ADAPTING TO A 4°C WORLD

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SUMMARY

The Paris Agreement's goal to hold warming to 1.5°-2°C above pre-industrial levels now appears unrealistic. Profs. Robin Kundis Craig and J.B. Ruhl have recently argued that because a 4°C world may be likely, we must recognize the disruptive consequences of such a world and respond by reimagining governance structures to meet the challenges of adapting to it. In this latest in a biannual series of essays, they and other members of the Environmental Law Collaborative explore what 4°C might mean for a variety of current legal doctrines, planning policies, governance structures, and institutions.

Participants at the Environmental Law Collaborative's (ELC's) most recent meeting in July 2021 were asked to consider the adaptation challenges of the worst-case climate scenario: a world that warms by 4 degrees Celsius (°C) (or more) by 2100. As environmental law professors, we remain dedicated to the study and support of laws and policies designed to mitigate greenhouse gas (GHG) emissions and avert the worst-case scenario. But we cannot ignore what scientific studies and newer climate models show. The Paris Agreement's goal to hold warming to 1.5°-2°C above pre-industrial levels now appears unrealistic.[1] In the United States, regulatory inaction and political gridlock frustrate efforts to implement the decarbonization measures that we need now to prevent the warming predicted by climate models. At the international level, the commitment and cooperation necessary for dramatic emissions reductions also appear unlikely.

To frame and inspire discussion about the consequences of a 4°C world, participants read a recent article by two ELC members, Robin Kundis Craig and J.B. Ruhl, who argue that because a 4°C world is likely, we must recognize the disruptive consequences of such a world and respond by reimagining governance structures to meet the challenges of adaptation.[2] A 4°C world is one marked by dramatic sea-level rise, devastating heat waves, extreme drought, increased flooding, food insecurity, and radical shifts in ecosystems and biodiversity. Some communities may not be able to adapt; they may simply have to move. Adapting our laws and governance structures to physical and social disruption at this scale requires transformative thinking.

In the essays that follow, ELC participants explore what it means to adapt to a 4°C world. Some essays highlight the inadequacy of current legal doctrines, planning policies, and governance structures to meet the adaptation challenges ahead. Others examine the need to rethink laws and institutions that govern ecosystem services and issues of biodiversity. And some focus on issues of social equity and environmental injustice. Although each essay makes its own contribution, they all share a deep concern for the future and an urgency to mitigate not only the emissions that drive us closer to 4°C, but also the serious harms that we will suffer if we fail to plan for the worst-case scenario.

Authors' Note: The Environmental Law Collaborative (ELC) comprises a rotating group of law professors who assemble every other year to think, discuss, and write on an important and intriguing theme in environmental law. The goals of this meeting are both scholarly and practical, as ELC participants seek to use their disparate areas of scholarly expertise to study trends and important events in the law and ultimately to improve the environmental conditions of the world in which we live.

1. For a summary of the Paris Agreement and links to the document, see United Nations Climate Change, The Paris Agreement, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (last visited Jan. 6, 2022).

I. Western Water Rights in a 4°C Future

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Western water rights reflect a short and stable climate history, but that period of stability is ending. Looming climate

2. J.B. Ruhl & Robin Kundis Craig, *4°C*, 106 Minn. L. Rev. 191 (2021).

change of 4°C will produce not only higher temperatures, but decreased snowpack, shifts in runoff patterns,[3] and the dramatic shrinkage of giant reservoirs.[4] The climatic changes that have already traumatized the West will only intensify and cross even more dangerous thresholds,[5] necessitating the deliberate adaptation of water rights systems.

A. *Hydrology in a Changing Climate*

A climate-changed future is inherently uncertain, but the general consensus predicts a dire future for water supply in the arid West. Precipitation patterns are the biggest source of uncertainty, due to the potential increase in extreme weather events.[6] This could both increase and decrease water supplies as larger snowstorms could dump more precipitation in some years, while other impacts on the snowpack would lead to declines. However, higher temperatures in the summer and fall are expected to offset potential increases in snowpack in most years, leading to an overall trend of less water supply in a warming future.[7] Temperature increases along the Colorado River may reduce flows by more than 20% mid-century and 35% by 2100,[8] reducing vital water supplies to seven states and 23 tribal nations.[9]

Intra- and inter-annual variability will continue as a hallmark of western water systems. In the Colorado River basin, for example, the impacts of a changing climate are already apparent as the current megadrought fueled by climate change recently led to the first ever federal water shortage declaration.[10] Experts urge us to plan for even worse impacts to come.[11]

Looking beyond the Colorado River basin, a 4°C world leads to large declines in snowpack in the western United States, perhaps in the range of a 40% decrease due to generally less precipitation and shifts from snow to rain.[12] The snowpack in the Sierra Nevada mountains recently hit its lowest point going back at least 500 years.[13] Decreasing snowpack reduces water availability throughout hot, dry summers, resulting in significant seasonal water shortages. One recent study even projects that critical mountain ranges in the western United States may lose their snowpacks for years at a time by mid-century.[14]

Warmer temperatures and less frequent precipitation also mean that even normal snowpacks do not necessarily bring relief from droughts. For example, Colorado's 2021 snowpack was almost normal, but because soils in many western watersheds were unusually dry, most of the water went into the soils and not into streams, rivers, and reservoirs for human uses.[15] Another driver of drought in a warming world is the increase in evapotranspiration caused by higher temperatures as plants need more water and evaporation from rivers and reservoirs increases.[16] These factors point toward a drying and warming future in the southwestern United States, particularly in the Colorado River basin.

B. *Water Law Historically Adapted to Hydrology*

The changes in the West's hydrology are very likely to produce changes in water law, which has historically evolved in response to differing climatic conditions.[17] Early U.S. water law decisions[18] drew heavily on English water law, establishing a system based on riparian water rights. Riparian rights come from ownership of land that abuts a watercourse, and they are generally limited to reasonable use of the water on the riparian land. Riparian rights have many other limits; they do not allow storage or long-distance transportation of water, for example, and they are not absolute, leading to some uncertainty about the quantity and reliability of water. These limitations meant that riparian rights were poorly suited to western hydrologic regimes, where seasonal (and total) water availability patterns

3. Abigail C. Lute et al., *Projected Changes in Snowfall Extremes and Interannual Variability of Snowfall in the Western United States*, 51 Water Res. Rsch. 960, 969-70 (2015).
4. Jaweed Kaleem & Thomas Curwen, *"Unrecognizable." Lake Mead, a Lifeline for Water in Los Angeles and the West, Tips Toward Crisis*, L.A. Times (July 11, 2021, 5:01 AM), https://www.latimes.com/world-nation/story/2021-07-11/lake-mead-hoover-dam-drought-nevada-arizona-california.
5. Hervé Douville et al., *Water Cycle Changes*, *in* Climate Change 2021: The Physical Science Basis. Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change 8-1, 8-96, 8-119 to 8-121 (Valérie Masson-Delmotte et al. eds., Cambridge Univ. Press 2021).
6. Linda O. Mearns et al., *The North American Regional Climate Change Assessment Program: Overview of Phase I Results*, 98 Bull. Am. Meteorological Soc'y 1337, 1358-59 (2012).
7. Bradley Udall & Jonathan Overpeck, *The Twenty-First Century Colorado River Hot Drought and Implications for the Future*, 53 Water Res. Rsch. 2404, 2414-15 (2017).
8. *Id.* at 2404.
9. Water Education Foundation, *Colorado River*, https://www.watereducation.org/aquapedia/colorado-river (last visited Jan. 6, 2022).
10. Kirk Siegler, *Colorado River, Lifeline of the West, Sees Historic Water Shortage Declaration*, NPR (Aug. 22, 2021, 5:13 PM), https://www.npr.org/2021/08/22/1030154245/colorado-river-lifeline-of-the-west-sees-historic-water-shortage-declaration.
11. John Fleck & Brad Udall, *Managing Colorado River Risk*, 372 Science 885, 885 (2021), *available at* https://www.science.org/doi/epdf/10.1126/science.abj5498.
12. David R. Easterling et al., *Precipitation Change in the United States*, *in* Climate Science Special Report: Fourth National Climate Assessment, Volume I 207, 218 (Donald J. Wuebbles et al. eds., U.S. Global Change Research Program 2017), https://science2017.globalchange.gov/downloads/CSSR_Ch7_Precipitation.pdf.
13. Soumaya Belmecheri et al., *Multi-Century Evaluation of Sierra Nevada Snowpack*, 6 Nature Climate Change 2, 2 (2016), *available at* https://www.nature.com/articles/nclimate2809.pdf.
14. Erica R. Siirila-Woodburn et al., *A Low-to-No Snow Future and Its Impacts on Water Resources in the Western United States*, 2 Nature Revs. Earth & Env't 800 (2021), *available at* https://www.nature.com/articles/s43017-021-00219-y.epdf.
15. Miguel Otárola, *Colorado's Snowpack Was Almost Normal This Winter, but It May Not Be Enough Water for the Year*, CPR News (Apr. 2, 2021), https://www.cpr.org/2021/04/02/colorados-snowpack-was-almost-normal-this-winter-but-it-may-not-be-enough-water-for-the-year/.
16. Michael F. Wehner et al., *Droughts, Floods, and Wildfires*, *in* Climate Science Special Report: Fourth National Climate Assessment, Volume I, *supra* note 12, at 231, 232, 236-39, 247, https://science2017.globalchange.gov/downloads/CSSR_Ch8_Drought_Floods_and_Wildfires.pdf.
17. Joseph W. Dellapenna, *United States: The Allocation of Surface Waters*, *in* The Evolution of the Law and Politics of Water 189, 189 (Joseph W. Dellapenna & Joyeeta Gupta eds., Springer 2009).
18. *See, e.g.*, Tyler v. Wilkinson, 24 F. Cas. 472 (C.C.D.R.I. 1827) (No. 14,312).

require storage and transportation of water to maximize the benefits of available water.

California developed a system of appropriative rights based on the use of water, not on land ownership. Appropriative rights allow water storage and transportation, and these advantages led all of the states west of the Mississippi to adopt some version of appropriative rights. Coastal states like California and Washington, and midwestern states like Kansas and Nebraska, tend to blend riparian and appropriative doctrines, while drier western states like Colorado embrace a purer appropriative rights approach that does not recognize riparian rights at all.[19]

Appropriative water rights systems give priority to the first user of the water, an approach often styled "first in time, first in right," so that later users may not get their full allocation of water in dry years. Maintaining appropriative water rights requires constant vigilance; these rights can be lost through disuse or to other users who take the water. Water rights are tied to the land and to its use; transferring the right to someone else or changing the place or use of the water generally requires permission of a state-level water agency.

The appropriative rights and the blended appropriative/riparian rights approaches are both inherently based on historic hydrology and patterns of land use and ownership. This can make them a barrier to climate adaptation. For example, the first-in-time approach gives priority to the earliest water users, regardless of how well-suited these uses are to a changing climate or changing societal needs. Historical aspects of water rights thus sometimes allow lower-value agricultural uses to take priority over domestic and industrial uses. Formally, water use is generally required to be reasonable and beneficial, but as a practical matter, courts and water boards rarely rein in inefficiency.[20] Recent droughts have shown many existing uses of water to be even more anachronistic. Because most water in the West is already appropriated, in a drier, climate-changed future, a reordering of priorities seems necessary.

Consider California's agricultural sector. Though productive and valuable, California agriculture constitutes about 80% of the state's human water use[21] while accounting for less than 3% of the state's gross domestic product (GDP).[22] The ag sector has become significantly more efficient in the past 30 years, using less total water to produce more agricultural value.[23] Nevertheless, in some cases and in some years, California water currently used in agriculture would be more valuable as drinking water or as water to support ecosystems. Growing fewer almonds or making less milk and cheese will likely be necessary in a 4°C world. A successful water rights system should encourage and accommodate these shifts.

Further, use-it-or-lose-it requirements disincentivize water conservation or land use changes that could free up water for other users. Riparian rights give strong rights to riparian landowners, a system that tends to maintain existing land uses and perpetuate distributive justice concerns. Use-based appropriative rights inherently value use over conservation or other "passive" uses, such as fish and wildlife habitat.

Finally, although existing water rights systems have succeeded in spurring economic development, they have done so at great environmental and social cost. The extensive, massive water diversions that have made California the most productive agricultural state in the United States[24] also completely transformed the entire Central Valley and altered the ecology of much of the state, driving many native species to extinction.

C. *Can Water Law Adapt to a Warmer Future?*

How is the western United States to cope with a world that is warmer by as much as 4°C and chronically short of water? We suggest three steps, emphasizing that these represent just a few out of many constructive actions that might be taken to prepare for a much warmer, much drier American West.

New diversions must be evaluated under a conception of reasonableness that includes climate change. Western water law has always embedded notions of reasonableness,[25] and has almost always, at least formally if not in practice, been predicated on some consideration of public interest.[26] These terms have been either ill-defined or defined in a way that gives short shrift to considerations of conservation and passive uses.[27] The phrase "public interest" has been infrequently deployed to protect passive or instream uses, and has in some cases simply been ignored in water permit applications.[28] Notions of reasonableness or beneficial use must[29] take account of future scarcity of water and an increased need for conservation and domestic uses.

Existing reasonableness requirements must be enforced as a limit on current water rights. With climate change already well underway, many existing allocations of water are economically inefficient, with too little regard for nonagricultural uses. Because most water in the West is

19. *See* Coffin v. Left Hand Ditch Co., 6 Colo. 443, 447 (Colo. 1882).
20. Janet C. Neuman, *Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use*, 28 Env't L. 919, 922 (1998).
21. California Department of Water Resources, *Agricultural Water Use Efficiency*, https://water.ca.gov/Programs/Water-Use-And-Efficiency/Agricultural-Water-Use-Efficiency (last visited Jan. 6, 2022).
22. University of Arkansas Division of Agriculture, Economic Impact of Agriculture, *California*, https://economic-impact-of-ag.uada.edu/california (last visited Jan. 6, 2022).
23. Ellen Hanak & Jeffrey Mount, PPIC Water Policy Center, Water Use in California (2019), https://www.ppic.org/wp-content/uploads/jtf-water-use.pdf.
24. U.S. Department of Agriculture Economic Research Service, *Cash Receipts by State*, https://data.ers.usda.gov/reports.aspx?ID=17843#P9c68c7a5c4354e2998c56e99e444d414_5_17iT0R0x5 (last updated Dec. 1, 2021).
25. *See* Cal. Const. art. X, §2.
26. Mark Squillace, *Restoring the Public Interest in Western Water Law*, 2020 Utah L. Rev. 627, 652-54.
27. Joseph L. Sax, *The Constitution, Property Rights, and the Future of Water Law*, 67 U. Colo. L. Rev. 257, 277-79 (1990); *see generally* Janet C. Neuman, *Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use*, 28 Env't L. 919 (1998).
28. Squillace, *supra* note 26, at 659, 661.
29. Brian E. Gray, *Global Climate Change: Water Supply Risks and Water Management Opportunities*, 14 Hastings W.-Nw. J. Env't L. & Pol'y 1453, 1459-61 (2008).

already allocated, current water uses must be reexamined and curtailed if they fail to meet a realistic reasonableness test that accounts for the drier, hotter realities of a climate-changed future.[30]

States must actively secure water rights in preparation for severe and prolonged water shortages in the future. States must create new institutions to collect water rights as an effective stockpile against future scarcity, which may present more serious threats than the loss of crops or livestock. States must migrate some water and water rights into a governance mechanism that operates outside of traditional water law. A state-chartered trust instrument, such as a "resources trust,"[31] might be legislatively charged with gathering up water and water rights in order to act as a water supplier of last resort should the dire need arise. In hedging against severe and prolonged water shortages, such a resources trust might employ a range of legal instruments, such as options, to secure future supply.

II. Designing the 4°C Electricity System to Achieve a 2°C Future

This section was authored by Melissa Powers, Jeffrey Bain Faculty Scholar and Professor of Law, Lewis & Clark Law School.

In August 2021, for the first time ever, the federal government declared a water shortage in the Colorado River basin.[32] While the declaration was not necessarily surprising—the Colorado River has been in an official state of drought for the past two decades,[33] and experts have demonstrated that drought conditions are, in fact, natural for the Colorado River basin[34]—it served as a stark illustration of the "new normal" we have entered due to climate change. Indeed, Lake Mead's water level reached lows not seen since the Hoover Dam was completed in the 1930s, forcing river managers to impose draconian cuts in water use that they acknowledged would do little to remedy the water crisis in the basin.[35]

Such feckless response measures are not new for the Colorado River; conservationists have long advocated for a fundamentally different approach to Colorado River management and use that would no longer subordinate the "mighty" Colorado's ecological values to its other uses.[36] In practice, however, conservation efforts have proceeded slowly and incrementally, while uses of the river's water for drinking and municipal uses, power production, and, especially, irrigated agriculture, have grown exponentially. Perhaps the severity of the drought, the declaration of the shortage, and the growing realization that climate change is indeed upon us will finally lead to a fundamental change in not only Colorado River management, but development in the Southwest. At a minimum, it should at least change legal regimes governing water allocation, which are based on a long-acknowledged legal fiction overstating the Colorado River's flow.[37]

This reckoning regarding water availability should also spur reevaluation of electricity system decarbonization models and the role of hydropower in our future energy system. For the past several years, a number of models have attempted to assess the technical and economic feasibility of rapidly decarbonizing the electricity system. Some models focus on pursuing "least-cost" strategies to reduce GHG emissions[38]; others aim to demonstrate how the United States or areas of the United States could "electrify everything"[39] through 100% renewable energy.[40]

These models affirm that it is technically and economically feasible to decarbonize our energy system. However, most depend on hydropower to at least some extent, and they fail to anticipate deep drops in hydroelectric production caused by climate change. But as climate change both worsens droughts and intensifies precipitation and flooding, these models and their increasingly unrealistic assumptions require reconsideration.

