defended as a more equitable and democratic alternative to carbon markets.

Like accounting and moral concerns, political critiques typically assume that climate mitigation is, and should be, the sole function of carbon markets, in its case for public alternatives to offsetting. But even if mitigation is most appropriately implemented by public bodies at higher levels of governance according to democratic procedures, *climate resilience* should be implemented according to forms of governance most appropriate for *both* mitigation and adaptation. This raises the two questions presented in Part I: what are the ideal types of governance for climate resilience and, by extension, for climate adaptation?

Surprisingly, market-based approaches have often presented the most financially sustainable, transparent, and accessible sources of adaptation funding for climate-vulnerable communities. Public alternatives—defined as efforts led by governmental actors and governed by democratic processes—by contrast have often failed to remedy

251. Lin, *Making Net Zero Matter*, *supra* note 3, at 702.
252. *Id.* at 759-60. For hard-to-decarbonize industries like steel and cement production, disclosure may force companies to reach a consensus on appropriate industry-specific ceilings on offsetting.
253. Welton, *supra* note 3, at 4-5.
254. *See* Section I.C.
255. Welton, *supra* note 3.
256. *Id.* at 40 ("Behind the [carbon] neutrality mirage . . . lies a giant transfer of political and social control from the state to the market, with an attendant loss of opportunities for democratically shaping the outcomes[.]"); Michael Vandenbergh, *Private Environmental Governance*, 99 Cornell L. Rev. 129, 134 (2013) (describing public environmental governance as "the unspoken assumption" of environmental law and policy). *See also* Michael P. Vandenbergh & Jonathan M. Gilligan, Beyond Politics: The Private Governance Response to Climate Change 3 (2018); Sarah E. Light, *The Law of the Corporation as Environmental Law*, 71 Stan. L. Rev. 137, 139 n.5 (2019); Michael P. Vandenbergh, *The New Walmart Effect: The Role of Private Contracting in Global Governance*, 54 UCLA L. Rev. 913, 914-15 (2007).
257. Joshua U. Galperin, *Environmental Governance at the Edge of Democracy*, 39 Va. J. Env't L. 70 (2021); Joshua U. Galperin, The Public Role in Private Governance (manuscript on file with author).
258. *See*, *e.g.*, Ann E. Carlson, *The Clean Air Act's Blind Spot: Microclimates and Hotspot Pollution*, 65 UCLA L. Rev. 1036 (2018); Shalanda Baker, *Anti-Resilience: A Roadmap for Transformational Justice Within the Energy System*, 54 Harv. C.R.-C.L. L. Rev. 1, 6 (2019); Richard T. Drury et al., *Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy*, 9 Duke Env't L. & Pol'y F. 231, 251-58 (1999) (critiquing an early cap and trade in Los Angeles based on its creation of pollution hot spots).
259. Lyons & Westoby, *supra* note 158 (example of land grab in Uganda attributed to production of CDM credit). *See also* Indigenous Environmental Network, *Carbon Pricing Is a False Solution to Climate Chaos*, https://www.ienearth.org/carbon-pricing/ (last visited Apr. 10, 2023).
260. Alice Kaswan, *Environmental Justice and Domestic Climate Change Policy*, 38 ELR 10287, 10295 (May 2008).
261. César Dugast, Net Zero Initiative—A Framework for Collective Carbon Neutrality (2020); Wara, *supra* note 13, at 1801.

climate injustices due to a lack of institutional incentives and political holdouts.