For example, while energy models in California predict an 11% decline in hydropower production by 2050,[41] actual events suggest hydropower production will be much lower—an extended drought in 2015 reduced California's hydropower output by 59% compared to the prior two decades.[42] Models from the Pacific Northwest assume that hydropower output will remain the same in 2050 as it was in 2020,[43] and predict that hydropower will con-

30. *Id.* at 1455-58.
31. Shi-Ling Hsu, *Climate Triage: A Resources Trust to Address Inequality in a Climate-Changed World*, 50 Env't L. 97, 99-100 (2020), *available at* https://myweb.fsu.edu/shsu/publications/50EnvtlL97.pdf.
32. Henry Fountain, *In a First, U.S. Declares Shortage on Colorado River, Forcing Water Cuts*, N.Y. Times (Aug. 27, 2021), https://www.nytimes.com/2021/08/16/climate/colorado-river-water-cuts.html.
33. *Id.*
34. National Research Council, Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability 5 (2007).
35. Fountain, *supra* note 32.
36. *See* Jonathan Waterman, *The American Nile*, Nat'l Geographic, https://www.nationalgeographic.com/americannile/ (last visited Jan. 6, 2022).
37. As Shi-Ling Hsu, Karrigan Börk, and Kevin Lynch argue in another ELC essay focused on 4ºC (see Part I), this new normal will require reconsideration of the laws governing water rights.
38. *See* Amber Mahone et al., Energy and Environmental Economics, Inc., Deep Decarbonization in a High Renewables Future: Updated Results From the California PATHWAYS Model 2 (2018), https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012.pdf.
39. David Roberts, *The Key to Tackling Climate Change: Electrify Everything*, Vox (Oct. 27, 2017), https://www.vox.com/2016/9/19/12938086/electrify-everything.
40. Mark Z. Jacobson et al., *100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for the 50 United States*, 8 Energy & Env't Sci. 2093 (2015).
41. Mahone et al., *supra* note 38, at 25-26. This deep decarbonization model for California estimates an 11% decrease in hydropower output from 2015-2050. The authors of the report recognize that hydroelectric production will likely not decrease linearly and will vary on a seasonal basis, but explain that their decarbonization model cannot incorporate such variability. *Id.* As a result, hydropower is projected to provide about 9% of total energy supply in 2050, down from about 10% in 2015. *Id.* at 38, B-16.
42. Craig D. Zamuda et al., *Energy Supply, Delivery, and Demand*, *in* Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II 174, 182 (D.R. Reidmiller et al. eds., U.S. Global Change Research Program 2018), https://nca2018.globalchange.gov/downloads/NCA4_Ch04_Energy_Full.pdf.
43. *See* Clean Energy Transition Institute, Meeting the Challenge of Our Time: Pathways to a Clean Energy Future for the Pacific Northwest 34 fig.12 (2019).

stitute nearly 40% of the Pacific Northwest's electricity supply in 2050.[44] Yet in 2021, drought maps produced by the National Oceanic and Atmospheric Administration (NOAA) showed that nearly all the hydropower facilities in the western United States were in drought conditions not only in late summer, when water levels are often low, but also in late December, when precipitation would have been expected to replenish reservoirs.[45] Decarbonization models also fail to account for catastrophic hydropower system failures resulting from more intense storms and floods that are causing entire dams to fail.[46]

Whether due to too much or too little water, the nation's hydropower supply is at risk. And these impacts are occurring when average global temperatures have climbed by only (only!) about 1°C.[47] If hydropower is becoming an increasingly unreliable resource today, it's hard to imagine what it will look like at 4°C.

But it's not just hydropower; the energy system as a whole will be at risk as average temperatures rise. According to the Fourth National Climate Assessment released in 2018, already vulnerable aspects of our energy infrastructure will face intense challenges, if not complete destruction, at 4°C.[48] The impacts will go far beyond droughts and floods eliminating hydropower production. In a 4°C future, wildfires caused by electricity transmission lines will burn those lines down in return[49]; power plants that need water for cooling will face forced outages as rivers, lakes, and ocean waters become too warm to prevent the power plants from overheating[50]; severe wind and ice storms will knock over critical infrastructure or make it inoperable[51]; and escalating energy demand during heat waves could trigger blackouts that result in heat-related deaths.[52] While these consequences have already manifested throughout the United States, they are still infrequent enough to generate headlines. They could become commonplace if we allow a 4°C future to become our reality.

Our current approach to energy system planning and modeling could make these catastrophic consequences more likely. The current approach to energy modeling usually aims to pursue the lowest-cost strategies to achieve various rates of decarbonization. Through this modeling, energy planners assume that decarbonization should involve gradual changes to the energy system we have today, namely by replacing existing (and, usually, older) fossil-fueled power plants with renewable facilities and, in some cases, nuclear power. They assume steady-state or gradual changes in the climate as the energy system decarbonizes.

They therefore predict that hydropower will provide a meaningful amount of energy into the future and that other renewable resources will replace fossil resources only. They rarely envision scenarios in which both fossil and hydroelectric facilities are taken offline early. Similarly, most of the models project that the energy transition will require a substantial expansion of the existing transmission system, but they do not model the costs of rebuilding transmission lines that get destroyed by fires or of burying the existing lines to avoid such fires in the first place. Finally, while the models show that deep decarbonization through relatively modest changes is achievable, they fail to address how and whether a decarbonized energy system can be designed to minimize, or at least not exacerbate, harms to humans and the environment that our energy system has caused.

This omission of ecological welfare from energy system decarbonization planning creates the risk that our gradual efforts to mitigate climate change will hasten the demise of species and communities we are ostensibly trying to save from the ravages of climate change. Models that aim to maintain the current hydropower system illustrate this dynamic. Although hydropower can provide abundant amounts of emissions-free electricity (assuming water supplies are sufficient and the reservoirs do not release methane created through anaerobic decomposition of organic matter[53]), dams have exacted an enormous toll on the environment—including on species that are at greatest risk of extinction due to climate change.

The famed Federal Columbia River Power System, which supplies a substantial amount of electricity in the Pacific Northwest (and in California), has so altered stream flows and warmed waters in Idaho, Oregon, and Washington that almost all the species of salmon in the Columbia Basin are listed as endangered or threatened under the Endangered Species Act (ESA).[54] Declining salmon populations are also linked to the imperiled status of Pacific orca whales,[55] which feed on the anadromous

44. *Id.*
45. National Integrated Drought Information System, *U.S. Power Plants in Drought*, https://www.drought.gov/sectors/energy#map (last visited Jan. 6, 2022).
46. Henry Fountain, *"Expect More": Climate Change Raises Risk of Dam Failures*, N.Y. Times (May 21, 2020), https://www.nytimes.com/2020/05/21/climate/dam-failure-michigan-climate-change.html.
47. Rebecca Hersher, *Earth Is Barreling Toward 1.5 Degrees Celsius of Warming, Scientists Warn*, NPR (May 26, 2021), https://www.npr.org/2021/05/26/1000465487/earth-is-barreling-toward-1-5-degrees-celsius-of-warming-scientists-warn.
48. Zamuda et al., *supra* note 42, at 176-95.
49. *Id.* at 183; Associated Press, *PG&E Will Bury 10,000 Miles of Power Lines So They Don't Spark Wildfires*, NPR (July 21, 2021), https://www.npr.org/2021/07/21/1019058925/utility-bury-power-lines-wildfires-california.
50. Zamuda et al., *supra* note 42, at 183; Rebecca Hersher, *Hot Weather Spells Trouble for Nuclear Power Plants in Europe*, NPR (July 27, 2018), https://www.npr.org/2018/07/27/632988813/hot-weather-spells-trouble-for-nuclear-power-plants.
51. Zamuda et al., *supra* note 42, at 179; Douglas MacMillan & Beth Reinhard, *Louisiana Power Outages Renew Questions About Utility Giant's Preparedness for Storms*, Wash. Post (Aug. 31, 2021), https://www.washingtonpost.com/business/2021/08/31/ida-entergy-hurricane-louisiana-power/; Joshua Fechter, *Texas Cities Weren't Ready for a Massive Winter Storm in February. Has That Changed?*, Tex. Trib. (Dec. 6, 2021), https://www.texastribune.org/2021/12/06/texas-cities-winter-storm/.
52. Zamuda et al., *supra* note 42, at 181; Nicholas K. Geranios, *Rolling Blackouts Hit Pacific Northwest as Cities Swelter in Record-Breaking Heat Wave*, L.A. Times (June 29, 2021), https://www.latimes.com/world-nation/story/2021-06-29/rolling-blackouts-us-northwest-heat-wave.
53. Bobby Magill, *Hydropower May Be Huge Source of Methane Emissions*, Climate Cent. (Oct. 29, 2014), https://www.climatecentral.org/news/hydropower-as-major-methane-emitter-18246.
54. 16 U.S.C. §§1531-1544, ELR Stat. ESA §§2-18; *see also* Oregon Department of Fish and Wildlife, *Threatened, Endangered, and Candidate Fish and Wildlife Species*, https://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp (last revised July 2021).
55. Gene Johnson, *Study: Chinook Salmon Are Key to Northwest Orcas All Year*, Or. Pub. Broadcasting (Mar. 4, 2021), https://www.opb.org/ar-

fish. Declining stocks of salmon have also caused profound harm to Native American tribes, who for "time immemorial" have harvested salmon and called the wild Columbia River their home.[56]

None of this information, of course, is new. But the consequences of the dams on the species and people of the Pacific Northwest have been amplified by climate change, and they will only worsen as temperatures continue to rise. However, the models that assume that those dams will remain in place and supply power in a decarbonized energy system rarely discuss these risks. In an effort to show that decarbonization can be facilitated through "least-cost" hydropower systems, they fail to consider all of the other costs of climate change we are aiming to avoid.

Even worse, there is a good chance that the energy models' projections of hydropower output are wrong. The decarbonization studies all acknowledge that future hydropower production is uncertain, and that existing decarbonization models cannot precisely or accurately predict how hydroelectric facilities will function in an increasingly variable climate. Nonetheless, the models assume that existing hydropower facilities will provide necessary power well into the future. But if the models are wrong, then we will seek to decarbonize via "least-cost" strategies, sacrificing endangered species and tribal rights, for no good. So long as the models assume the hydropower system will function more or less as it does now, those sacrifices seem, tragically, inevitable.

But what if modelers were charged instead with modeling a decarbonized energy system for a 4°C world? In that world, large hydropower projects would almost certainly play a much smaller role—if any role at all—since their ability to provide electricity in drought-affected and flood-impacted areas would be highly uncertain. The hydropower capacity in today's decarbonization models would be replaced with other zero-emitting resources in the energy system designed for a 4°C future, and, ideally, the dams would be removed and free-flowing waters would be restored.

Of course, if we wait for 4°C to be locked in, the salmon, the orca, and a host of other species will be gone, and the tribes will suffer even more. So, let's not wait. Instead, let's jettison narrow "least-cost" approaches to energy decarbonization that ignore the massive costs our current energy system already imposes on habitats, species, and humans. While trade offs are inevitable and there are likely no ways to decarbonize that do not exact some toll on humans and the environment, we can at least aim to eliminate the most destructive facilities. Let's start planning for a decarbonized electricity system that can operate in a 4°C world so that species and people have a chance in a 2°C one.

ticle/2021/03/04/study-chinook-salmon-are-key-to-northwest-orcas-all-year/.

56. Columbia River Inter-Tribal Fish Commission, *Tribal Salmon Culture*, https://critfc.org/salmon-culture/tribal-salmon-culture/ (last visited Jan. 6, 2022).

III. Compensation at 4°C

This section was authored by Josh Galperin, Assistant Professor of Law, Elisabeth Haub School of Law at Pace University.

Governments, and therefore taxpayers, could be saddled with enormous costs as global temperatures increase over the coming years. One aspect of these costs is the compensation governments in the United States must pay property owners if governments use eminent domain to acquire private property to modernize infrastructure to accommodate huge shifts in population density. Some obscure aspects of Compensation Clause doctrine might provide a road map for minimizing these costs.

A ProPublica report from 2020 explains that there is an ideal human climate niche—an area with water, temperatures, and other climatic factors that make the area livable and productive.[57] In the United States today, the ideal niche covers most of the eastern seaboard from southern New England to middle Georgia and stretches westward to about the western border of the Dakotas, Nebraska, and Oklahoma.[58] As the world warms, that niche will shift northward. At 4°C warming, places like the Great Lakes region and the central and northern Appalachians will be among the only places left in the United States for significant human populations to persist.[59]

When this shift happens, there will be massive population shifts with people migrating from "sending zones" like the coasts, the Southwest, and Southeast to "receiving zones" like the Great Lakes region.[60] With population increases of possibly 200,000,000 people in the receiving zones,[61] governments will have to play a massive role to avoid chaos, preparing receiving-zone infrastructure to support transportation, housing, water management, and other necessities for dense, growing populations. The problem is that the U.S. Constitution can make this difficult.

The Takings Clause of the Fifth Amendment provides governments "eminent domain" authority to take property from private owners so long as the government puts it to public use.[62] The takings power will be essential as governments acquire property for things like roads, reservoirs, treatment plants, mass transit, schools, police stations, military bases, shelters, cooling stations, and much more. Most of this infrastructure already exists, but dramatically shifting populations will require new concentrations of, and updates to, infrastructure in receiving zones.

57. Al Shaw et al., *New Climate Maps Show a Transformed United States*, ProPublica (Sept. 15, 2020), https://projects.propublica.org/climate-migration/.
58. *Id.*
59. *Id.*
60. Abrahm Lustgarten, *Climate Change Will Force a New American Migration*, ProPublica (Sept. 15, 2020), https://www.propublica.org/article/climate-change-will-force-a-new-american-migration/.
61. U.S. Census Bureau, *U.S. Census Bureau United States Population Growth by Region*, https://www.census.gov/popclock/print.php?component=growth&image=//www.census.gov/popclock/share/images/growth_1561939200.png (last visited Jan. 6, 2022). This estimate includes roughly the populations of the coasts, Southeast, and Southwest.
62. U.S. Const. amend. V.

Fortunately, at least as an initial matter, the Constitution's Takings Clause makes this massive infrastructure program possible because these uses clearly serve a public purpose apparent even to those who refuse to understand climate change.

Of course, the Compensation Clause requires governments to pay for any property they acquire through eminent domain.[63] In that way, it makes sense to think of government takings as a forced sale of property. The government must pay the former owner fair market value for taken property. The U.S. Supreme Court has taken the Compensation Clause further, and said that even if governments do not take ownership of property, they must still pay compensation if a regulation imposes a sufficient burden on the property.[64]

Therefore, whether a government intentionally takes ownership of property or designs regulations to address climate migrations, there will be a cost to this land-acquisition authority. This is particularly true considering that receiving zones will be among the only places where people can survive under a 4°C warming scenario and there will, therefore, be huge demand for property in these areas, pushing up values and the costs of government compensation. How will the government afford to compensate property owners in a 4°C world, where the need for government intervention will be so stark?

There are two ways to approach this question. First, governments can capitalize on mass population shifts to raise money that will pay for compensation. With respect to this fundraising question, traditional strategies like raising tax revenue seem plausible, but the volatility of a 4°C economy might make the tax strategy difficult. Another option is to leverage newly available property in sending zones.[65] If people are fleeing Florida because of flooding, Los Angeles because of drought, and Louisiana because of heat and humidity, governments may be able to obtain property in those areas at very low cost. The ability of a government to add value by taking and then consolidating land in sending zones might make the properties more attractive to speculators who are unwilling to take the risk of parcel-by-parcel acquisition but see value in consolidated tracts.

Second, governments can minimize the costs of compensation while remaining within constitutional bounds. This is a "doctrinal" strategy for reducing the costs of takings in the receiving zones. Courts measure just compensation by the fair market value of a property. Experts estimate what a willing buyer would pay a willing seller, and that is the amount the government pays the former owner. Although the calculation is not always simple, in practice the principle is at least easy to understand.

Things get more complicated when we are dealing with a "partial taking,"[66] which occurs when the government does not acquire an entire property, but only part of it, leaving the owner with a "remainder." For example, to enlarge a road, a government might take 10 feet of property from 25 homeowners, leaving those homeowners with most of their property remaining in their possession. The government, of course, must pay for the slice of the lot it has taken, but factoring in the remainder property can change the calculation.

Suppose a government project, like the road widening, provides a financial benefit to the remainder property. The Supreme Court has written that "just compensation" must be just to both the person from whom the property was taken and to the public.[67] In other words, while the government must pay, it must not overpay. If a government project creates a measurable benefit to remainder property, and the compensation does not account for that benefit, then the landowner may get a windfall from both the direct payment *and* an increase in the remainder property's value. This is unjust for the public, which ultimately pays the compensation through tax dollars.

Over the years, the Court has developed a test for deciding what sort of benefits it will offset from compensation and what sort of benefits will leave the compensation unchanged. Broadly speaking, the Court allows "special benefits" to be subtracted from compensation, but it does not allow subtraction of "general benefits."[68] The way the Court has defined these terms is a jumbled mess, and certain doctrinal tweaks may be necessary to make the most sense of this area of law, particularly in light of the need for government intervention at 4°C.[69] But the important concept is that certain types of government infrastructure and planning projects will generate enough clear and calculable financial benefit to remainder properties that the government will not have to offer any *additional* cash compensation.

This offsetting suggests a possible strategy for compensation at 4°C. When a government acquires property in climate receiving zones in order to make those zones inhabitable for vastly larger populations, the government should consider two things. First, governments should make efforts not to take entire properties. Leaving a remainder property creates a potential for reducing costs by generating benefits to the remainder.

Second, governments should thoughtfully, carefully, and explicitly identify financial benefits to the remainder so that courts can easily understand the way a project provides in-kind compensation that can offset cash payments. There is little question that drinkable water, efficient transporta-

63. *Id.*
64. *E.g.*, Pennsylvania Coal Co. v. Mahon, 260 U.S. 393 (1922).
65. Renee Cho, *How Climate Change Impacts the Economy*, St. Planet (June 20, 2019), https://news.climate.columbia.edu/2019/06/20/climate-change-economy-impacts/.
66. Abraham Bell & Gideon Parchomovsky, *Partial Takings*, 117 Colum. L. Rev. 2043 (2017).
67. Bauman v. Ross, 167 U.S. 548 (1897).
68. Brittany Harrison, *The Compensation Conundrum in Partial Takings Cases and the Consequences of* Borough of Harvey Cedars, 2015 Cardozo L. Rev. De Novo 31 (2015).
69. Joshua Ulan Galperin, *Raisins and Resilience: Elaborating* Horne*'s Compensation Analysis With an Eye to Coastal Climate Change Adaptation*, 35 Stan. Env't L.J. 3 (2016).

tion, public safety services, and reliable electricity provide significant benefits to property owners who rely on them. When properly structured, 4°C infrastructure projects can use these significant benefits to reduce the cost, keeping the United States functioning in the warming world.

IV. Room for Nature

This section was authored by Karrigan Börk, Acting Professor of Law, University of California, Davis School of Law.

Profs. J.B. Ruhl and Robin Kundis Craig paint a vision of a 4°C world marked by "discontinuous and often unpredictable transformation."[70] Nature, from climate to ecosystems to species, is hard to predict in the best of times. It's a wild beast in a 4°C world. This means that we will have to give up our efforts to tightly control nature and instead give her room. Room in a real, physical sense, like space for species to migrate[71] and for seas to rise[72] and for rivers to roam[73]; and room in a metaphorical sense, by not harvesting and managing and controlling and consuming right up to (and even beyond) the edge of destruction.[74]

The only certain thing in this uncertain 4°C future is change: The weather in many locations will be marked by increased variability, higher temperatures, more extreme precipitation events, and changes in total precipitation. Sea levels will rise. Storms will be more intense. In short, climate change will make many of our current climate expectations obsolete. Moreover, a 4°C world does not just present a new set of stable conditions that society can assume will continue into the future; continuing unpredictable shifts in climate are a hallmark of a 4°C world.[75]

This is especially challenging because core aspects of our society, from infrastructure to farming to insurance to conservation, have been designed with the assumption of relatively predictable climate. Infrastructure, for example, is often tailored very narrowly to meet a predicted climate range; flood insurance programs require levee protection designed to withstand a 100-year flood event in most areas. But in a 4°C world, levees will face storms that exceed those design standards much more frequently than once every 100 years.[76]

We've left ourselves a narrow margin of safety in all kinds of systems, from infrastructure to agriculture to environmental protection.[77] This approach leaves little room for error, and the predictable climate that enabled this approach is ending. We're moving into a climate that is predictably unpredictable. Our current world of just-in-time delivery, thin margins, efficiency, precise timing, and long supply chains is not built for the uncertainties of a 4°C future.[78] This problem extends to the ways we currently manage ecosystems, using approaches that leave little room for nature itself.

Prof. Dave Owen describes the prevailing ecosystem management ethos as "allow[ing] resource consumption right up to perceived brinks of illegality and . . . provid[ing] just enough protection to avoid legal violations, but no more."[79] Managing at the brink of illegality is part of a broader problem of trying to manage natural systems within carefully delineated boundaries, under tight control. Of course, we actively manage ecosystems to protect particular species or provide particular ecosystem goods and services. But in many cases, as Professor Owen describes, we try to do so with too little room for error, giving ecosystems only enough to deliver what we seek. Examples include just-in-time delivery of habitat for migrating birds,[80] the deployment of just-in-time water management for fish protection,[81] the provision of just enough protection for species to avoid a jeopardy opinion under the ESA,[82] and limitations on protections for desirable species to small habitat areas on the assumption that managers can unfailingly provide the precise conditions the species require.[83]

The inclination toward these approaches is entirely understandable. They present the irresistible promise of using science, technology, and engineering in real time to meet the needs of nature while putting as few constraints on human activities as possible. Who doesn't want more with less? In so many ways, it fits with our cultural zeitgeist. Even under current conditions, though, this approach often falls apart in the face of uncertainty and the inherent challenges of predicting natural system responses.[84] And when these kinds of efforts fail, they generally place the burden of failure on ecosystems and species; they are not safe-to-fail approaches.

In an uncertain 4°C world, tight management to achieve a narrow range of ecosystem conditions will be both increasingly expensive and increasingly impossible. The nature or character of an ecosystem is determined based on physical characteristics of the ecosystem, like pre-

70. Ruhl & Craig, *supra* note 2, at 217.
71. Alejandro E. Camacho, *Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change*, 27 Yale J. on Reg. 171 (2010).
72. Miyuki Hino et al., *Managed Retreat as a Response to Natural Hazard Risk*, 7 Nature Climate Change 364 (2017).
73. Sigrun Rohde et al., *Room for Rivers: An Integrative Search Strategy for Floodplain Restoration*, 78 Landscape & Urb. Plan. 50 (2006).
74. Johan Rockström et al., *A Safe Operating Space for Humanity*, 461 Nature 472 (2009).
75. *See* Melinda Morgan & Robin Kundis Craig, *The End of Sustainability*, 27 Soc'y & Nat. Res. 777 (2014).
76. *See* Nigel W. Arnell et al., *Global and Regional Impacts of Climate Change at Different Levels of Global Temperature Increase*, 155 Climate Change 377, 384 (2019).
77. *See* Rockström et al., *supra* note 74, at 472-73.
78. Merve Er Kara et al., *Modelling the Impact of Climate Change Risk on Supply Chain Performance*, 59 Int'l J. Prod. Rsch. 7317 (2021).
79. Dave Owens, *Law, Environmental Dynamism, Reliability: The Rise and Fall of CALFED*, 37 Env't L. 1145, 1147 (2008).
80. *See, e.g.*, Jim Robbins, *Paying Farmers to Welcome Birds*, N.Y. Times (Apr. 14, 2014), https://www.nytimes.com/2014/04/15/science/paying-farmers-to-welcome-birds.html.
81. *See, e.g.*, Karrigan Börk et al., *Small Populations in Jeopardy: A Delta Smelt Case Study*, 50 ELR 10714, 10717 (Sept. 2020).
82. *See, e.g.*, J.B. Ruhl, *Section 7(a)(1) of the "New" Endangered Species Act: Rediscovering and Redefining the Untapped Power of Federal Agencies' Duty to Conserve Species*, 25 Env't L. 1107, 1109-10 (1995).
83. *See, e.g.*, Karrigan Börk, *Governing Nature:* Bambi *Law in a WALL-E World*, 62 B.C. L. Rev. 155, 214, 228, 230 (2021).
84. *See* Börk et al., *supra* note 81, at 10722.

cipitation, soil characteristics, and temperatures, and on species availability (what gets introduced to the ecosystem) and the interactions between the species that find their way into the ecosystem. Changing any of those aspects of an ecosystem can produce a cascade of changes throughout the whole of the ecosystem, altering ecosystem aspects such as the abundance and kinds of species present as well as physical conditions in the ecosystem.

Climate change is already producing widespread changes in ecosystem conditions.[85] Predicting *exactly* how a particular ecosystem will react to these changes is very difficult, but scientists can nevertheless predict that change is very likely. For example, based on increasing temperatures alone, more than one in every three local species in the Americas will be different in 90 years.[86] The ecosystems that will develop in a 4°C world are unpredictable, with no analog in today's ecosystems, and tightly managing those ecosystems to provide desired outcomes will be tremendously, well, uncertain.[87]

Instead, managers must approach ecosystem management with humility, not an expectation of understanding and control.[88] What, precisely, does managing with humility mean? I'm excited to flesh that out in future work, but as a baseline, humility counsels leaving time and space for nature.[89] Physical space: Space for new wetlands. Space for rising seas. Space for shifting floodplains. Space for fire. Space for new species. Space and time for natural processes to develop and shift and adapt.[90] And metaphorical space: relaxed expectations about our ability to control nature and predict the outcome of management actions, more conservative estimates of how species will respond to conservation efforts, more leeway in estimating water needs for nature, less belief in the power of science and engineering to replicate natural systems, and more space to fail without irreparable and unacceptable consequences.[91]

In some ways, leaving space for nature fits well with our 4°C infrastructure challenges. "Reconciliation ecology,"[92] defined by its originator Michael L. Rosenzweig as "the science of inventing, establishing and maintaining new habitats to conserve species diversity in places where people live, work and play,"[93] provides ways to integrate human and natural system needs. Thus, to use one example, perhaps "leaving space for wetlands and floodplains" means building seawalls and levees set far enough back from coasts and rivers to provide both improved flood protection and space for nature. Moreover, we must also consider how to integrate the inevitable human migration with healthy ecosystems: as people migrate to more hospitable places, we must leave room for nature in the new developments. And, although perhaps it is more restoration than reconciliation, as we manage our retreat from places made unlivable by climate change, we must not salt the earth, but rather rewild the lands and waters we leave behind.

Some states have begun to embrace this approach in their climate adaptation plans. California, for example, lists "prioritize natural infrastructure solutions" as one of its seven overarching principles for climate change adaptation and highlights the importance of restoration and conservation of natural systems to successful adaptation.[94] This is a good start. But more broadly, we must recognize that tight controls of all kinds will fail in a 4°C future, that the ecosystems of the future will not be the ecosystems of the present, and that nature needs space if it is to continue supporting life in the ways we have come to expect.

V. In a 4°C World, the Inexorable Climate Change-Biodiversity Nexus

This section was authored by David Takacs, Professor of Law, University of California, Hastings Law School. Thanks to Donato Catrina, University of California, Hastings Law School Class of 2023, for excellent research assistance.

A 4°C world will reshape the human and nonhuman landscapes of the planet. That's axiomatic. This reshaping, which we could have avoided, will now unfurl beyond our control: seas will inundate, storms will destroy, droughts will parch. But within our control is how we reshape the landscapes in response as we abandon, tear down, migrate, resettle, rebuild, mitigate, adapt.

The latest Intergovernmental Panel on Climate Change (IPCC) report,[95] other essays in this Article, and Robin Kundis Craig and J.B. Ruhl's prescient, unhappiness-inducing article[96] lay out the consequences of a 4°C rise. The latest report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (the IPCC's more obscure cousin) predicts that more than one million species are imminently threatened with extinc-

85. Brett R. Scheffers et al., *The Broad Footprint of Climate Change From Genes to Biomes to People*, 354 Science 719, 719 (2016).
86. *See* Joshua J. Lawler et al., *Projected Climate-Induced Faunal Change in the Western Hemisphere*, 90 Ecology 588, 591-92 (2009).
87. *See* John W. Williams & Stephen T. Jackson, *Novel Climates, No-Analog Communities, and Ecological Surprises*, 5 Frontiers Ecology & Env't 475, 475 (2007).
88. *See* John Copeland Nagle, *Humility and Environmental Law*, 10 Liberty U. L. Rev. 335, 354-55 (2016).
89. Börk, *supra* note 83, at 229.
90. *See* Nature Conservancy Conservation Gateway, *Conserving Nature's Stage*, https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/climate/stage/Pages/default.aspx (last visited Jan. 6, 2022).
91. *See*, *e.g.*, Paul Stanton Kibel, *Of Hatcheries and Habitat: Old and New Conservation Assumptions in the Pacific Salmon Treaty*, 10 Wash. J. Env't L. & Pol'y 90, 92-93 (2020) (analyzing the faulty assumption that an increase in salmon volumes released from hatcheries will result in higher abundance forecasts).
92. *See Ecologist Urges Sharing Land With Other Species to Foster Biodiversity*, Johns Hopkins (Mar. 22, 2004), https://publichealth.jhu.edu/2004/reconciliation; *see also* Adrian Ayres Fisher, *Ethics and Ecosystem Interactions: Why Reconciliation Ecology Matters*, Resilience (Apr. 28, 2016), https://www.resilience.org/stories/2016-04-28/ethics-and-ecosystem-interactions-why-reconciliation-ecology-matters/.
93. Michael L. Rosenzweig, Win-Win Ecology: How the Earth's Species Can Survive in the Midst of Human Enterprise 7 (2003).
94. California Natural Resources Agency, Safeguarding California Plan: 2018 Update 27 (2018).
95. IPCC, Climate Change 2021: The Physical Science Basis. Working Group I Contribution to the Sixth Assessment Report of the IPCC (Valérie Masson-Delmotte et al. eds., 2021), https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf.
96. Ruhl & Craig, *supra* note 2.

tion.[97] Those in the know increasingly warn that climate change exacerbates already dire human threats to biodiversity, rendering protected biodiversity redoubts no longer habitable but leaving no places to which to migrate.

As we needlessly hurl ourselves into the 4°C future, and as we gobble ever more of earth's resources, climate change and biodiversity portend intertwined, grave threats. Nonetheless, we think of these crises (when we think of them at all) in separate buckets: you over there, think about and tackle GHG buildup and responses; and over here, we'll think about biodiversity loss.

It's time to multitask, to simultaneously envision how conserving biodiversity helps us mitigate and adapt to GHG buildup, and how mitigating and adapting to climate change can and must promote biodiversity. Both because these grave threats are braided and can and should be addressed symbiotically, and for practical reasons—we only have so much time and money to invest to arrest these cataclysms and sustain a livable planet—we should be merging our approaches to climate change mitigation and adaptation, and biodiversity depletion. Think of it as biodiversity "mitadaptation." Biodiversity helps us mitigate GHG buildup; biodiversity helps us adapt to changing ecological regimes; efforts to mitigate GHG accumulation can help or harm biodiversity; and efforts to adapt to climate change can help or harm biodiversity. In a 4°C future, we must pay a lot more attention to the inexorably linked climate-biodiversity mitadaptation nexus.

Jurisdictions' pledges to achieve the Convention on Biological Diversity's ambitious goal of 30% of land protected by 2030[98] could be synergistic if planners thought: How do our plans to reach 30 x 30 produce co-benefits if we think of biodiversity as mitadaptation? How could our nascent plans for nature-based solutions to mitadaptation improve outcomes for biodiversity by specifically incorporating and putting biodiversity's needs at the center? Because many biodiversity mitadaptation decisions are project-based, we need not wait for international or national agreements to think holistically and synergistically. Consider the following serving suggestions.

Rebecca R. Hernandez et al. describe "techno-ecological synergies" when devising solar energy systems.[99] In response to mandates to reduce GHGs, large-scale solar energy developers produce unintended consequences[100] by scarfing down water and destroying biodiversity.[101] By carefully planning where and how to develop solar, and by mitigating the ecological degradation that solar development (currently pegged at nearly one-half the U.S. energy supply by 2050[102]) causes, developers may minimize damage to biodiversity. To account for demand for ecosystem services to support the solar energy development, the community-owned Westmill Solar Park in the United Kingdom[103] managed and achieved some biodiversity benefits (e.g., they planted native grasses and created pollinator habitat) that simultaneously increase transpiration under the panels, thus cooling them and generating energy more efficiently.[104]

Building artificial, biodiversity-enhancing coral reefs may protect low-lying coastal areas from storms and flooding.[105] In cooler climes, the Netherlands has long battled threatening seas, and is now leading the world in learning to live with rising seas by using a "build with nature" philosophy.[106] The "sand motor" off the coast of the Netherlands provides a model of techno-ecological adaptation to climate change that simultaneously explicitly attends to biodiversity. In this pilot project, the Dutch harvested sand offshore (perhaps itself not a sustainable model) to build its buffer island. The goals of the project explicitly include creation of new habitat for flora and fauna, and at its 10-year anniversary, researchers found a rich diversity of shellfish and snails, providing food for shorebirds.[107]

Forests are the savior of GHG reduction goals, with net-zero or carbon-neutral targets depending on "offsetting" the carbon externalities of development; trees are repurposed as carbon sequestration devices. But win-win-win programs under the aegis of REDD+ usually do not pay sufficient or any attention to biodiversity co-benefits.[108] Ninety-two percent of plantation expansion in the tropics between 2000-2012 occurred in biodiversity hot spots,[109] sometimes fueled by carbon offset funds, but seldom with biodiversity/climate change mitadaptation in mind.

97. Media Release, IPBES, Nature's Dangerous Decline "Unprecedented"; Species Extinction Rates "Accelerating," https://ipbes.net/news/Media-Release-Global-Assessment.
98. Convention on Biological Diversity, Zero Draft of the Post-2020 Global Biodiversity Framework, CBD/WG2020/2/3 (Jan. 6, 2020), https://www.cbd.int/doc/c/efb0/1f84/a892b98d2982a829962b6371/wg2020-02-03-en.pdf.
99. Rebecca R. Hernandez et al., *Techno-Ecological Synergies of Solar Energy for Global Sustainability*, 2 Nature Sustainability 560 (2019).
100. David Takacs, *Protecting Your Environment, Exacerbating Injustice: Avoiding "Mandate Havens,"* 24 Duke Env'y L. & Pol'y F. 315 (2014).
101. Katherine Harmon Courage, *Solar Farms Are Often Bad for Biodiversity—But They Don't Have to Be*, Vox (Aug. 18, 2021), https://www.vox.com/2021/8/18/22556193/solar-energy-biodiversity-birds-pollinator-land; Kiera Butler, *Big Solar's Death Panels*, Mother Jones (Mar./Apr. 2011), https://www.motherjones.com/environment/2011/02/solar-panels-desert-tortoise-mojave/.
102. Ivan Penn, *From 4% to 45%: Energy Department Lays Out Ambitious Blueprint for Solar Power*, N.Y. Times (Sept. 8, 2021), https://www.nytimes.com/2021/09/08/business/energy-environment/biden-solar-energy-climate-change.html.
103. Westmill Solar Co-operative Ltd., *Wider Work*, http://westmillsolar.coop/wider-work/ (last visited Jan. 6, 2022).
104. Alona Armstrong et al., *Solar Park Microclimate and Vegetation Management Effects on Grassland Carbon Cycling*, 11 Env't Res. Letters 074106 (2016), *available at* https://iopscience.iop.org/article/10.1088/1748-9326/11/7/074016/pdf.
105. United Nations Climate Technology Centre & Network, *Artificial Reefs*, https://www.ctc-n.org/technologies/artificial-reefs (last visited Jan. 6, 2022).
106. Climate-ADAPT, *Sand Motor—Build With Nature Solution to Improve Coastal Protection Along Delfland Coast (the Netherlands)*, https://climate-adapt.eea.europa.eu/metadata/case-studies/sand-motor-2013-building-with-nature-solution-to-improve-coastal-protection-along-delfland-coast-the-netherlands (last visited Jan. 6, 2022).
107. Netherlands Ministry of Infrastructure and Water Management, The Sand Motor (2021), https://dezandmotor.nl/app/uploads/2021/06/Publiekssamenvatting-Zandmotor_ENG_digi.pdf.
108. David Takacs, *Forest Carbon Projects and International Law: A Deep Equity Analysis*, 22 Geo. Int'l L. Rev. 521 (2010).
109. Matthew Fagan et al., *The Expansion of Tree Plantations Across Tropical Biomes*, Nature Portfolio (June 22, 2021), https://www.researchsquare.com/article/rs-604751/v1.

When foresters restore land degraded by industrial logging or destroyed by fires, they usually emphasize rapidly growing monocultures, and employ biocides to battle "weeds." That is, they prioritize short-term economic rather than ecological value. To quote one article, foresters can't see the forest for the plantations.[110] The U.S. Department of Agriculture (USDA) considers it[111] progressive evolution to plant trees uphill 500 feet from where a species has traditionally grown—a few steps uphill in the right direction, but not one that creatively imagines what a biodiversity-rich forest will comprise in a 4°C world.

In one British Columbia reforesting project, Seed the North[112] is "[f]ighting climate change, one sprout at a time." They harvest seeds from land neighboring disturbed areas, and employ indigenous people (and not just their knowledge) to harvest and cultivate the seeds. They then use drones to drop diverse, biochar-encased seeds of native species over remote areas. They aim to create vast carbon sinks composed of native species that sustain greater biodiversity and are more able to adapt to changing climate conditions.[113]

Biodiversity itself may mitigate GHG accumulation. Oswald J. Schmitz et al. show that animals regulate carbon exchange between the atmosphere and ecosystems in major, not always well-understood ways.[114] Predator/herbivore-prey/carbon relationships are complicated. For example, wolves in boreal ecosystems control moose populations, which, through altered grazing intensity, increases carbon retention in plants; on the other hand, wolves that prey on elk in prairie ecosystems end up releasing more carbon into the atmosphere. Living whales store tons of carbon, and their excrement nourishes carbon-sucking phytoplankton. When whales die and sink to the bottom of the ocean, they take their stored carbon with them.[115] Forest elephants in Central Africa browse smaller trees, alleviating competition and allowing surviving trees to grow larger; researchers estimate that loss of elephants has decreased carbon stocks by 7% in their forest ecosystems.[116]

We have no time not to think about biodiversity as we mitadapt, and no time not to think about mitadaptation when we effect biodiversity conservation. Nature-based solutions are also predicated on the notion that attending to functioning ecological communities makes human communities function better as well. Finally, and perhaps most importantly, it not only makes practical and economic sense to promote biodiversity when implementing climate change mitigation and adaptation goals, and vice versa. If we are to survive this period of rapid ecological transition, we require a cultural paradigm shift[117] where we see ourselves as fundamentally interconnected with the natural world. The mitadaptation examples above sample ways that our actions, policies, and laws could evolve to reflect and reinforce synergistic, holistic, systems-thinking imaginings.