Four examples from U.S. and international climate law illustrate the advantages of market-based approaches for equitable allocation of adaptation funding. First, consider the village of Kivalina—a litmus test for adaptation governance as one of America's most climate-vulnerable and socioeconomically marginalized communities. Public approaches have failed Kivalina spectacularly in dealing with climate change. Kivalina's climate woes began with the executive branch in 1905, when the Bureau of Indian Affairs effectively forced traditionally nomadic Inupiat communities to permanently relocate to a narrow barrier island in Northwest Alaska to enroll their children in a newly built school.[262]

As rising Arctic waters lapped at its shores for the next century, Kivalina developed a relocation plan.[263] A U.S. Court of Appeals for the Ninth Circuit decision in 2012 declining to even hear Kivalina's tort claim against carbon polluters on the merits (and subsequent certiorari denial by the U.S. Supreme Court) effectively shut the door to any judicial recourse for funding that plan.[264] Recognizing that its decision "obviously does not aid Kivalina," the court nevertheless punted "the solution to Kivalina's dire circumstances" to "the hands of the legislative and executive branches of our government."[265]

Yet, legislative channels have proven to be no less disappointing for Kivalina. As of 2022, state funding has fallen short due to persistent budgetary constraints. Nor has federal funding come through, due to the absence of governance structures and liability schemes dedicated to climate-related relocation and, most egregiously, to Alaska's holdout against a targeted federal proposal funded by cuts to oil and gas subsidies.[266] What Kivalina has been able to accomplish so far in the service of relocation has relied on unpredictable pulses of private philanthropic funding and technical assistance from state and federal agencies.[267]

Two dueling approaches to international adaptation finance under the UNFCCC further illustrate the pitfalls of relying exclusively on public bodies and democratic procedures for equitable allocation of adaptation resources. On the one hand, developed countries jointly committed to contribute $100 billion per year by 2020 to developing countries to be "balanced" between mitigation and adaptation efforts, as part of the Green Climate Fund (GCF) under the 2009 Copenhagen Accord.[268] As the deadline approached, it became evident to beneficiaries and watchdog groups that donors were falling far short of their commitments,[269] especially for adaptation funding,[270] and especially funding for the poorest developing countries.[271] Donor countries were accused of overinflating their own contributions—an easy misrepresentation given, ironically, the inherent difficulty of identifying what counts as additional climate assistance as opposed to business-as-usual aid.[272]

The GCF's democratic governance structure did not prevent, nor has it remedied, persistent shortfalls in adaptation funding. Donor and beneficiary countries are equally represented on the GCF's 24-member board, and engage in consensus-based decisionmaking.[273] The real problem is that rich countries simply have too little to gain in the short term from "giving poor people money to help them deal with the impacts of climate change," as a Bangladeshi adaptation policy expert puts it bluntly.[274]

Indeed, the Trump Administration predictably refused to contribute "billions of dollars that ought to be invested right here in America" to the GCF, after announcing the United States' withdrawal from the Paris Agreement in 2017.[275] But even the Barack Obama and Biden Administrations consistently failed to fulfill their GCF pledges—easy concessions to predictable Republican opposition when more politically salient funding priorities were at stake.[276]