VI. America Erased

This section was authored by Michele Okoh, Senior Lecturing Fellow, Environmental Law and Policy Clinic, Duke Law School.

Drought. Flooding. Extreme heat. Climate change has many tools for destruction, but no matter the disaster, in a 4°C world, parts of the United States will be left uninhabitable.[118] Significant portions of the population will be forced to leave their homes due to climate disasters and will live their lives as internally displaced people.[119] These people will bring with them diverse cultural identities. They will also have left places of significant cultural and historical relevance.[120] The locations may be lost, but the people will endure.

If the United States is to protect culture in the face of climate change, it must shift its focus toward protecting the culture that resides within those people.[121] However, much of the current approach to protecting culture and history is rooted in protecting places. The paragon of this approach is the National Historic Preservation Act. Places deemed worthy of preservation are listed on the National Register of Historic Places, which has historically not been racially and gender inclusive, thereby failing to reflect the United States' diversity.[122] Places that have been recently added to address this lack of diversity are especially vulnerable to climate change.[123]

110. Gianluca Cerullo, *Should Tree Plantations Count Toward Reforestation Goals? It's Complicated*, Mongabay (Sept. 10, 2021), https://news.mongabay.com/2021/09/should-tree-plantations-count-toward-reforestation-goals-its-complicated/.
111. Pacific Southwest Research Station, USDA, Creating More Resilient Forests Through Active Management (2018), https://www.fs.fed.us/psw/topics/tree_mortality/california/documents/EcoManagementReport.pdf.
112. Seed the North, *Approach*, https://seedthenorth.ca/approach/ (last visited Jan. 6, 2022).
113. Amanda Follett Hosgood, *Seed the North: Fighting Climate Change, One Sprout at a Time*, Grist (May 22, 2021), https://grist.org/science/seed-the-north-fighting-climate-change-one-sprout-at-a-time.
114. Oswald J. Schmitz et al., *Animals and the Zoogeochemistry of the Carbon Cycle*, 362 Science eaar3213 (2018), https://www.science.org/doi/10.1126/science.aar3213.
115. Michelle Carrere, *To Fight Climate Change, Save the Whales, Some Scientists Say*, Mongabay (Mar. 1, 2021), https://news.mongabay.com/2021/03/to-fight-climate-change-save-the-whales-some-scientists-say/; Sophie Yeo, *How Whales Help Cool the Earth*, BBC (Jan. 19, 2021), https://www.bbc.com/future/article/20210119-why-saving-whales-can-help-fight-climate-change.
116. Fabio Berzaghi et al., *Carbon Stocks in Central African Forests Enhanced by Elephant Disturbance*, 12 Nature Geoscience 725 (2019), *available at* https://www.nature.com/articles/s41561-019-0395-6.
117. David Takacs, *We Are the River*, 2021 U. Ill. L. Rev. 545 (2021).
118. Ruhl & Craig, *supra* note 2.
119. *See* Internal Displacement Monitoring Centre, Global Report on Internal Displacement (2021), https://www.internal-displacement.org/global-report/grid2021/downloads/IDMC_GRID21_Final_HQ.pdf?v=2.
120. *See* David G. Anderson et al., *Sea-Level Rise and Archaeological Site Destruction: An Example From the Southeastern United States Using DINAA (Digital Index of North American Archaeology)*, 12 PLoS One e0188142 (2017); Abby Neal, *Cultural Heritage Is a Necessary Component of Climate Solutions*, Env't & Energy Study Inst. (Aug. 14, 2020), https://www.eesi.org/articles/view/cultural-heritage-is-a-necessary-component-of-climate-solutions.
121. *See* W. Neil Adger et al., *Cultural Dimensions of Climate Change Impacts and Adaptation*, 3 Nature Climate Change 112 (2013), https://www.nature.com/articles/nclimate1666.
122. Neal, *supra* note 120.
123. *Id.*

Executive Order No. 13146 is an example of historic preservation beyond the National Historic Preservation Act. In the wake of Hurricane Floyd's devastation of Princeville, North Carolina, President William Clinton issued Order No. 13146 to recognize the historical significance of Princeville as the first city founded in the United States by freed slaves and to create the President's Council on the Future of Princeville, North Carolina.[124] However, memory is ephemeral, and until recently, the National Museum of African American History and Culture recognized Eatonville, Florida, as the first town chartered by Black Americans.[125] This error has since been corrected, and Princeville's pride in being the first town chartered by Black Americans endures.[126] Despite this previous inaccuracy, residents of Princeville are aware of their cultural significance and the value their community holds in American history.[127]

Many residents of Princeville were relocated following Hurricane Floyd, but the town was rebuilt.[128] Eventually, Princeville's population returned to its levels prior to Hurricane Floyd.[129] The town of Princeville had the option of a buyout, but ultimately, the town rejected the buyout.[130] Princeville instead opted to rebuild its levees to protect it from the 100-year floodplain.[131]

Unfortunately, the 100-year flood came 83 years early with Hurricane Matthew in 2016.[132] Again, the town was flooded, destroying 450 homes.[133] The population was only 2,200 at the time of Hurricane Matthew.[134] The road to recovery has been long, with many residents not wanting to abandon the historical significance of Princeville.[135] Following Hurricane Matthew, North Carolina provided funding to purchase a total of 141 acres of neighboring land to relocate the most threatened parts of the town.[136] However, in a 4°C world, partial retreat will be insufficient.[137] The places communities value most will be lost.

Princeville is an example of cultural and historical resilience. When their history was forgotten by other Americans, the people of Princeville remembered who they were as a community. The attachment to place will endure, but in the face of destruction, governments can choose to invest not just in protecting places, but also in the people who take pride in that culture and history. However, memory is ephemeral, and geography is a part of community identity.[138] Once communities are dispersed, the United States risks losing that community identity and consequently the history and culture associated with that community.

Place is an important and complex aspect of individual and collective identity, but it is not the only source of identity. Geographic communities are just one type of community, just one classification existing among a multitude of identities.[139] Culture and history can be protected if a cultural/historical perspective is taken toward communities. The geography may be lost, but the community will remain if protected. To protect this culture and history, the United States can choose to take an anticipatory or reactive approach to adaptation. The current approach is largely reactive, but an anticipatory approach is necessary to protect these resources against the advancing threat of climate change.[140]

Documents can be preserved. Oral histories can be recorded. But land, places that are slated to become uninhabitable in a 4°C world, cannot be saved from climate change. What will happen if America chooses to continue emphasizing place in its approach to protecting and preserving history and culture? If people lose both their geographic community and the proximity geography provides to one's social community, what culture and history will be lost? Will America take the anticipatory approach to preserving the culture and history existing within these communities? Or will America simply be *erased*?

VII. The Mutable Boundaries of a Worst-Case Climate World

This section was authored by Cinnamon P. Carlarne, Associate Dean for Faculty and Intellectual Life and Alumni Society Designated Professor of Law, Moritz College of Law, The Ohio State University.

Climate change disrupts the boundaries that demarcate human existence.

Boundaries are an essential tool in contemporary human life. They produce and entrench identity. They ground governance systems. They determine who can come, who must go, and what the terms for living among others will be.

Law codifies and fixes boundaries. It defines political[141] and property[142] boundaries, and even attempts to

124. Exec. Order No. 13146, 65 Fed. Reg. 12318 (Mar. 8, 2000).
125. Cynthia A. Grace-McCaskey et al., *Finding Voices in the Floods of Freedom Hill: Innovating Solutions in Princeville, North Carolina*, 11 J. Env't Stud. & Sci. 341 (2021), *available at* https://link.springer.com/article/10.1007/s13412-021-00701-5.
126. *Id.*
127. *Id.*
128. *Id.*
129. *Id.*
130. *Id.*
131. *Id.*
132. *Id.*
133. Coastal Resilience Center, *Hurricane Matthew Recovery—Princeville*, https://coastalresiliencecenter.unc.edu/crc-projects/hurricane-matthew-recovery/hurricane-matthew-recovery-engagement/hurricane-matthew-recovery-princeville/ (last visited Jan. 6, 2022).
134. *Id.*
135. Grace-McCaskey et al., *supra* note 125.
136. *Id.* at 348.
137. Ruhl & Craig, *supra* note 2.
138. Jianchao Peng et al., *Place Identity: How Far Have We Come in Exploring Its Meanings?*, 11 Frontiers Psych. 294 (2020).
139. Travis B. Paveglio et al., *Re-Conceptualizing Community in Risk Research*, 20 J. Risk Rsch. 931 (2017), *available at* http://dx.doi.org/10.1080/13669877.2015.1121908.
140. Shiv Someshwar, *Adaptation to Climate Change: Moving Beyond "Reactive" Approaches*, World Res. Inst., https://www.wri.org/our-work/project/world-resources-report/adaptation-climate-change-moving-beyond-reactive-approaches (last visited Jan. 6, 2022).
141. *See, e.g.*, Jeffrey Herbst, *The Creation and Maintenance of National Boundaries in Africa*, 43 Int'l Orgs. 673 (1989).
142. *See generally* Keith Hirokawa, *Three Stories About Nature: Property, the Environment, and Ecosystem Services*, 62 Mercer L. Rev. 541 (2011).

delineate the boundaries of ecological systems.[143] These boundaries, too often, are politically and environmentally arbitrary.[144] They divide and reconstruct communities; they fragment ecosystems.

Questions of boundaries consume legal scholars—how they are constructed, how they operate, how they evolve. For environmental lawyers, these conversations frequently advance ecologically oriented thinking[145] and the benefits of recognizing functional, rather than geographical, boundaries of ecological systems and ecosystem services.[146] Increasingly, they also center consideration of planetary boundaries that "define the safe operating space for humanity with respect to the earth system."[147]

In a territorialized world where boundaries are the foundation of the rule of law, and indeed the body politic itself, shifting boundaries are a conundrum. They pose existential challenges to systems of law that thrive on and, too often, assume stability. Stasis is law's comfort zone. Climate change shatters assumptions of stasis. It doesn't just force us to rethink boundaries; it moves the boundaries right under our feet.

In a worst-case climate world,[148] climate change will redraw our maps, rewire our minds, and revolutionize our politics. For the sake of simplicity in this short essay, we can imagine key shifts along the axis of the physical, psychological, and the political.

First, the physical. Climate change is altering our landscapes. Globally, the tropics and the Sahara are expanding.[149] In the United States, flood zones fluctuate, the 100th meridian line shifts east, and plant hardiness zones push farther north.[150] But it's not just climate zones and ecosystem boundaries that are changing. Glacial zone retreat in the Alps blurs the border lines between Italy and Switzerland.[151] Equally, Arctic coastal states scramble to expand their outer continental shelf boundaries as sea ice disappears and new opportunities appear for territorial expansion.

Second, the psychological. As physical boundaries shift, so too does our sense of place, stability, and identity. As our landscapes change, we are forced to rethink who we are, where we belong, and what we are capable of absorbing. The physical health effects of climate change are too many to mention. But the indirect psychological effects of both slow- and sudden-onset disasters—climate anxiety, ecoguilt, and the psychological effects of displacement and diaspora[152]—are likewise daunting. In a worst-case climate world, our sense of self, security, and well-being teeters on a precipice.[153]

Third, the political. Even as landscapes and our sense of place and identity shift, we imagine our political systems largely functioning in standstill mode on a standstill planet. In today's almost, but not yet worst-case climate world, mainstream politicians continue to advance stasis-dependent frameworks—property, gray infrastructure, and resource extraction—and stasis-driven responses to climate change—carbon taxes, cap-and-trade regimes, bridge fuels, and technological fixes. Yet, different visions for the role of law are emerging around the peripheries of mainstream politics. These visions perceive the shifting ground of climate change and seek to harness law as a tool not for sustaining the norm, but instead for engaging (rather than ignoring) inevitable disruption and creating opportunities to reimagine the world unfettered by fixed boundaries.

Moreover, across the domains of the physical, psychological, and political, law frequently employs concepts of boundaries to classify humans—to determine who is worthy of inclusion and who will be excluded. These forms of conceptual boundaries are deeply embedded in our systems of law and tend to reinforce persistent patterns of inequality. Unaddressed conceptual boundaries intensify historical patterns of othering and exclusion along lines of race, gender, religion, sexuality, country of origin, and socioeconomic status. Moreover, conceptual boundaries operate particularly perniciously for those who straddle categories of historical exclusion. Absent efforts to the contrary, unfettered climate change threatens to further deepen the subjugating tendencies of law's conceptual boundaries.

In a worst-case climate world, we will be confronted with levels of destabilization that challenge us to rethink what is possible at every level of governance. In this climate-destabilized world, political boundaries are more mutable and, yet, more important than ever. The role of local governments in responding to adaptation needs, for example, becomes increasingly acute even as it becomes more difficult to constrain climate effects from one territorially bounded unit to another. Equally, the role of national governments in advancing mitigation, adaptation, and loss-and-damage responses becomes ever more urgent even as the futility of acting domestically in the absence

143. *See*, *e.g.*, Geoffrey Garver, *The Rule of Ecological Law: The Legal Complement to Degrowth Economics*, 5 Sustainability 316, 317-18 (2013).
144. *See*, *e.g.*, Anastasia Telesetsky, *Restoration and Large Marine Ecosystems: Strengthening Governance for an Emerging International Regime Based on "Ecoscape" Management*, 35 U. Haw. L. Rev. 735, 762 (2013).
145. *See*, *e.g.*, Bradley C. Karkkainen, *Collaborative Ecosystem Governance: Scale, Complexity, and Dynamism*, 21 Va. Env't L.J. 189, 190 (2002).
146. *See*, *e.g.*, Keith Hirokawa, *More Better Information as 4°C Preparedness: Ecosystem Benefit Flows and Community Engagement*, Env't L. Prof Blog (Oct. 14, 2021), https://lawprofessors.typepad.com/environmental_law/2021/10/more-better-information-as-4c-preparedness-ecosystem-benefit-flows-and-community-engagement.html.
147. *See* Rockström et al., *supra* note 74, at 472.
148. *See* Ruhl & Craig, *supra* note 2.
149. *See* Paul W. Staten et al., *Re-Examining Tropical Expansion*, 8 Nature Climate Change 768 (2018), *available at* https://www.nature.com/articles/s41558-018-0246-2.
150. *See*, *e.g.*, Nicola Jones, *Redrawing the Map: How the World's Climate Zones Are Shifting*, Yale Env't 360 (Oct. 23, 2018), https://e360.yale.edu/features/redrawing-the-map-how-the-worlds-climate-zones-are-shifting.
151. *See*, *e.g.*, Douglas Broom, *Climate Changes Risks Moving This Restaurant From Italy to Switzerland—Without Shifting a Brick*, World Econ. F. (May 20, 2020), https://www.weforum.org/agenda/2020/05/climate-change-restaurant-glacier-italy-switzerland/.
152. *See*, *e.g.*, Paolo Cianconi et al., *The Impact of Climate Change on Mental Health: A Systematic Descriptive Review*, Frontiers Psych. (Mar. 6, 2020), https://www.frontiersin.org/articles/10.3389/fpsyt.2020.00074/full.
153. *See*, *e.g.*, Jessica Owley, *Harnessing Eco-Anxiety and Triaging for the Future*, Env't L. Prof Blog (Oct. 15, 2021), https://lawprofessors.typepad.com/environmental_law/2021/10/harnessing-eco-anxiety-and-triaging-for-the-future.html.

of global cooperation becomes clear. In this worst-case climate world, political, ecological, and planetary boundaries are increasingly tenuous and in tension.

In a stubbornly stasis-oriented world, imagining how a worst-case climate will alter the physical, psychological, and political parameters of our world remains at the periphery of our legal imagination. Shifting boundaries challenge fundamental assumptions about how the rule of law operates at every level. Bringing these shifting boundaries into focus now allows us to envisage the role that law can play in averting crisis and advancing positive change in a worst-case climate world. It also forces us to ask whether law—with its predilection for boundaries and predictability—is the best tool for the task.

VIII. The 4°C City

This section was authored by Sarah Fox, Associate Professor of Law, Northern Illinois University College of Law.

Just as rising global temperatures will accelerate change in ecological systems, a 4°C world will catalyze social changes in the United States. In some parts of the country, these changes will include greater need for rapid emergency responses, heavier reliance on health care systems, and obsolescence and emergence of industries. In other parts, they will include the need to accommodate population influxes and a greater draw on social services. Though it is impossible to generalize regarding what life in 4°C cities will be like, it is clear that such a world will require different local responses, of different magnitudes, than we see currently. Some of the questions that this level of warming will raise are: What must a city give up in a world of 4°C warming? What should it be unwilling to lose? And how might it need to transform?

Many cities will lose both land and people in a 4°C world. Contemplating that first loss, land, is likely to feel sacrilegious to many cities. There are currently few incentives, and many disincentives, for a city to shrink its square footage. Property taxes are generally the primary funding mechanisms available to local governments.[154] That tax base, tied so explicitly to land and what is on it, means that a loss of property equals a loss of revenue. But a 4°C world will render large parts of many cities unlivable and will require dramatic reconfigurations of others. Many cities will experience the loss of land beset by flooding, fire, drought, or other destructive forces. Even if these disasters do not result in the total destruction of the land, they may well alter its usability and the buildings—and taxpayers—upon it.

Those realities mean that many cities will lose some of their property tax base. It also means that cities will be forced to choose what to protect and what to abandon. Historic sites, cultural objects, and landmarks may need to be abandoned in favor of investing resources to protect people who used to live in the city and those who may remain. Because along with the land and property, population loss will be an inevitable part of a 4°C future in some places. There is no amount of adaptation that will be sufficient to keep current population levels in place in many cities, particularly those in coastal areas vulnerable to sea-level rise or those located in the West, where water resources will be increasingly scarce and temperatures increasingly ill-suited for human habitation. Thus, cities will have to contend with the loss of people. Successful out-migration may be a best-case scenario, with loss of life to flooding, heat, and fire a real prospect as well.

Those losses are enormous. They will feel enormous. But to confront them in a clear-eyed way, cities will need to face the question of what they can provide in a 4°C future and what they must retain so they can fulfill their new roles. Cities will still exist, likely in even larger form as climate change is expected to fuel massive urbanization.[155] And the COVID-19 pandemic has illuminated the vital role of cities as places where people gather and seek aid. This has long been the role of cities, and they will continue as important intersections of public and private space. Cities are likely to remain a locus for expression of local opinions, needs, and culture.

Any more generalization than that is difficult, as a 4°C world will impact communities in distinct ways. As the level of government closest to the ground, cities are well-positioned to respond to those shifting and varied needs. In order to do so, however, cities must retain broad local authority. This need was illustrated dramatically by the COVID-19 pandemic.

At different points during the pandemic, local entities such as cities and school districts have attempted to combat local spread by implementing mask mandates and other public health measures. In some cases, state legislatures have reacted by prohibiting local governments from taking such actions. This dynamic strips away an important layer of crisis responsiveness, and makes it very difficult for local entities to respond to the health and safety needs of their citizens[156] and constituents. Similar preemption dynamics could make it difficult for local governments to respond in ways that a 4°C world may require.

There will be times when local authority is exercised in ways that run counter to the best science and policy on climate change. For example, local governments in many states have created barriers to renewable energy facilities being sited within their boundaries.[157] Local governments

154. *See, e.g.*, Jeff Chapman et al., Pew Charitable Trusts, Local Tax Limitations Can Hamper Fiscal Stability of Cities and Counties (2021), https://www.pewtrusts.org/-/media/assets/2021/07/statetaxlimitations_brief.pdf.

155. *See, e.g.*, Abrahm Lustgarten, *The Great Climate Migration*, N.Y. Times (July 23, 2020), https://www.nytimes.com/interactive/2020/07/23/magazine/climate-migration.html.

156. *See, e.g.*, Mark Walsh, *Mask Mandate Lawsuits Reflect Bigger Battle: Do States or Locals Control Schools?*, Educ. Wk. (Aug. 27, 2021), https://www.edweek.org/policy-politics/mask-mandate-lawsuits-reflect-bigger-battle-do-states-or-local-districts-control-schools/2021/08.

157. *See, e.g.*, Sabin Center for Climate Change Law, Columbia Law School, Opposition to Renewable Energy Facilities in the United States (2021), https://climate.law.columbia.edu/sites/default/files/content/RELDI%20report%20updated%209.10.21.pdf.

have economic and political incentives to promote development in coastal areas vulnerable to sea-level rise and flooding.[158] And parochial actions at the local level have long been used to limit available housing stock, as well as to drive gentrification; it would not be surprising to see similar trends in climate destination cities when larger population shifts start occurring.

A call for protecting the capacity for local action in response to climate change does not and cannot guarantee the shape of those actions. But even with some inevitably undesirable local actions, experience has shown that cities are often on the front lines of climate planning and, depending on the politics of the moment, may be the only entity in the federal system willing to take action.[159] Beyond that, they are the entities most likely to know and understand the needs of their citizens in a rapidly changing environment, and they are going to need to respond to large swings in population, public health needs, natural disasters, and more. The federal government and the states must play an outsized role in making the regulatory and structural changes that a 4°C future will require, and can exercise their authority to set regulatory floors for local government climate response.[160] It would be a mistake, however, to fully strip authority from local governments to act.

So, what needs to change to allow 4°C cities to fill the roles required of them? There are of course as many answers as there are local governments. All, however, are likely to center on some version of flexibility. Every city will need a greater ability—and, perhaps, a new willingness—to understand and interpret climate data and to use that data in planning for the future. In doing that planning, both physical and policy agility will be hugely important. Physically, cities must recognize when they are entering infrastructure time horizons that no longer make sense; having the foresight to avoid committing funds and locking in obsolete physical patterns (e.g., water lines in flood-prone areas, new development unsupported by available water resources, massive infrastructure aimed at serving shrinking populations, and others) will be crucial for city survival. Cities must also be willing to reimagine planning documents to account for new physical realities and changing demographics.

On the policy side, cities must be nimble enough to adjust to the needs of their citizens and willing to engage with those needs without being too wedded to the past. Depending on the city, that may mean managing water rationing, adapting the housing supply, making decisions about whether or not to rebuild in areas impacted by natural disaster, providing health and disaster response services, joining forces with other cities for service provision, and on and on. All of that will require the 4°C city to have greater flexibility in financing and in collaborating with other jurisdictions.

As described above, local governments cannot afford to lose this authority over climate responsiveness, and many may in fact need to acquire that authority in the first instance. Broadly speaking, this flexibility and autonomy are something that can only be—and, where it is lacking, should be—conveyed by the state. The prospect of a 4°C future, and the limited capacities of all levels of government, should serve as an impetus for a more expansive idea of local authority. States could ensure local flexibility by, for example, reforming available local revenue sources[161]; allowing for and encouraging regional planning around climate impacts; putting in place forms of home-rule authority that presume local ability to act; and moving away from deregulatory preemption.[162] Cities in a 4°C world will have much to contend with. One thing they should not have to worry about is the authority to act.

The 4°C city is likely to be similar in mission to current cities, but will perhaps have a very different footprint and makeup. Current local government structures, including financing mechanisms, policy incentives, limited authority, and entrenched commitments, make it extremely difficult to accommodate this coming reality. Now is the time for cities, states, and the federal government to ensure that cities that will be impacted by climate change (read: all of them) have the authority and flexibility they need to prepare for a 4°C future.

IX. Climate Change Lessons From a Disney Princess

This section was authored by Karen Bradshaw, Professor of Law and Mary Sigler Fellow, Arizona State University Sandra Day O'Connor College of Law.

It may seem an unlikely connection, but while reading Robin Kundis Craig and J.B. Ruhl's excellent (if depressing!) article *4°C*,[163] I found myself thinking about the Disney movie *Frozen II*.[164] *Frozen II* presents a parable about climate change through the story of a young queen named Elsa leading her country during a period of rapid change in the natural environment. Amidst rapid changes and uncertain circumstances, Elsa's governance approach becomes "do the next right thing."

Like the characters in the film, we find ourselves in a time of deep unknowns, where there are no predictable or "correct" answers. Conditions are changing and evolving more quickly than the U.S. Congress or agencies can regulate. Forecasting is complicated; creating political will is

158. *See*, *e.g.*, Megan Mayhew Bergman, *Florida Is Drowning. Condos Are Still Being Built. Can't Humans See the Writing on the Wall?*, Guardian (Feb. 15, 2019), https://www.theguardian.com/environment/2019/feb/15/florida-climate-change-coastal-real-estate-rising-seas.

159. *See*, *e.g.*, Sarah Fox, *Localizing Environmental Federalism*, 54 U.C. Davis L. Rev. 133, 149-51 (2020).

160. *See*, *e.g.*, S.B. 2408, 102d Gen. Assemb. (Ill. 2021), *available at* https://www.ilga.gov/legislation/102/SB/PDF/10200SB2408lv.pdf.

161. *See* Erin Scharff, *Cities on Their Own: Local Revenue When Federalism Fails*, 48 Fordham Urb. L.J. 919 (2021).

162. *See* National League of Cities, Principles of Home Rule for the 21st Century (2020), https://www.nlc.org/wp-content/uploads/2020/02/Home-Rule-Principles-ReportWEB-2-1.pdf.

163. Ruhl & Craig, *supra* note 2.

164. Frozen II (Disney 2019), https://movies.disney.com/frozen-2.

near-impossible. Yet, the effects of climate change necessitate ex post responses. Responding to droughts, wildfires, hurricanes, and floods inherently relies on small groups of people working together in localized ways. Fortunately, the tool of stakeholder collaborations can fill this void between the lack of agency knowledge and preparation and the urgent local demands of disaster response, providing an important, yet overlooked, piece to effective climate change response.

Stakeholder collaborations are small groups of people working cooperatively in an ongoing way to guide agency land and resource management decisions. In 2017, the Administrative Conference of the United States (ACUS) hired me as an academic consultant to create a longitudinal overview of the use of collaborations by 13 federal land and resource management agencies. The resulting report showed that thousands of stakeholder collaborations exist, a level of governance that merges localized considerations with federal agency action, which is largely unexplored in administrative law scholarship. Subsequent work explored the doctrinal questions[165] surrounding collaboration and ways that collaborations can be used to improve representation in federal agency decisionmaking, highlighting the benefits and downsides of this tool.

Most vitally to considering Craig and Ruhl's thought-provoking article, the ACUS research revealed that much agency action in climate change response and mitigation is happening through federal land and management agencies engaging in collaboration. This is good news. Agencies are experts in using collaborations; courts are good at assessing them. We have a hidden tool in our belt, one developed before it was so crucially needed.

In the future, I plan to write a paper outlining how stakeholder collaborations are vital to the kind of adaptive response for which Craig and Ruhl advocate. For now, I sketch three brief lessons drawn from years of studying stakeholder collaborations.

First, it is time to let go of baselines and instead embrace values of ecological responsibility. In a changing climate, we will expend ever-increasing amounts of resources if we work toward the goal of preserving a rapidly shifting natural world. Our focus should shift from preservation to building and maintaining rich natural environments—albeit with the understanding that they may look different than the environments of the past. It may help to look to traditional ecological knowledge embedded in indigenous conceptions of nature (which are many and varied) to understand the earth as a living thing—forever changing—while also understanding that our obligations to act responsibly toward the natural world are fixed.

Second, the present degree of polarization must end—our survival depends on it. As the parents sitting in the movie theater know, there is little to be gained from fights over who started a conflict or who did what to whom. Instead, maintaining functioning and healthy families requires adopting skills of healthy communication in which all participants can respectfully express their opinions and reach negotiated outcomes. National politics are not so different. Stakeholder collaborations force those with strongly held but conflicting objectives to negotiate,[166] shifting from he-said, she-said to an adult conversation—kind, firm, fair, compassionate, and willing to find a middle ground.

Third, we must be bold and welcoming of new and unconventional ideas, which means pursuing and valuing diverse ideas and perspectives. We need new approaches. I believe that marginalized members of society—those most absent from academic discourse and positions of federal policymaking—hold the insights that are key to our collective survival. For example, the use of traditional ecological knowledge to restore fire[167] to the forested northern California landscape or manage caribou herds in Alaska[168] combines indigenous land management practices with agency action. Stakeholder collaborations are a way to radically democratize environmental decisionmaking and incorporate more diverse perspectives, which are sorely needed.

Frozen II taught millions of American children a lesson, which adults need to learn too. In problems rest opportunities. Climate change is an invitation to redefine and better articulate our values—those toward the environment, one another, and marginalized communities. Values guide actions amidst rapidly changing circumstances and deep uncertainty. Stakeholder collaborations are a forum for doing so while producing desperately needed adaptive governance. They are the way we can continue to—one step ahead of another—do the next right thing.

X. More Better Information as 4°C Preparedness: Ecosystem Benefit Flows and Community Engagement

This section was authored by Keith Hirokawa, Professor of Law, Albany Law School.

From an ecosystem services perspective, access to nature—and the benefits that come from functioning ecosystems—is poorly distributed across class, race, gender, and throughout communities. We might explain the divide by comparing ecosystem services demand between rural and denser population areas, or the manner in which our cities and towns have become socio-ecological traps,[169] where

165. Karen Bradshaw, *Stakeholder Collaboration as an Alternative to Cost-Benefit Analysis*, 2019 BYU L. Rev. 655 (2020), *available at* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3097075.

166. Karen Bradshaw, *Agency Engagement With Stakeholder Collaborations, in Wildfire Policy and Beyond*, 51 Ariz. St. L.J. 437 (2019), *available at* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3433476.

167. Laurence Du Sault, *The Karuk Tribe Fights a Growing Wildfire Threat and a Lack of Funding*, High Country News (Mar. 12, 2019), https://www.hcn.org/issues/51.6/tribal-affairs-in-california-the-karuk-tribe-fights-a-growing-wildfire-threat-and-a-lack-of-funding.

168. Bradshaw, *supra* note 166.

169. Jonathan W. Long & Frank K. Lake, *Escaping Social-Ecological Traps Through Tribal Stewardship on National Forest Lands in the Pacific Northwest, United States of America*, 23 Ecology & Soc'y 10 (2018).

perceived need continues to drive reallocation of water into cities in a way that reflects the disproportionate appropriation of ecosystems by cities.[170] We might also recognize that occupation of upstream areas, particularly rural and suburban areas outside of cities and towns, places an enormous amount of power in the hands of those who manage, but may not directly benefit from, ecosystem service flows.

Given such allocation challenges of ecosystem services, resource decisionmaking is often disconnected from the communities and individuals that would benefit from ecosystem services, and this divide is pervasive at the urban/rural interface. Moreover, the divide will become increasingly acute as climate change continues to drive more intense storms, droughts, wildfires, and disease, as well as rising temperatures and continuation of the human and ecosystem migration.

How do we bridge the gap? One promising avenue involves mapping of ecosystem service benefit flows between and among geographically distinct communities. Ecosystem services—a form of wealth—concern the benefits that humans derive from functioning ecosystems, and include provisioning services (e.g., goods), regulating services (e.g., nutrient regulation), supporting services (e.g., structural and other mechanisms), and cultural services (e.g., spiritual, recreational, and aesthetic). Ecosystem services research illustrates the enormous costs of losing functioning ecosystem services (regulating, supporting, and cultural, but also trade offs and temporal loss of provisioning services, such as forest harvest or conversion at the expense of habitat productivity or flood and erosion control).

Mapping the flows of ecosystem services helps to identify life-supporting benefits (to humans) from functioning ecosystem services and, in some ways more importantly, helps to identify the beneficiaries of those services, a neat trick that will also inform the distribution of ecosystem benefits. Consequently, although the ecosystem services approach may not solve all of our equity problems, the information generated through benefit-flows mapping will facilitate more effective and equitable resource management planning beyond local borders in the following ways.

First, mapping ecosystem benefit flows begins with an inventory of the ecosystem services at hand, their supply and demand. Understanding ecosystem services is a crucial step away from the resourcification of ecosystems,[171] the process of conceptually transforming ecosystems from the processes they engage in to a pile of commodifiable resources for the market. The spatially explicit information generated in benefit-flows mapping "provides baseline data to measure new future gains or losses for policy impact assessment,"[172] engendering more effective planning decisions. Moreover, mapping flows will provide better information for understanding shifting risk factors resulting from ecosystem migration, and for targeting areas where fruitful ecosystem investments could accommodate human migration.

Second, mapping these flows helps to foster understanding of the relationships between different stakeholders and the ecosystem processes that provide benefits: "Understanding of ES [ecosystem services] flows is essential for understanding ES demand as they allow people to actually benefit from a good or service."[173] In many cases, mapping illustrates the ways multifunctional landscapes provide cascading services, suggesting that attention should be given to subunits and specific benefit demands that might be overlooked (and thus ignored) from generalizations about ecosystem-wide services.[174] Benefit-flow mapping also helps to "identify which regions are critical to maintaining the supply and flow of benefits for specific beneficiary groups."[175]

Third, mapping benefit flows will provide a better understanding of the power relationships between ecosystem service beneficiaries, with recognition that "those stakeholders able to manage . . . keystone ecological properties and ecosystem services can affect the well-being of other stakeholder groups by determining the ecosystem's capacity to provide services and/or by controlling them."[176]

Finally, if we want all communities to improve resiliency, engage in adaptive measures, and otherwise be prepared for climate change, we have to think in terms of climate justice. Benefit-flows mapping will provide an accessible depiction of the ways that geographically distinct communities are related and connected. It will assist as stakeholders engage in communicating needs and priorities among ecosystem benefits and empower more specific and effective communication within and among power relationships, ensuring a more equitable allocation of resources to where they are needed.

Mapping benefit flows is an act of community empowerment. The process will activate perspectives on accountability and collaboration in the preparedness process. It provides granular-level information about the different dependencies and power structures among forest, watershed, agricultural, and groundwater-dependent communities. And, in the end, it will give us all something to talk about.

170. *See* Carl Folke et al., *Ecosystem Appropriation by Cities*, 26 Ambio 167, 171 (1997).

171. Timothy Luke, *Eco-Managerialism: Environmental Studies as a Power/Knowledge Formation*, *in* Living With Nature: Environmental Politics as Cultural Discourse (Frank Fisher & Maarten Hajer eds., Oxford Univ. Press 1999), *available at* http://aurora.icaap.org/index.php/aurora/article/view/79/91.

172. Joachim Maes et al., *Mapping Ecosystem Services for Policy Support and Decision Making in the European Union*, 1 Ecosystem Servs. 31, 32 (2012).

173. Sarah Wolff et al., *Mapping Ecosystem Services Demand: A Review of Current Research and Future Perspectives*, 55 Ecological Indicators 159 (2015).

174. Katja Malmborg et al., *Mapping Regional Livelihood Benefits From Local Ecosystem Services Assessments in Rural Sahel*, 13 PLoS ONE e0192019, at 14 (2018).

175. Kenneth J. Bagstad et al., *From Theoretical to Actual Ecosystem Services: Mapping Beneficiaries and Spatial Flows in Ecosystem Service Assessments*, 19 Ecology & Soc'y 64, 73 (2014).

176. María R. Felipe-Lucia et al., *Ecosystem Services Flows: Why Stakeholders' Power Relationships Matter*, 10 PLoS ONE e0132232, at 17 (2015).

XI. Harnessing Eco-Anxiety and Triaging for the Future

This section was authored by Jessica Owley, Professor of Law and Faculty Director for the Environmental Law Program, University of Miami School of Law.

Our children[177] are scared[178] and anxious.[179] Our climate scientists are facing unprecedented levels of stress[180] and depression.[181] The future appears a dark and scary[182] place. Sometimes, it seems like the only sensible engaged response is to pour all energy and attention into climate change mitigation. Climate change impacts are already severe, and there seems no realistic scenario where things aren't worsening.[183] Through the Paris Agreement,[184] the nations of the world agreed to hold global warming to 2°C above pre-industrial levels while (1) acknowledging that the real goal should be 1.5°C[185] and (2) failing to set in motion any measures that would realistically achieve[186] the 2°C goal. It is understandable that many of us are feeling stressed and depressed.

Some activists[187] argue that we should embrace this eco-anxiety and use it to motivate action. If nothing else has spurred us to act, maybe fear will be the final push we need.

The challenge is how to harness our eco-anxiety into a fight for climate mitigation without leaving behind our other environmental or societal aspirations. The time has come for us to make the hard choices for what we want our world to be. Our economies were built on the idea that we can have it all. We throw the word "sustainability" around, suggesting that there is some magic sweet spot we can find where we meet our economic, environmental, and social goals simultaneously. But it hasn't worked. The economic drivers remain dominant while environmental and social goals seem increasingly unattainable. As we look out at the 4°C (and rising) world we have created, it seems time to acknowledge that we just can't have nice things anymore.

Now comes the winter of our hard decisions. What are we willing to sacrifice? Should we fight to protect an endangered desert tortoise[188] if it will hamper our development of renewable energy facilities? Are we willing to rely on nuclear power[189] in exchange for getting rid of our coal-burning power plants? The questions get even trickier when we add climate change adaptation choices. Are we willing to put our parks and special places[190] to more active use as climate migration forces people and facilities to relocate?

Environmentalists are now so worried about climate change that our eco-anxiety is making us willing to compromise and sacrifice our other environmental goals. Yet are these really the places to push for change? We should all make changes in our daily lives. We should drive less and stop eating beef. We should reduce the single-use plastics in our lives and question our consumption habits. But environmentalists being better environmentalists is not moving any needle. Compromising conservation goals to combat climate change might be needed, but only after we have tackled the bigger structural problems in our economy.

International climate law is guided by the principle of common but differentiated responsibilities (CBDR). Could we take that same principle and think about it not across countries, but across interest areas? Why isn't it the big economic players that should change? Environmentalists may find themselves willing to sacrifice protected lands and endangered species, but should they? Doing so is at heart an acknowledgement that we are going to continue propping up industries that mismanage and burn fossil fuels.