262. Christine Shearer, Kivalina: A Climate Change Story 34 (2011).
263. *Id*. at 102.
264. Native Vill. of Kivalina v. ExxonMobil Corp., 696 F.3d 849, 42 ELR 20195 (9th Cir. 2012), *cert. denied*, 569 U.S. 1072 (2013).
265. *Id*. at 858.
266. The U.S. Congress declined to appropriate the Obama Administration's proposed $2 billion Coastal Climate Resilience Program in 2016. The proposal included a coastal relocation program for Alaska Native villages funded by repealing certain oil and gas subsidies. Fact Sheet, The White House, President Obama Proposes New Funding to Build Resilience of Alaska's Communities and Combat Climate Change (Feb. 9, 2016), https://obamawhitehouse.archives.gov/the-press-office/2016/02/09/fact-sheet-president-obama-proposes-new-funding-build-resilience-alaskas. To date, no federal government agency has the statutory mandate to provide relocation assistance for communities. Existing federal disaster programs overwhelmingly focus on restoration and rebuilding in the aftermath of disasters. Shearer, *supra* note 262, at 102-03.
267. U.S. Climate Resilience Toolkit, *Relocating Kivalina*, https://toolkit.climate.gov/case-studies/relocating-kivalina (last modified Aug. 9, 2021).
268. UNFCCC, *Copenhagen Accord*, art. 8, U.N. Doc. FCCC/CP/2009/L.7 (Dec. 18, 2009).
269. In a 2020 report, Oxfam, an international aid organization, estimated public climate financing only reached $19-$22.5 billion, much of which is in the form of loans rather than grants. Julie Bos & Joe Thwaites, World Resources Institute, Breakdown of Developed Countries' Public Climate Finance Contributions Towards the $100 Billion Goal (2021).
270. Adaptation constituted less than half of total mitigation funds transferred in 2019. Multilateral Development Banks, Joint Report on Multilateral Development Banks' Climate Finance (2020); AdaptationWatch, Toward Implementation: The 2017 AdaptationWatch Report (Kevin M. Adams & Danielle Falzon eds., 2017) (finding that only $2.3 billion out of $10.1 billion in adaptation funding claimed in 2012 was clearly adaptation-related).
271. Developed countries gave only $5.9 billion between 2014 and 2018 to the U.N.'s 46 "least developed countries" for adaptation—less than 20% of the amount developed countries said they had given. Marek Soanes et al., International Institute for Environment and Development, Follow The Money: Tracking Least Developed Countries' Adaptation Finance to the Local Level (2021), https://www.iied.org/20326iied.
272. *Id*.
273. UNFCCC, *Decision 3/CP.17, Launching the Green Climate Fund*, U.N. Doc. FCCC/CP/2011/9/Add.1, annex, para. 4 (Dec. 11, 2011). However, the GCF Board's consensus-based voting procedure has prevented countries from completely blocking funding for legitimate projects. *See* Kashmala Kakakhel, *How Pakistan Won a Skirmish With India Over Climate Change Funds*, Dawn, Oct. 17, 2016, https://www.dawn.com/news/1290373 (describing India's unsuccessful attempt to block funding for a flood-control project in a contested region of Pakistan).
274. Jocelyn Timperley, *The Broken $100-Billion Promise of Climate Finance—And How to Fix It*, 598 Nature 400, 402 (2021).
275. *Trump's Speech on Paris Climate Agreement Withdrawal, Annotated*, NPR (June 1, 2017), https://www.npr.org/2017/06/01/531090243/trumps-speech-on-paris-climate-agreement-withdrawal-annotated.
276. In total, the Obama and Biden Administrations were only able to secure $2 billion out of a pledged $6 billion to the GCF. Nick Soczyk, *Biden Tries*

In contrast with adaptation grants, mitigation "investments" like loans for solar panels and electric cars yield clearer financial and reputational returns for developed countries. Thus, mitigation loans have eclipsed adaptation grants in total GCF funding, even though loans ultimately exacerbate developing countries' debt burdens.[277]

Broken donor promises for adaptation funding contributed to rising tensions between rich and poor countries in subsequent climate negotiations.[278] This, in turn, contributed to holdouts on critical decarbonization measures like the "phasing out" of coal power in China and India,[279] which, under multiple climate models, is necessary to keep temperatures under the Paris Agreement's 2°C goal.[280] Unless the GCF and successor mechanisms like a proposed "Loss and Damage" fund more effectively engage the self-interest of donor countries and, better yet, openly self-interested donors like the private sector,[281] failure to deliver on adaptation funding will continue to threaten collective action on decarbonization goals.