What does this lead to? Combining our eco-anxiety with righteous anger. So, we are angry and anxious and the only people who are willing to act aren't the ones we *need* to act.

And now I have written myself into a corner. I have no solution, especially not one that can be expounded on in a short essay. As professors of environmental and climate change law, we all use techniques in the classroom to prevent our students from becoming too depressed. I show how, despite the challenges that remain, our air is cleaner since the passage of the Clean Air Act (CAA).[191] Many of our waterways are in better shape even with the

177. Laura M. Holson, *Climate Change Is Scaring Kids. Here's How to Talk to Them.*, N.Y. Times (June 27, 2019), https://www.nytimes.com/2019/06/27/science/climate-change-children-education.html.
178. Jason Plautz, *The Environmental Burden of Generation Z*, Wash. Post (Feb. 3, 2020), https://www.washingtonpost.com/magazine/2020/02/03/eco-anxiety-is-overwhelming-kids-wheres-line-between-education-alarmism/.
179. Elizabeth Marks et al., Young People's Voices on Climate Anxiety, Government Betrayal, and Moral Injury: A Global Phenomenon (2021), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3918955.
180. Daniel Gilford et al., *The Emotional Toll of Climate Change on Science Professionals*, Eos (Dec. 6, 2019), https://eos.org/features/the-emotional-toll-of-climate-change-on-science-professionals.
181. Marissa Fessenden, *Even Climate Scientists Are Getting Depressed by Our Lack of Progress*, Smithsonian Mag. (Nov. 5, 2014), https://www.smithsonianmag.com/smart-news/even-climate-scientists-are-getting-depressed-our-lack-progress-180953252/.
182. *Id.*
183. *"Climate Commitments Not on Track to Meet Paris Agreement Goals" as NDC Synthesis Report Is Published*, United Nations Climate Change (Feb. 26, 2021), https://unfccc.int/news/climate-commitments-not-on-track-to-meet-paris-agreement-goals-as-ndc-synthesis-report-is-published.
184. United Nations Climate Change, *supra* note 1.
185. IPCC, Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty (Valérie Masson-Delmotte et al. eds., 2018), https://www.ipcc.ch/sr15/.
186. Peiran R. Liu & Adrian E. Raftery, *Country-Based Rate of Emissions Reductions Should Increase by 80% Beyond Nationally Determined Contributions to Meet the 2°C Target,* 2 Comm. Earth & Env't art. 29 (2021), https://www.nature.com/articles/s43247-021-00097-8.
187. Jonathan Davies, *Suffering From Eco-Anxiety? Embrace It! Here Is Why . . .*, Beeco (Jan. 4, 2022), https://www.beeco.green/blog/how-to-embrace-eco-anxiety/.
188. Stephanie Castillo, *Desert Tortoise Deaths Raise Concerns as Solar Farms Solve Energy Need*, Las Vegas Rev.-J. (July 30, 2021), https://www.reviewjournal.com/news/science-and-technology/desert-tortoise-deaths-raise-concerns-as-solar-farms-solve-energy-need-2408456/.
189. Richard Rhodes, *Why Nuclear Power Must Be Part of the Energy Solution*, Yale Env't 360 (July 19, 2018), https://e360.yale.edu/features/why-nuclear-power-must-be-part-of-the-energy-solution-environmentalists-climate.
190. Jessica Owley, *Climate-Induced Human Displacement and Conservation Lands*, 58 Hous. L. Rev. 665 (2021), *available at* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3739577.
191. 42 U.S.C. §§7401-7671q, ELR Stat. CAA §§101-618.

economic and population growth we have experienced. I point to movements in big cities in the United States and Europe to reduce cars and encourage electric vehicles. We have better control of pesticides and disposal of toxics. But frankly, I am at a loss when trying to do a climate change pep talk. Our political and economic leaders continue to deny, ignore, and obfuscate.

Decades of knowledge about the problem has not resulted in significant progress. Furthermore, the COVID pandemic illustrates that we (as a species and definitely we as Americans) are willing to let millions of people die even when science is clear and solutions are not that onerous.[192] Climate change solutions won't be as easy as getting a vaccine or wearing a mask. It won't be simply flying less and carrying around a reusable bag.

The only glimmer of hope in the climate change debate is that the number of people paying attention is growing. The number of people morphing their eco-anxiety into righteous anger is increasing. Next time my students look to me for hope, I will have none to offer. But maybe anger is what they need instead.

XII. Rawls@4°C

This section was authored by J.B. Ruhl, David Daniels Allen Distinguished Chair of Law, Vanderbilt Law School, and James Salzman, Donald Bren Distinguished Professor of Environmental Law with joint appointments at the Bren School and University of California, Los Angeles Law School.

The "veil of ignorance" thought experiment devised by the philosopher John Rawls has long haunted law school seminar rooms and lecture halls. And for good reason. In his ambitious 1971 book, *A Theory of Justice*, Rawls offered a way to determine just principles of law from a purely selfish perspective. What would he have to say to us in the era of climate change?

Imagine, he says, that you are the lawgiver operating today. If acting purely from self-interest, one would expect you to establish laws that favor you and your friends/family/colleagues. No surprise that we see this around us every day. Rawls' thought experiment, though, changes the game. You are still the lawgiver, but you are now operating behind a veil of ignorance. Once you have established the laws and removed the veil, you will then learn whether you are rich or poor, white or Black, young or old, a citizen of France or Bangladesh, and so on.

Rawls argues that, operating in ignorance of your identity, you will choose principles that ensure the fair and equitable allocation of rights, duties, and opportunities among everyone in the society. Since you don't know who you will be, best to provide for every possibility and favor people equally.

Prof. Edith Brown Weiss took Rawls' veil of ignorance one step further, asking what it means for sustainable development.[193] In her version, you not only do not know who you are, you also do not know *when* in the future you will live. It could be in the present, or three or six generations hence. If you were negotiating under this veil of ignorance, what types of rules would you want to impose?

In this framing, our obligations to future generations become immediate. Professor Weiss proposes a principle of "intergenerational equity" that would seek to ensure future people will "inherit the Earth in as good a condition as did their ancestors and with at least comparable access to its resources."[194] Since you don't know who you will be, best to provide for every possibility and favor people equally, now and in the future.

Let's play this mind game a little further. Imagine, if you will, that you are still the ruler operating behind a veil of ignorance—you do not know who you will be or when in the future you will be. But, and here's the twist, you *do* know that the world is unavoidably on a path to 4°C over the next 200 years. You could live anywhere on that path—2°C? 3°C? 4°C?—you don't know. With this knowledge, what laws would you establish today to best ensure a fair and equitable society over the next 200 years of climate change? And how would these be different than Professor Weiss' framing for sustainable development?

The climate change veil of ignorance changes the game in two important respects. First, although scientists can develop rough scenarios of what the world experiences along the climate change path, significant uncertainty remains, especially at local scales. You'll have to design rules for the future now without a firm grasp of what the future looks like for many people. Second, it is more likely than not that climate conditions for many people will deteriorate, making it nearly impossible to set up rules in the present that will ensure future generations inherit an earth in as good a shape as prior generations experienced. You can't stop sea levels or temperatures from rising, so you can't satisfy the goal of the Weiss thought experiment.

These constraints change the kind of thinking that Rawls and Weiss expected of their rulemaker in three ways. First, given the 200 years of vastly changing conditions that lie ahead, the rules you design today must be rapidly adaptable as predicted changes evolve and unforeseen changes arise. If you wind up living in the 3°C world, you likely would not want to be bound by rules that applied in the 1.5°C world. So, you must design an *adaptive governance* regime, not a fixed set of rules with the hope of locking in socially just conditions in the present and going forward.

Second, you'll need to anticipate tipping points and nonlinear change trajectories without knowing when they will be triggered or what the other side looks like. When will massive domestic migration start, and where do the migrants go? What if you are one of those migrants? Your

192. Paul Krugman, *The Quiet Rage of the Responsible*, N.Y. Times (Aug. 19, 2021), https://www.nytimes.com/2021/08/19/opinion/covid-masks-vaccine-mandates.html.

193. Edith Brown Weiss, *In Fairness to Future Generations and Sustainable Development*, 8 Am. U. Int'l L. Rev. 19 (1992).

194. *Id.* at 21.

adaptive governance regime will need to include a substantial planning and monitoring component using updated scenario projections—what social scientists refer to as *anticipatory governance*.

Finally, in addition to the resource consumption trade off dilemmas that sit at the heart of Weiss' exercise, your rules will also require an ongoing process for determining how much to invest at any given time in protective adaptation measures for future generations. What if you live in the future as a resident of a city that did not build adequate flood control infrastructure or heat wave relief opportunities? But how much should a previous generation have invested? You can't possibly make all those decisions in the present—there's too much uncertainty. The adaptive-anticipatory governance regime you design today thus must focus not only on sustainable resource conservation, but also on capacity, ensuring continuous decisionmaking for provision of physical and social adaptation infrastructure.

In summary, the climate change veil of ignorance will demand a much more fluid governance process, one that continually anticipates unforeseeable change, nimbly adapts the rules, and manages over long time frames for adaptation measures that equitably protect future generations. The fairness question will not be how to ensure future generations enjoy the same quality of life, but how to protect those groups (including possibly you) that will be much worse off.

XIII. The Costs of Political Polarization and Gridlock

This section was authored by Shannon Roesler, Professor of Law, University of Iowa College of Law.

Although some Republican officials have signaled a willingness to work on mitigation and adaptation policies, political promises to address climate change still largely come from only one party: the Democrats. In fact, according to the Center for American Progress, 139 members of the 117th Congress reject climate science and the reality of a warming world; all 139 are Republicans.[195] State governors follow a similar pattern, with several Republican governors vowing to fight the Joseph Biden Administration's efforts to lower emissions before specific policy proposals even surface.[196]

Climate change is not the only problem that is complicated by the political polarization that pervades our political and social institutions, but it is likely the problem that will cost future generations the most. The most recent IPCC report is clear: we can avoid the worst-case scenarios for warming only if we act today. As I write this, Democratic members of Congress cannot even reach agreement among themselves about how much to spend on pressing problems including climate change.[197] The political gridlock shows no signs of abating. It is the source of the anger and anxiety that Jessica Owley describes in her essay (see Part XI).

Can we assess the costs of this political failure to address climate change? Newer climate models suggest that costs are high. These models, which are considered in the latest IPCC assessment,[198] use a set of five narratives about the future of global socioeconomic development to forecast different warming scenarios. Created by an international team of experts, these five "shared socioeconomic pathways" (SSPs) offer different visions of the future based on the influence of various socioeconomic factors.[199]

The "regional rivalry" narrative (SSP 3) is the worst-case scenario because it presents the steepest challenges to *both* mitigation and adaptation. This is a world defined by rising nationalism and decreasing global cooperation. It is a 4°C world unable to adapt because democratic institutions fail, and cooperation is impossible. Although this development narrative contemplates rivalry at a global scale, political gridlock and polarization at the domestic level only make the international trends in that direction more likely—especially when these divisions undermine climate policies in wealthy nations like the United States.

In their essay (see Part XII), J.B. Ruhl and Jim Salzman modify the Rawlsian "veil of ignorance" thought experiment to give the lawmaker knowledge that the world will warm to 4°C over the next 200 years. Their essay made me wonder what effect this knowledge would have on our foundational constitutional commitments. Understanding that society will have to adapt to a warming world, we would no doubt want to make possible the kind of anticipatory and adaptive governance that they envision. But could we accomplish this without throwing out much of our constitutional structure?

Would we make different choices? For example, our constitutional structure is designed to make laws difficult to enact and change. Would we design our political institutions differently so that it is easier to change the status quo? Would we give states less control over national elections? Would we preclude political gerrymandering of election districts? And would we be willing to commit ourselves to limitations on speech that current First Amendment doctrine does not? For example, would we permit the regulation of false and misleading speech when it undermines the ability of others to speak? Would we commit ourselves to meaningful regulation of money in politics?

These are big questions that would ignite contentious debates today. I do not mean to suggest answers, but only

195. Ari Drennen & Sally Hardin, *Climate Deniers in the 117th Congress*, Center for Am. Progress (Mar. 30, 2021), https://www.americanprogress.org/article/climate-deniers-117th-congress/.

196. *See* Nichola Groom, *Some Republican States Would Fight Forced Utility Emissions Cuts Under Biden Climate Agenda*, Reuters (Dec. 2, 2020), https://www.reuters.com/article/us-usa-climatechange-republican-states/some-republican-states-would-fight-forced-utility-emissions-cuts-under-biden-climate-agenda-idUSKBN28C1NK.

197. Geof Koss et al., *Democrats Delay Infrastructure Vote as Talks Continue*, E&E News (Oct. 1, 2021), https://www.eenews.net/articles/democrats-delay-infrastructure-vote-as-talks-continue/.

198. IPCC, *supra* note 95.

199. Brian C. O'Neill, *The Roads Ahead: Narratives for Shared Socioeconomic Pathways Describing World Futures in the 21st Century*, 42 Global Env't Change 169 (2017), *available at* https://www.sciencedirect.com/science/article/abs/pii/S0959378015000060.

to highlight some of the constitutional commitments that enable or at least aggravate political polarization and ideological division—and to acknowledge that these commitments are deeply entrenched in our constitutional culture. Ideas and norms grounded in the separation of powers, federalism, and free speech are not easily challenged.

So, if we are to break the gridlock on climate change, we will need climate change to break out of its partisan prison. Work in cultural cognition studies shows that people will hold onto beliefs even when credible evidence proves them wrong, when those beliefs are closely tied to their social and cultural identities.[200] If acknowledging the scientific consensus regarding human-caused climate change requires breaking from your group's belief system, then it is less costly to you to continue denying it. We are seeing this dynamic play out with the anti-vaccination movement during the COVID-19 pandemic, as some anti-vaccine groups invent new narratives to justify their continued rejection of vaccine safety and efficacy.[201]

There are signs that the cost-benefit calculus is shifting for some Republicans in Congress who now acknowledge the threat that climate change poses.[202] We need more of these voices to speak now and speak loudly. There was a moment about 30 years ago when climate change had more bipartisan support.[203] It must happen again. Although we may feel today that we have little in common with people on the other side of the political divide, we will share in whatever future we make for ourselves now. The costs of continued gridlock are simply too great to give up on bridging the divide.

XIV. Contemplating Equity From the Deck of the *Titanic*: A Metaphoric Meditation for a 4°C World

This section was authored by Robin Kundis Craig, Robert C. Packard Trustee Chair in Law, University of Southern California Gould School of Law.

Contemplating a world possibly heading toward a state of being 4°C warmer, on global average, than it was before the Industrial Revolution[204] potentially changes how we think about social equity. Of course, climate change has already added at least a couple of new twists to the discussion of social equity, notably asking what is equitable between the global North and the global South (or, developed and developing nations)[205] or between the current and future generations (or, intergenerational equity).[206] A closer parallel to the equity issues that a 4°C world creates, however, is the equity problem that arises with respect to the nations and cultures who are already facing existential threats, such as many native villages in Alaska[207] or Pacific Island nations.[208]

A 4°C warmer world, however, universalizes the existential threat so that it is no longer possible to distinguish communities that might cease to exist from those that face no such risk: we will *all* be at risk of losing our homes, communities, culture, and lives. This essay argues that the distinct possibility that we are heading toward that universalized existential crisis should prompt a conversation about what our current social equity priorities should actually be. Specifically, we should be modeling how efforts to improve social equity now, including in the United States, correlate to increasing universal survival equity later.

However, long experience presenting various stages of the *4°C* article has taught me that fully grasping the ramifications of a 4°C warmer world does not come easily to many people. As a result, I ask readers to indulge in an extended metaphor.

The deck chairs on the *Titanic* are not arranged so that all passengers would have fair access to them. For that matter, *all* of the ship's amenities are inequitably distributed, from food to medical care to cabin space. Many of the passengers enjoying the benefits of first class can afford to be there only because their parents, grandparents, or great-grandparents seized and exploited the wealth and labor of colonized people in the global South, establishing the white privilege from which these passengers have benefitted their entire lives.

In contrast, many of the passengers in steerage (third class) don't really deserve to be there, either, having been trapped by an exploitative capitalistic system of labor in the lower classes.[209] Nevertheless, they still benefit from white privilege, as evidenced by the almost complete lack of nonwhite passengers[210] on this oh-so-prestigious crossing. Even

200. *See*, *e.g.*, Dan M. Kahan, *Ideology, Motivated Reasoning, and Cognitive Reflection: An Experimental Study*, 8 Judgment & Decision Making 407 (2013), *available at* https://ssrn.com/abstract=2182588.

201. *See* Dylan Scott, *Why People Who Don't Trust Vaccines Are Embracing Unproven Drugs*, Vox (Oct. 1, 2021), https://www.vox.com/coronavirus-covid19/22686147/covid-19-vaccine-betadine-hydroxychloroquine-ivermectin-trump-conspiracy.

202. *See* Matthew Daly, *In Break With Trump, House GOP Forms Group on Climate Change*, AP News (June 23, 2021), https://apnews.com/article/donald-trump-business-climate-climate-change-e1f0f572a7b5841bb6141456776bafec.

203. Scott Waldman, *Bush Had a Lasting Impact on Climate and Air Policy*, E&E News (Dec. 3, 2018), *available at* https://www.scientificamerican.com/article/bush-had-a-lasting-impact-on-climate-and-air-policy/.

204. *See generally* Ruhl & Craig, *supra* note 2.

205. These differences in perspective continue to influence, for example, negotiations at Conferences of the Parties (COPs) for the United Nations Framework Convention on Climate Change. *E.g.*, Sinan Ülgen, *How Deep Is the North-South Divide on Climate Negotiations?*, Carnegie Eur. (Oct. 6, 2021), https://carnegieeurope.eu/2021/10/06/how-deep-is-north-south-divide-on-climate-negotiations-pub-85493.

206. *E.g.*, Simon Caney, *Climate Change, Intergenerational Equity, and the Social Discount Rate*, *in* The Ethical Underpinnings of Climate Change Economics 41 (Adrian Walsh et al. eds., Routledge 2017).

207. Dalia Faheid, *Indigenous Tribes Facing Displacement in Alaska and Louisiana Say the U.S. Is Ignoring Climate Threats*, Inside Climate News (Sept. 13, 2021), https://insideclimatenews.org/news/13092021/indigenous-tribes-alaska-louisiana/.

208. Saber Salem, *Climate Change and the Sinking Island States in the Pacific*, E-Int'l Rel. (Jan. 9, 2020), https://www.e-ir.info/2020/01/09/climate-change-and-the-sinking-island-states-in-the-pacific/.

209. David White, Titanic*: Passengers Famously Separated by Class*, Soc. Stud. for Kids, https://www.socialstudiesforkids.com/articles/worldhistory/titanic_passengers.htm (last visited Jan. 6, 2022).

210. Devon Link, *Fact Check: Black Woman Didn't Drown When Titanic Sank*, USA Today (Aug. 13, 2020, 2:22 PM), https://www.

so, their safety is far less protected, and if violence breaks out belowdecks, it is questionable whether anyone will do anything about it. The environment that these people must live in[211] is also far less pleasant, although, admittedly, often better than what they were used to at home—close quarters, poor air circulation, shared meals and sanitation facilities, and fellow travelers who are often sick, both from seasickness and shared contagions.