On the other hand, adaptation funding has flowed more steadily and transparently under a "share of proceeds" approach that taxes revenue from market-based schemes. The first climate instrument to do this was the Adaptation Fund (AF) under the Kyoto Protocol, which is funded by a 2% levy on revenue from its three carbon trading mechanisms.[282] Like the GCF, the AF Board is governed by democratic structure and procedures. Unlike the GCF, beneficiary countries have greater representation on the AF Board and more direct access to funding.[283]

Most importantly, the AF does not rely solely on discretionary donations from developed countries. It instead depends on a fixed carbon revenue tax from offset projects physically situated within beneficiary countries. As a result, developing countries regard the AF as "their own money." They have voiced "ardent and almost unanimous support" for its continuation in post-Kyoto climate agreements, in contrast with other funding mechanisms.[284]

Lastly, state cap-and-trade programs take a similar "share of proceeds" approach. For example, a substantial portion of financial revenue from quarterly allowance auctions under California's cap-and-trade program is reserved for the Greenhouse Gas Reduction Fund (GGRF), which funds projects that advance California's emission-reduction goals as well as economic, environmental, and public health co-benefits within the state.[285] In addition to funding agricultural and forestry climate resiliency efforts like wildfire prevention and forest pest reduction projects, 35% of GGRF funds are statutorily earmarked in total for "low-income" communities and "disadvantaged" communities defined based on levels of pollution burden.[286] By late 2022, and with a two-year-late start, California's GGRF eclipsed the United States' total contribution to the GCF by a whopping tenfold.[287]

Like California's and Kyoto's carbon markets, voluntary carbon offset markets offer a growing source of leviable revenue for jurisdictions to spend on adaptation needs that will only increase over time. Restructuring offsets for climate resilience goes one step further. It ensures that polluters are paying directly for adaptation services while also potentially contributing to non-discretionary funding pools for high-priority but underfunded adaptation projects without a mitigation hook, like climate-induced relo-

Again on Green Climate Fund, Fossil Fuel Tax Breaks, E&E News (Mar. 28, 2022); Sara Schonhardt, *U.S. Spending for Global Climate Response "Pitifully Too Low,"* E&E News (Mar. 14, 2022).

277. *See* Bos & Thwaites, *supra* note 269.

278. Timperley, *supra* note 274. *See also* Brad Plumer et al., *Developing Nations Have a Message at Global Climate Talks: Polluters, Pay Up*, N.Y. Times (Nov. 6, 2022), https://www.nytimes.com/2022/11/06/climate/loss-and-damage-climate-cop27.html.

279. The 2021 Glasgow Climate Pact had originally called for a "phase out" of unabated coal combustion, but a last-minute objection by India (supported by China) watered down the phrase to "phasedown." UNFCCC, *Decision 1/CMA.3, Glasgow Climate Pact*, para. 36, U.N. Doc. FCCC/PA/CMA/2021/10/Add.1 (Mar. 8, 2022). Megan Rowling, *Climate "Loss and Damage" Earns Recognition but Little Action in COP26 Deal*, Reuters (Nov. 13, 2021), https://www.reuters.com/business/cop/climate-loss-damage-earns-recognition-little-action-cop26-deal-2021-11-13/.

280. As a 2019 study concluded, "both China and India will have to expand their renewable energy infrastructure at unprecedented rates" in order to support population growth, development, and climate limitations under Paris. Coal constituted 56%-60% of both countries' total primary energy consumption as of 2017 (compared to 15% for the United States) but between 92%-97% of proven fossil fuel reserves. Kevin J. Warner & Glenn Jones, *The 21st Century Coal Question: China, India, Development, and Climate Change*, 10 Atmosphere 476 (2019).

281. Timperley, *supra* note 274.

282. Kyoto Protocol art. 12 §8, Dec. 10, 1997, 2303 U.N.T.S. 148. The Doha Amendment expanded the CDM adaptation levy to cover the Joint Implementation and International Emissions Trading Mechanisms. *See* UNFCCC, *Decision 1/CMP.8, Doha Amendment to the Kyoto Protocol*, §7(c), U.N. Doc. FCCC/KP/CMP/2012/13/Add.1 (Feb. 28, 2013).

283. The AF Board consists of 16 members selected equitably from all participating groups of countries and follows a "one-country-one-vote" procedure. UNFCCC, *Report of the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol on Its Second Session, Held at Nairobi From 6 to 17 November 2006: Decisions Adopted by the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol*, U.N. Doc. FCCC/KP/CMP/2006/10/Add.1 (Mar. 2, 2007); UNFCCC, *Report of the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol on Its Third Session, Held in Bali From 3 to 15 December 2007: Decisions Adopted by the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol*, U.N. Doc. FCCC/KP/CMP/2007/9/Add.1 (Mar. 14, 2008).

284. Support for the AF from developing countries persisted even though it makes up less than 4% of total climate finance and the share of proceeds from the CDM basically collapsed after 2012. Taking Kyoto's lead, the Paris Agreement reserves a portion of revenue from its carbon trading mechanism to assist the adaptation efforts of "particularly vulnerable" developing countries. Paris Agreement to the UNFCCC art. 6 §6, Dec. 12, 2015, T.I.A.S. No. 16-1104. Anna McGinn & Cindy Isenhour, *Negotiating the Future of the Adaptation Fund: On the Politics of Defining and Defending Justice in the Post-Paris Agreement Period*, 21 Climate Pol'y 383 (2021); Marco Grasso, *The Role of Justice in the North-South Conflict in Climate Change: The Case of Negotiations on the Adaptation Fund*, 11 Int'l Env't Agreements: Pol. L. & Econ. 361 (2011).

285. *See generally* Cal. Code Regs. tit. 17, §95870(i); Cal. Gov't Code §16428.8 (West); Cal. Health & Safety Code §§39710 et seq. (West).

286. Cal. Health & Safety Code §39713(a); 2016 Cal. Stat. ch. 359, §1 (A.B. 1550). Washington and Oregon have created similar funds from allowance auction proceeds with earmarked percentages for disadvantaged communities. *See* Wash. Rev. Code §70A.65.230; H.B. 2020, §35, 2019 Reg. Sess. (Or. 2019). *See also* Vien Truong, *Addressing Poverty and Pollution: California's SB 535 Greenhouse Gas Reduction Fund*, 49 Harv. C.R.-C.L. L. Rev. 493 (2014). *See generally* Alex Wang et al., UCLA School of Law et al., Key Governance Issues in California's Carbon Cap-and-Trade System 15-16 (2022).

287. *See* CARB, *Auction Notices and Reports*, https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/auction-information/auction-notices-and-reports (last visited Apr. 10, 2023). The GGRF is far from perfect. *See* Wang et al., *supra* note 286, at 18-19 (discussing volatility of market-based funding mechanisms and under-inclusivity of "disadvantaged" and "low-income" definition of beneficiary communities).

cation. Contrary to political critiques of carbon markets, they can serve as a stable and transparent form of climate finance for vulnerable communities, shielded from the vagaries of politics and empty altruism.

Beyond giving short shrift to market-based approaches, a deeper problem with political critiques of carbon markets is that they perpetuate a false dilemma between public and private environmental governance. As the examples above show, U.S. and international carbon markets have in practice recognized both private economic interests and public values, while their implementation has relied on the participation of both governmental actors and private stakeholders.

VI. Conclusion

Ultimately, it remains to be seen whether public-private collaborations will result in federal regulations or voluntary standards that effectively curb unjust land grabs, pollution hot spots, and other distributive inequities associated with offset trading. Substantive recommendations highlighted in this Article to restructure carbon offset markets for climate resilience—public certification, governmental offset procurement reform, and subsidies for small-scale offset developers—are aimed at deterring exactly these harms, while ensuring that carbon markets work in the service of climate-vulnerable communities and future generations.

One thing is clear: carbon offsets, simply by virtue of belonging to the "market-based" or "private" bucket of solutions to societal problems, are not immune from the influence of the broader global community implicated in climate change. Carbon offsets will only fall under greater public and regulatory scrutiny as net-zero claims spread from corporate boardrooms to grocery stores, and as heat waves and floods become even more devastating and unbearable. Ideally, these changes will be treated as opportunities for enduring climate justice, rather than yet another exhausting moral and ideological battleground.