No doubt about it: the *Titanic* needs an equity overhaul. However, those day-to-day inequities among the people on board, or between the people who got to be on the *Titanic* and those who did not, pale in importance in light of one critical fact: the ship is on a collision course with an iceberg, and there aren't enough lifeboats for everyone.

The question of how to fit climate change survival equity into the more general pursuit of social equity is a debate worth having, given the increasing probability that a significantly warmer planet is in all of our futures. In terms of the *Titanic*, should we continue putting energy into rearranging the deck chairs (and other amenities)? Or should we try to get a few more lifeboats built before the ship goes down?

Of course, answering *those* questions would be a whole lot easier if we had the answer to another, critical one: *Does immediately redistributing amenities more equitably help to get more lifeboats built and equitably accessed, or does the redistribution effort result in fewer people surviving overall?*

Contemplating survival equity potentially raises thorny ethical choices, including—although this is by no means yet established—that there might be trade offs between pursuing day-to-day social equity *now* and ensuring the most equitable survival five to 15 decades into the future. Accepting the real possibility of a 4°C increase in global average temperature by the end of this century or very soon thereafter (and maybe earlier) complicates how one thinks about every aspect of human society, and that includes equity.

The first issue is definitional: what do we mean by climate change survival equity? That question raises the most difficult aspect of contemplating equity in connection with a future that is 4°C warmer than the present: people *are* going to die. How to keep that reality from devolving into "them versus us" politics is a serious governance challenge for a 4°C future. On the real *Titanic*, after all, status was a major determinant of whether a person survived: approximately 76% of both the crew and third-class passengers perished, compared to 68% of the total number of people on board, 58% of the second-class passengers, and 39% of the first-class passengers.[212] First-class women and children passengers, in contrast, survived at a rate of about 97%.[213]

Given that the risk of death *for everyone* increases dramatically as global average temperature rises, climate change survival equity in a 4°C warmer world *cannot* be premised on reducing the *absolute risk* of dying for individuals in the world's most vulnerable populations. Instead, the problem is one of bringing the *relative risks* of dying into some sort of global parity. Of course, "global parity" is also problematic, given that climate change affects different parts of the globe differently and that there are inherent biological differences between individuals regarding their vulnerabilities, such as to heat stroke.

Given these complications, perhaps a negative definition is the best place to start the discussion: 4°C climate change survival equity should mean that any individual's chances of surviving and thriving are not statistically correlated with the person's race, ethnicity, class, religion, socially assigned gender-based status, or relationship to colonialism. Instead, the 4°C world will be a lot more equitable if a person's chances of survival are, on the whole, either (1) relatively random from a social policy perspective (e.g., the result of genetics or freak disasters); (2) based on characteristics that we all will share (e.g., vulnerabilities associated with aging or special protections accorded children); or (3) the result of individual choice (e.g., refusing to move out of harm's way when all individuals have the means and opportunity to do so).

The second issue is how to proceed in trying to achieve survival equity. Following the recommendation of *4°C*, we should be thinking about the relationship between day-to-day equity and climate change survival equity in terms of scenarios.[214] Three general categories of scenarios will likely emerge from this exercise.

In the first scenario, as the *Titanic* metaphor suggests, a 4°C warmer world raises the possibility that the actions we *should be* taking now to promote survival equity (e.g., build more lifeboats) are not the same as the actions we *want* to take now to promote day-to-day social equity (e.g., ensure more equitable access to societal amenities and, perhaps, redress past exploitations). In a world of infinite time and resources, of course, the world could pursue both sets of actions and both equitable goals simultaneously.

The real world, however, is unlikely to have either all the time or all the resources it needs to pursue both goals to the extent necessary to actually achieve both forms of social equity. Thus, if this scenario turns out to be generally true, then governments, politicians, and populations face trade offs between the two equity goals and hard choices regarding the resource allocations to each. In the hardest of all scenarios, compromises in resource allocation achieve *neither* goal, meaning that the world must prioritize between achieving day-to-day social equity in the near term and ensuring the highest amount of survival equity in the future.

The second scenario is the one most people will naturally intuit to be the true one—although following that intuition without study is an impulse the world should resist. In this scenario, improving day-to-day equity now also promotes climate change survival equity later.

usatoday.com/story/news/factcheck/2020/08/13/fact-check-black-woman-didnt-drown-when-titanic-sank/3291094001/.

211. BBC, *What Was Life Like on Board Titanic?*, https://www.bbc.co.uk/bitesize/topics/z8mpfg8/articles/zkg9dxs (last visited Jan. 6, 2022).

212. White, *supra* note 209.

213. *Id.*

214. Ruhl & Craig, *supra* note 2, at 269-72.

The *Titanic* metaphor elides this scenario because of the immediacy of the oncoming iceberg catastrophe, but this scenario incorporates a logical projection of causation: improved day-to-day equity now will also, over time, dramatically improve the adaptive capacity of marginalized and otherwise vulnerable groups and individuals to survive a 4°C warmer world.

Indeed, this logic helps hone the narrative edge of one of the opening scenes in Kim Stanley Robinson's climate fiction novel *Ministry for the Future:* during a disastrous extreme heat wave in India, a lone American aid worker survives being parboiled in the lake that everyone has entered in an attempt to keep (relatively) cooler.[215] As the reader learns before this gruesome scene, the American has been keeping the limited supply of cold, clean, freshwater available at his office to himself, the last of which he takes with him to the lake. As another character suggests later, this relatively small advantage in hydration, coupled with a lifetime of being well-fed and medically cared for in the United States, might be the only explanation of why he survived and the local Indians did not.

The third scenario is one that J.B. Ruhl and I raise in *4°C*,[216] which posits that a radically warmer world somewhat ironically creates exactly the disruptive opportunity needed to both radicalize the pursuit of social equity and make it possible for the world to shed the social and economic institutions and structures, such as institutionalized racism, that currently thwart attempts to increase social equity. In this scenario, the very dislocations and rearrangements that a 4°C warmer world demands in response to its impacts are exactly what will allow the full range of social transformations needed to greatly improve both day-to-day social equity—that is, the equitable distribution of amenities and access to opportunity—and climate change survival equity—that is, roughly equal odds that every individual will survive and thrive in this hot new world.

In other words, there's the distinct possibility that a radical survival-based adaptation modality (what we call redesign adaptation[217]) is what will finally allow for radical progress in day-to-day equity, somewhat analogous to how the social transformations of World War II helped to pave the way to the Civil Rights Movement. Somewhat perversely, in this scenario, social equity would be the silver lining of the 4°C world, with all people simultaneously sharing relatively equal access to amenities and opportunities and relatively equal chances of dying.

Planning for each of these scenarios, as well as research into which is the most likely description of the temporal relationship between day-to-day social equity and climate change survival equity, should begin now. While the Parties attending the 26th Conference of Parties (COP26) in November 2021 committed yet again to keeping global average temperature increase to below 2°C, they also acknowledged that this goal "requires 'rapid, deep, and sustained reductions in global greenhouse gas (GHG) emissions, including reducing global carbon dioxide emissions by 45 per cent by 2030 relative to the 2010 level and to net zero around mid-century, as well as deep reductions in other greenhouse gases.'"[218] In light of past failures to achieve ambitious climate change mitigation goals, the world should also admit the possibility that we are in fact contemplating equity from the deck of the *Titanic*, and that it's time to start figuring out the best way to ensure that more of the world's most vulnerable have access to lifeboats.

XV. Letting Go of 2°C, Letting Go of Race? What Does Climate Justice Mean at 4°C?

This section was authored by Clifford J. Villa, Ronald and Susan Friedman Professor of Law, University of New Mexico School of Law.

While the international scientific community urges the need to contain global warming above pre-industrial levels to 1.5°C ideally, and 2°C at worst,[219] current trajectories suggest we may go well beyond that.[220] Taking a sober assessment of continued global warming, J.B. Ruhl and Robin Kundis Craig, in their provocative article *4°C*,[221] observe an "existential threat to democratic governance" and posit the need for a reframing of established approaches to climate adaptation. Beyond the "Three Rs" of *resist*, *resilience*, and *retreat*, Ruhl and Craig suggest the urgent need for *redesign*,[222] a process of radical transformation that may require "letting go" of closely held beliefs, expectations, and goals.[223]

Facing a future where "human suffering is likely to increase dramatically," the authors urge us to "ask uncomfortable questions," and consider even the most politically unpopular measures in order to preserve democracy through the cascade of change to come.[224] For Ruhl and Craig, necessary measures might include community relocation and "repurposing public lands for new human settlements."[225] Could the same dramatic changes in a 4°C world also require letting go of race and ethnicity as central constructs for pursuing climate justice?

For Ruhl and Craig, equity remains a fundamental principle for the redesign process. They stipulate that any successful redesign must maintain "opportunities and support for individuals and communities that otherwise

215. Kim Stanley Robinson, Ministry for the Future 10-12 (2020).
216. Ruhl & Craig, *supra* note 2, at 267-69.
217. *Id.* at 244-46.
218. Erin Grisby et al., *The Results of COP26*, Nat'l L. Rev. (Nov. 29, 2021), https://www.natlawreview.com/article/results-cop26.
219. IPCC, *supra* note 185, at 4-5.
220. *See*, *e.g.*, *id.* at vi (reservedly acknowledging that "recent trends in emissions and the level of international ambition . . . deviate from a track consistent with limiting warming to well below 2°C").
221. Ruhl & Craig, *supra* note 2, at 195.
222. *Id.* at 200-01.
223. *Id.* at 244.
224. *Id.* at 276.
225. *Id.*

face significant risks of being ignored, overrun, forgotten, left behind, or otherwise further marginalized."[226] In the United States, historically "marginalized" communities are often communities of color, including Black, Brown, indigenous, and Asian-Pacific Islander communities. Recognition of the disproportionate impacts of environmental pollution on communities of color gave rise to a movement for "environmental justice" that took hold more than 30 years ago[227] and remains as strong as ever today.[228]

Unlike the Civil Rights Movement of the 1960s[229] and the environmental movement of the 1970s,[230] the movement for environmental justice has never produced national legislation like the Civil Rights Act of 1964[231] or the Clean Water Act of 1972 (CWA).[232] Consequently, environmental justice has remained a largely grassroots movement, driven by community organizations and increasingly reflected in state legislation.[233] In the absence of national legislation, communities and scholars have long endeavored to define "environmental justice." According to the most common definition, maintained by the U.S. Environmental Protection Agency (EPA) and adopted by many states, "[e]nvironmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."[234]

One key element of this definition, embraced almost universally by state law and policy, is the application to "all people." For the George W. Bush/Dick Cheney-era EPA, "all people" rejected a conception of environmental justice as a program of affirmative action with racial preferences.[235] Perhaps unwittingly, "all people" also opened the door to an inclusive conception of environmental justice as a program intended to protect all people—*all of them*—to include children, the elderly, the homeless, the undocumented, and LGBTQ communities.

In the past two decades, the movement for environmental justice has inspired allied "justice" movements, such as "climate justice,"[236] "food justice,"[237] and "energy justice."[238] As with environmental justice, climate justice has been the subject of numerous efforts to define it. According to one simple definition, "[c]limate justice can be defined generally as addressing the disproportionate burden of climate change impacts on poor and marginalized communities."[239] Other scholars have submitted that "[a]s an extension of environmental justice, climate justice is understood to focus on 'equal rights and opportunities [for] every individual to seek a high quality of life under the impacts of global climate change.'"[240]

This inclusive conception of climate justice as applicable to "every individual" presents particular challenges for the 4°C future. How do we pursue a "high quality of life" and keep "every individual" safe from the impacts of a new climate regime that human civilization has never seen? Climate models abound, but climbing past 2°C and the tipping points of nonlinear change, how will we know what to look for, much less how to mitigate the worst impacts?

While acknowledging the "no-analog future,"[241] we can usefully examine experiences of the past and present to locate specific examples of disproportionate impacts from climate change, identify underlying causes for these impacts, and eliminate or mitigate such disparities in the future. For example:

- In 2005, Hurricane Katrina (and the anemic Federal Emergency Management Agency (FEMA) response) resulted in infamously disproportionate impacts among the Black population of New Orleans. Race discrimination operated systemically to place Black people in harm's way and acted implicitly to frustrate recovery efforts. But in terms of keeping people safe, Black and white, more lives might have been saved immediately by concentrating rescue operations on elderly people,[242] the population most likely to have impaired mobility.

- In 2017, in the wake of Hurricane Maria, studies indicated that two of the strongest indicators for mortality among hurricane victims were diabetes and heart disease.[243] While federal regulations often de-

226. *Id.* at 202.
227. *See* Clifford J. Villa, *Remaking Environmental Justice*, 66 Loy. L. Rev. 469, 481-89 (2020).
228. *See*, *e.g.*, Exec. Order No. 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, §1, 86 Fed. Reg. 7037 (Jan. 20, 2021) (presidential order asserting that "the Federal Government . . . must advance environmental justice").
229. For useful background on the Civil Rights Movement, leading to the Civil Rights Act of 1964, see Gerald N. Rosenberg, *The 1964 Civil Rights Act: The Crucial Role of Social Movements in the Enactment and Implementation of Anti-Discrimination Law*, 49 St. Louis U. L.J. 1147 (2004).
230. For background on the environmental movement leading to passage of the modern Clean Water Act in 1972, see William L. Andreen, *The Evolution of Water Pollution Control in the United States—State, Local, and Federal Efforts, 1789-1972, Part I*, 22 Stan. Env't L. Rev. 145 (2003).
231. 42 U.S.C. §2000a.
232. 33 U.S.C. §§1251-1387, ELR Stat. FWPCA §§101-607.
233. For an excellent summary of recent environmental justice legislation among the states, see Michael B. Gerrard & Edward McTiernan, *Emerging State-Level Environmental Justice Laws*, 265 N.Y. L.J. 91 (2021).
234. *See* U.S. EPA, *Environmental Justice*, https://www.epa.gov/environmentaljustice (last updated Dec. 16, 2021).
235. Villa, *supra* note 227, at 496.
236. *See*, *e.g.*, Clifford J. Villa et al., Environmental Justice: Law, Policy & Regulation ch. 14 (3d ed. 2020).
237. *See*, *e.g.*, *id.* ch. 16.
238. *See*, *e.g.*, Carmen G. Gonzalez et al., Energy Justice: US and International Perspectives (2018).
239. Randall S. Abate et al., *Recent Developments in Climate Justice*, 47 ELR 11005 (Dec. 2017).
240. Uma Outka & Elizabeth Kronk Warner, *Reversing Course on Environmental Justice Under the Trump Administration*, 54 Wake Forest L. Rev. 393, 417 (2019).
241. *See*, *e.g.*, J.B. Ruhl, *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 B.U. L. Rev. 1 (2008); Douglas Fox, *Back to the No-Analog Future?*, 316 Science 823 (2007).
242. *See* Myles Maltz, *Caught in the Eye of the Storm: The Disproportionate Impact of Natural Disasters on the Elderly Population in the United States*, 27 Elder L.J. 157 (2019) (noting that "elderly individuals over the age of sixty represent[ed] 71% of the fatalities in Hurricane Katrina").
243. Raul Cruz-Cano & Erin L. Mead, *Causes of Excess Deaths in Puerto Rico After Hurricane Maria: A Time-Series Estimation*, 109 Am. J. Pub. Health 1050 (2019).

fine Puerto Ricans as "minorities,"[244] a focus on such "minority" status would not allow federal responders to direct resources toward those individuals in Puerto Rico most likely in need of immediate, life-saving care after Hurricane Maria.

- In 2020, the COVID-19 pandemic resulted in particularly devastating impacts on Black, Brown, and indigenous communities. The coronavirus itself did not discriminate by race, but researchers identified important conditions that made some racial and ethnic subpopulations more vulnerable than others. Researchers from the Harvard School of Public Health, for example, found a strong correlation between COVID-19 death rates and air pollution, with poor air quality more likely found in communities of color.[245] Another study by the University of Southern California Department of Preventive Medicine revealed that Latinos in California between the ages of 20 to 54 have died from COVID-19 at a rate more than eight times higher than for non-Hispanic whites of the same age range,[246] due to factors including differential access to health care, mutigenerational households, and greater exposure to the public as "essential workers."[247]

- In late June 2021, the unprecedented heat wave experienced in the Pacific Northwest, with all-time high temperatures in British Columbia, Oregon, and Washington, resulted in strongly disparate impacts upon the elderly. According to one preliminary report, excessive heat—including a temperature of 116° Fahrenheit (F) on June 28—was directly responsible for 54 deaths in the Portland metro area.[248] Of these deaths, 81.5% were people ages 60 or older.[249] According to the report, "[l]ack of air conditioning was a key driver in mortality. Whereas about 80 percent of people in the Portland area have some level of air conditioning in their homes . . . , none of those who died had central air, and only eight people had a portable air conditioning unit in their home."[250]

Significantly, and defying traditional notions about climate justice, the preliminary report found that recorded deaths from the extreme heat in Portland were 92% white as well as 63% male.[251] While these findings surely reflect the particular demographics of Portland, Oregon, they may also remind us that race and ethnicity will not always predict, and help us prevent, all the worst impacts from climate change, particularly in the 4°C future (which in some ways is already here with 116°F in Portland).

A different approach may be grounded in vulnerability theory, pioneered by scholars including Martha Albertson Fineman.[252] Vulnerability theory looks beyond suspect classes, such as race, to understand *why* certain groups or individuals may be more susceptible than others to particular impacts in certain circumstances. Vulnerability theory has only recently received consideration in the context of environmental justice,[253] and it remains ripe for exploration in the context of climate justice. Through vulnerability theory, we may understand why white males experienced greater mortality from the 2021 heat wave in the Pacific Northwest or why Latinos may suffer most with increasing heat year after year in the Southwest.[254] Investigating climate justice through the lens of vulnerability theory leads necessarily to heavily contextual inquiries, eschewing generalizations and replacing suppositions with careful observations, analyses, and recommended actions.

One timely example may be illustrative. In certain regions, families commonly pass down real property from one generation to the next with minimal documentation of title. In the Deep South, "heirs property" often reflects the Jim Crow era, when Black people were excluded from the legal system.[255] Today, this system of property ownership has left many homeowners (including many people of color) more vulnerable to disasters following climate-related events such as hurricanes.[256] After the devastation wrought by Hurricane Ida in August 2021, FEMA finally changed its policy, allowing disaster survivors alternate forms of documentation to establish home ownership.[257] This welcome change in FEMA policy addresses a vulnerability factor grounded in historic race discrimination but persisting in new needs to prove property ownership.

244. *See*, *e.g.*, 24 C.F.R. §81.2 (2021) (defining "Minority" to include "a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race").
245. Xiao Wu et al., *Air Pollution and COVID-19 Mortality in the United States: Strengths and Limitations of an Ecological Regression Analysis*, 6 Sci. Advances 45 (2020).
246. Erika Garcia et al., *COVID-19 Mortality in California Based on Death Certificates: Disproportionate Impacts Across Racial/Ethnic Groups and Nativity*, 58 Annals Epidemiology 69, 71 (2021).
247. *Id.* at 74. *See also* Laura Gómez, *Anti-Latino Racism, the Racial State, and Revising Approaches to "Racial Disparities,"* 28 Pub. Health Mgmt. & Prac. S9, S12 (2022) (observing that "[i]n stark contrast to White deaths, Latino deaths from COVID-19 were among younger people who were unable to work at home because they were essential workers, were unable to self-quarantine at home when they or someone they share a home with was exposed, or unable to alter public transportation habits or afford to use grocery and other product deliver services").
248. Multnomah County, Preliminary Review on Excessive Heat Deaths 7 (2021).
249. *Id.*
250. *Id.* at 9.
251. *Id.* at 7.
252. *See*, *e.g.*, Martha Fineman, *The Vulnerable Subject: Anchoring Equality in the Human Condition*, 20 Yale J.L. & Feminism 1 (2008).
253. *See*, *e.g.*, Villa, *supra* note 227, at 509-16.
254. *See* John Dialesandro et al., *Dimensions of Thermal Inequities: Neighborhood Social Demographics and Urban Heat in the Southwestern U.S.*, 18 Int'l J. Env't Rsch. & Pub. Health 941 (2021).
255. *"The Real Damage": Why FEMA Is Denying Disaster Aid to Black Families That Have Lived for Generations in the Deep South*, Wash. Post (July 11, 2021), https://www.washingtonpost.com/nation/2021/07/11/fema-black-owned-property/.
256. Ivis Garcia, *The Lack of Proof of Ownership in Puerto Rico Is Crippling Repairs in the Aftermath of Hurricane Maria*, A.B.A. Hum. Rts. (May 21, 2021), https://www.americanbar.org/groups/crsj/publications/human_rights_magazine_home/vol--44--no-2--housing/the-lack-of-proof-of-ownership-in-puerto-rico-is-crippling-repai/.
257. Press Release, U.S. Department of Homeland Security, DHS Announces Changes to Individual Assistance Policies to Advance Equity for Disaster Survivors (Sept. 2, 2021), https://www.dhs.gov/news/2021/09/02/dhs-announces-changes-individual-assistance-policies-advance-equity-disaster.

So, will keeping people safe in the 4°C world require letting go of race? Given our history in the United States, including the racist histories we have only begun to acknowledge,[258] the answer must be "no," we cannot let go of race. To survive and thrive in the "no-analog future" will take everything we've got. We will need artists, economists, engineers, lawyers, historians, and health professionals,[259] as well as governance on all levels, the private sector, and community organizations. No one person needs to do it all. But we will still need some people to keep an eye on race to continue remedying mistakes of the past and help us avoid mistakes in our future. As Ruhl and Craig observe in conclusion, "We can do better to prepare the nation for the path to 4°C."[260] Preparing for that future may require letting go of some old notions and modes of inquiry, but may also require holding onto some lessons from the past.

XVI. Catastrophic Inequality in a Climate-Changed Future

This section was authored by Shi-Ling Hsu, D'Alemberte Professor of Law, Florida State University College of Law.

Climate change has consistently proven to be more extreme than climate models have projected.[261] If this trend toward extremely unpleasant surprises holds, more drastic adaptive responses will be required. Climate change poses an existential threat to human societies because it disrupts the supply of natural resources that provide basic life necessities such as water, food, energy, and housing. At least in affluent countries, these necessities are abundant enough to be readily available for a vast majority of their populations.

But in a climate-changed future, with floods, droughts, hurricanes, wildfires, and extreme heat disrupting the supply and production of life necessities, availability could become sporadic and uncertain. Wildfires, drought, and extreme heat could combine to significantly suppress California agricultural production, which accounts for one-seventh (by value) of all American agricultural products.[262] Unfortunately, demand for life necessities is very strong at low quantities—they are *necessities*, after all. Shortages will drive up prices sharply, posing hardships for many and posing severe hardships for poor households. With inequality measured less by wealth and more by probabilities of survival, unrest will follow.

Governments can avert this kind of catastrophic inequality by proactively developing a *capacity* to be a supplier of last resort for basic life necessities. It can do this by creating a trust instrument with the ability to step in to produce or supply basic life necessities should shortages occur. Importantly, such an instrument, which I have dubbed a "resources trust,"[263] should not normally interfere with ongoing market or administrative processes that supply life necessities; only when certain signs of shortage appear should a resources trust spring into action and inject some emergency supply. Also importantly, the amount supplied need not be very large. A resources trust need not make up every shortfall; it need only inject enough supplemental supply to lower the prices of life necessities to nearly normal levels. The demand for life necessities flattens out quickly once basic needs are met.

A resources trust is essentially an emergency standby supply of vital life necessities, an effective reserve for the growing number of emergencies in a climate-changed future. It is a tricky proposition to be *able* to produce, but to minimize interference with existing markets. But it can be accomplished by an astute collection of rights, options, and technologies. For example, a resources trust can assemble a portfolio of water *options*, which can be exercised in shortage situations. Or a resources trust could do what some billionaire investors are already doing: buy land with appurtenant water rights[264] for production or for speculative purposes,[265] so as to be able to maintain some capacity for extracting water or growing food.

Alternatively, a resources trust can also develop and deploy some *backstop technologies*[266] that only become economical at higher prices. Fortunately, that is what a resources trust is supposed to do: spring into action only when shortages have driven up prices, threatening the budgets of many households, but especially poor ones. One backstop technology that could be deployed to address potential water shortages is desalination[267]: while typically more expensive than traditional means of supplying water, in a shortage situation with high prices for water, it can mean the difference between life and death. This is how climate change will be a great *un*-equalizer for even affluent countries.

258. *See*, *e.g.*, Adam Heavin, *Preface*, 56 Tulsa L. Rev. vii (2021) (observing that, after the night of the Tulsa Race Massacre on May 31, 1921, when hundreds of Black Americans were murdered in the community known as "Black Wall Street," the "Massacre was scarcely reported in the news. . . . Even today, it's not uncommon to come across native Tulsans who were unaware of the event until recently, as the Tulsa Race Massacre is rarely discussed in Tulsa classrooms").
259. For an exploration of the roles that health professionals may play in helping to prepare communities for the climate future, see the Building Resilience Against Climate Effects (BRACE) Framework developed by the Centers for Disease Control and Prevention, *available at* https://www.cdc.gov/climateandhealth/BRACE.htm (last reviewed Sept. 9, 2019).
260. Ruhl & Craig, *supra* note 2, at 282.
261. Noah S. Diffenbaugh, *Verification of Extreme Event Attribution: Using Out-of-Sample Observations to Assess Changes in Probabilities of Unprecedented Events*, 6 Sci. Advances (2020), https://www.science.org/doi/10.1126/sciadv.aay2368.
262. USDA Economic Research Service, *Cash Receipts by Commodity, State Ranking*, https://data.ers.usda.gov/reports.aspx?ID=17844 (last updated Dec. 1, 2021).
263. Hsu, *supra* note 31.
264. Russell Gold, *Harvard Quietly Amasses California Vineyards—and the Water Underneath*, Wall St. J. (Dec. 10, 2018), https://www.wsj.com/articles/harvard-quietly-amasses-california-vineyardsand-the-water-underneath-1544456396.
265. Nathaniel Lee, *Here's Why the Ultra-Wealthy Like Bill Gates and Thomas Peterffy Are Investing in U.S. Farmland*, CNBC (Aug. 26, 2021), https://www.cnbc.com/2021/08/20/heres-why-the-ultra-wealthy-like-bill-gates-investing-to-farmland.html.
266. Carolyn Fischer & Stephen W. Salant, Alternative Climate Policies and Intertemporal Emissions Leakage: Quantifying the Green Paradox (Resources for the Future, Discussion Paper No. 12-16, 2012), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2047077.
267. Menachem Elimelech & William A. Phillip, *The Future of Seawater Desalination: Energy, Technology, and the Environment*, 333 Science 712 (2011), *available at* https://www.science.org/doi/abs/10.1126/science.1200488.

A resources trust might also adopt the backstop technology of greenhouse agriculture,[268] a seemingly simple technology, but in a modern society, a source of innovation and productivity gains over conventional technology. Greenhouse agriculture has enabled the tiny country of the Netherlands to be a world food export juggernaut, a fairly close second[269] to the United States.[270] Having a low footprint and low maintenance needs, greenhouse agriculture is capable of operating at low production levels until it is needed to ramp up quickly and produce at high quantities.

Another backstop technology that a resources trust might employ to be a supplemental energy supplier is the wide-scale adoption of energy storage, or batteries. Wind and solar energy are abundantly available, and if excess wind- or solar-generated electricity can be stored, they can provide a crucial reserve for emergencies during climate events such as hurricanes, wildfires, floods, or extreme heat, in which electricity shortages might occur. Fortunately, energy storage technologies are advancing rapidly,[271] so batteries might be situated in enough places to overcome transmission problems. A resources trust could, at reasonable cost, maintain significant reserves of electricity in a multitude of locations for use in times of shortage. Batteries could be installed in certain locations to guard against the common occurrence of electricity blackouts disproportionately affecting vulnerable populations.

Housing presents unique issues for a resources trust, as the history of government-subsidized housing is, on balance, disappointing. However, climate change is a uniquely existential threat, and shelter is such a basic human need that governments cannot shrink from being a provider of last resort. If, as expected, extreme weather, floods, wildfires, and other climate events become more frequent and more severe in the future, they may increase losses of housing by sufficient amounts to necessitate some response from a resources trust. It is worth keeping in mind that disaster responses have always involved the provision of some shelter, whether it be massive cooling stations, temporary shelters, or, more ignominiously, the Louisiana Superdome. Resources-trust provision of housing is just a difference in degree and, hopefully, in quality.

A resources trust appears to be a foreign concept, but it is really only different in degree from other government instruments intended to provide in times of need. The Strategic Petroleum Reserve is one analogous instrument. If it weren't so ironic, the Strategic Petroleum Reserve could be considered an emergency source of energy for times of climate crisis. Sovereign wealth provides another analogy, collecting excise taxes in small amounts and investing them in accordance with a charter setting forth some future, provisional purpose.[272] A resources trust is just an extension of the sovereign wealth concept, albeit one with complications extending beyond financial investments.

However, governments must be able to respond to the existential threats posed by climate change. Climate change threatens to impose vast harms upon everybody, but the most immediate and existential threats are borne by the most vulnerable. If government cannot ensure the availability of basic life necessities to its citizens, rich or poor, it becomes a failed state. Inequality of wealth is one thing; inequality of survival prospects is wholly another. Unrest will follow.

XVII. Precommitment Strategies to Avoid the Justice Worst Case in the Climate Worst Case

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Open-eyed assessment of the potential for and on-the-ground realities of 4°C of warming supports the implementation of extraordinary and immediate mitigation measures, and portends that even with such measures, climate impacts will strain adaptive capacity to the breaking point and beyond, resulting in significant societal dislocation and loss and damage. In both contexts—the implementation of extraordinary mitigation measures and adaptation to high-level warming—urgency and need have the potential to sideline or overwhelm justice.

In the context of extraordinary mitigation, environmental review processes and community engagement—important mechanisms for surfacing and preventing environmental injustice—are already eyed warily as speed bumps to be streamlined, truncated, or waived to avoid impeding the rapid deployment of mitigation infrastructure. In the context of adaptation to high-level warming, societies will transition from a steady state punctuated by the need to manage periodic emergencies to a near-constant state of managing emergency. Responses to the pandemic reveal the ease with which emergency can overwhelm justice. Vaccine nationalism evidences the instinctive national hoarding borne of unfolding emergency; domestically, the pandemic's disproportionate impact on low-income communities and communities of color illustrates emergency's exacerbation of vulnerability.

It is hard to imagine that, faced with successive and deepening domestic climate emergencies (and resulting internal displacement, food insecurity, and political instability), a 4°C United States will have the inclination or resources to send adaptation assistance abroad, regardless of the relatively more severe harms befalling its developing country neighbors and its conceded role in exacerbating

268. Frank Viviano, *This Tiny Country Feeds the World*, Nat'l Geographic (Aug. 31, 2017), https://www.nationalgeographic.com/magazine/article/holland-agriculture-sustainable-farming.

269. *Agricultural Exports Worth Nearly €92 Billion in 2017*, Gov't Neth. (Jan. 19, 2018), https://www.government.nl/latest/news/2018/01/19/agricultural-exports-worth-nearly-%E2%82%AC92-billion-in-2017.

270. USDA Foreign Agricultural Service, *GATS Home*, https://apps.fas.usda.gov/gats/default.aspx (last visited Jan. 6, 2022).

271. Energy Storage Association, *Why Energy Storage*, https://energystorage.org/why-energy-storage/technologies/ (last visited Jan. 6, 2022).

272. Hsu, *supra* note 31.

those harms. And it is easy to imagine how, within the United States, scarcity and struggle could sap the motivation and capacity to attend to justice. The best intentions—for example, to manage internal migration to support successful relocation by low-income communities, avoid climate gentrification, and prevent receiving locations from adopting discriminatory policies, a tricky task in the best of times—may yield to the urgency of other, more pressing adaptation needs.

Can we prevent the urgency of avoiding the climate worst case, and then the exigencies of adapting to it, from eclipsing justice? Incorporating binding precommitments to rough justice, triggered and enforceable through automatic processes and made in the relative cool of now as opposed to the heat of later, into mitigation and adaptation law could help. Key aspects of a precommitment might include that it should be binding (not easily reversed—set out in statute as opposed to regulation, for example), automatic (trigger a clear and measurable outcome or duty that is not dependent on the exercise of discretion), and early (the commitment should be made prior to the circumstance(s) in which it would be implemented). Such precommitment strategies are unlikely to achieve fully just outcomes (and might best be accompanied by other, more typical mechanisms for advancing justice), but they could help to prevent least-just outcomes. (Of note, the phrase "precommitment strategy" is used here in a broad sense and does not refer specifically to restraints on future legislative action, although some advocate for such precommitment approaches to buttress climate mitigation policy[273]; however, the concept is similar.)

New York's Climate Leadership and Community Protection Act provides an example of a precommitment to justice, as well as examples of more typical efforts to advance justice, that might prove less durable in the face of high-level warming. The statute provides that disadvantaged communities "shall receive no less than thirty-five percent of the overall benefits of spending on clean energy and energy efficiency programs," giving statutory force to the recognition that environmental justice includes equitable distribution of benefits.[274] This precommitment is automatic, binding, and early—a clear duty, enshrined in statute, and decided prior to the distribution of funds. The statute contains many other mechanisms for incorporating justice into mitigation and adaptation policy, some of which come close to a precommitment to justice by mandating a relatively clear duty and others that require too much judgment or discretion in their application to be considered automatic.

For example, in developing regulations to implement statewide GHG emission limits, the Department of Environmental Conservation is required to "[e]nsure that activities undertaken to comply with the regulations do not result in a net increase in co-pollutant emissions."[275] The bar on an increase in co-pollutants constitutes a relatively clear statutory command, but the need to evaluate whether and how the Department's regulations prompt an increase in co-pollutants introduces some uncertainty about the automaticity of the command—whether its violation would be clear and the command readily enforceable. The Department is also exhorted to "[p]rioritize measures to maximize net reductions of greenhouse gas emissions and co-pollutants in disadvantaged communities," a charge that is not sufficiently clear to constitute a precommitment.[276] All of these efforts to advance justice through mitigation and adaptation policy are good; the present point is simply that precommitments may prove especially durable and valuable as we face high-level warming.

What might precommitments to justice look like in other contexts? With respect to the knotty problem of balancing fulsome review with speed in siting and deploying mitigation and adaptation infrastructure (knotty in part because there are important justice values served by achieving rapid, effective mitigation and adaptation), a precommitment to justice might take the form of preserving process where it is most likely to serve justice (i.e., by streamlining, truncating, or waiving environmental review processes *except* in environmental justice communities). So, a high-voltage transmission line (or an industrial-scale solar array or wind farm or grid-scale battery storage) would be eligible for streamlined review and process if located to avoid environmental justice communities.

This would create a disincentive to locate undesirable mitigation infrastructure in environmental justice communities, thereby countering the many forces that tend to pull such undesirable land uses to them, like low cost and less-effective community opposition. And it would preserve process for communities most likely to need the protection that process can afford because the interests of their residents are less well-represented in upstream decisionmaking, community members are not positioned to access other levers of power to prevent harms, and they may be more likely to already be suffering from cumulative environmental harms.

Precommitments might also—building on the idea that they should be early in time—take the form of automatic transfers that occur only if/when certain warming thresholds are crossed (contingency). Efforts by low-lying island states to seek compensation for loss and damage have gained little traction on the world stage, despite the strong moral claim that underlies them and the foreseeable perils these nations face. (Although loss and damage is addressed in Article 8 of the Paris Agreement, the decision adopting the Paris Agreement states that "Article 8 of the Agreement does not involve or provide a basis for any liability or compensation."[277])

273. Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 40 ELR 10749 (Aug. 2010).
274. N.Y. Env't Conserv. Law §75-0117 (McKinney 2021).
275. *Id.* §75-0109.
276. *Id.*
277. United Nations Framework Convention on Climate Change, *Report of the Conference of the Parties on Its Twenty-First Session, Held in Paris From 30 November to 11 December 2015*, 51 U.N. Doc. FCCC/CP/2015/L.9/Rev.1 (Dec. 12, 2015).

But what if low-lying island states proposed that polar assets, increasingly valuable in a warming world and subject to disputed claims of ownership, be understood to constitute a common heritage of mankind except that interests in those polar assets (ownership, shares, a mechanism for profit sharing) are to be automatically transferred to citizens of low-lying island states should certain warming thresholds be crossed and/or climate impacts realized? An early, contingent precommitment may reduce opposition (states aren't being asked to transfer wealth now or perhaps ever) and create a global incentive to mitigate to avoid crossing those thresholds.

Or imagine adopting, as an adaptation policy now, a contingent precommitment to grant title in public land in climate-safe(r) locations upon the crossing of identified climate thresholds to tribes whose sovereign lands become uninhabitable as a result of climate change. This could be done without requiring tribes to cede ownership of or formally abandon land to which they are deeply connected—even uninhabitable areas might retain significant value for visitation to maintain a connection to place—and thereby perhaps encourage safer, earlier relocation.

As pie-in-the-sky as some of these ideas sound, achieving just outcomes may be more in reach now than it will become in the decades to come—in the heat of the moment, competing against a multitude of pressing climate concerns. Any precommitment strategy would, of course, need to be carefully examined in the context in which it is being deployed. With respect to environmental review for mitigation infrastructure, for example, delaying infrastructure deployment could negatively impact justice by exacerbating climate change and its impacts on the most vulnerable; care would also need to be taken not to drive green investment away from environmental justice communities, resulting in a loss of economic opportunity. And it should be conceded that precommitment strategies can't satisfy all justice values; we should continue to push for more. But perhaps we should also hedge our bets by locking in a modicum of rough justice.