ATTRIBUTION FOR CLIMATE TORTS

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Abstract: This Article argues that advances in climate science overcome key challenges to U.S. climate tort lawsuits by making it possible to attribute specific climate damages to human contributions to greenhouse gases. In the absence of comprehensive statutory regulation or executive action on greenhouse gas emissions, those seeking to mitigate and compensate the harms of climate change are turning to tort law as a tool of last resort. They are filing common-law negligence and nuisance claims against high-emitting industries like fossil fuel producers, electric utilities, and car manufacturers, for their contributions to the physical and economic impacts of climate change. This Article comprehensively reviews and systematically analyzes the climate science referenced in U.S. climate tort lawsuits and concludes that the state of science in such suits lags available methods. It demonstrates that novel methods of climate attribution can overcome obstacles that have previously frustrated tort lawsuits such as injury in fact, redressability, and causation. Climate attribution methods share important features with epidemiological methods that have been accepted by courts in toxic tort litigation since the 1970s. This Article has implications for climate tort lawsuits currently pending in state courts, and more broadly for efforts to establish causal linkages for climate change.

INTRODUCTION

In July 2018, the State of Rhode Island filed a lawsuit pleading eight causes of action against twenty-one fossil fuel companies, including Chevron, ExxonMobil, BP, Shell, and ConocoPhillips, for their contributions to climate change impacts and harms.[1] The State alleged that the defendant companies actively championed a disinformation campaign about the global impact of fossil fuels, failed to transition to renewable alternatives, and profited hand-

Note: Because not all platforms support tables and graphics, the appendices in this Article are also archived at https://www.bc.edu/content/dam/bc1/schools/law/pdf/law-review-content/BCLR/64-4/Saad%20Web%20Appendices.pdf [https://perma.cc/RRD4-7KZ7].

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[1] Complaint at 115–38, Rhode Island v. Chevron Corp., No. PC-2018-4716 (R.I. Super. Ct. July 2, 2018) [hereinafter Rhode Island Complaint].

somely from their strategy.[2] The complaint asserted that the defendants were collectively responsible for almost fifteen percent of carbon dioxide emitted between 1965 and 2015, through their direct emissions and through the burning of their fossil fuel products.[3]

For the coastal state of Rhode Island, the consequences of climate change are existential—the state is sinking, quite literally. Sea levels on the coastal Northeast are rising almost four times faster than the global average.[4] By 2100, sea level rise due to past and future greenhouse gas emissions from human activities is projected at 12 to 48 inches.[5] This has formidable implications for infrastructure, wildlife, livelihood, and for a state budget that must shoulder the costs of adaption and mitigation. In 2020, in *Rhode Island v. Shell Oil Productions Co.*, the U.S. Court of Appeals for the First Circuit observed that the defendants' alleged activities "left the state up the creek without a paddle" as Rhode Island confronted the impacts of climate change.[6] The U.S. District Court for the District of Rhode Island was even more candid in recognizing a pragmatic angle to the State's claims: "[c]limate change is expensive, and the State wants help paying for it."[7]

Rhode Island's case is among nearly two dozen recent lawsuits turning to private law to deal with the impacts of climate change.[8] As the legislative and executive branches have failed to deliver comprehensive climate regulation, cities, states, and municipalities are looking to the courts for redress.[9] Plaintiffs

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[2] *Id.* at 1.

[3] *Id.* at 4.

[4] *See* R.I. SEA GRANT, SEA LEVEL RISE IN RHODE ISLAND: TRENDS AND IMPACTS 2 (2013), http://www.beachsamp.org/wp-content/uploads/2016/09/climate_SLR_factsheet2013.pdf [https://perma.cc/VAV2-TNJF] (noting that this increased rate in the Northeast has led to a 6-inch rise in sea levels between 1970 and 2012); *see also* Christopher G. Piecuch et al., *Origin of Spatial Variation in US East Coast Sea-Level Trends During 1900–2017*, 564 NATURE 400, 400–04 (2018) (explaining the variability in rates of change in sea level along the eastern coast of the United States).

[5] *See* JENNIFER RUNKLE & KENNETH E. KUNKEL, NAT'L OCEANIC & ATMOSPHERIC ADMIN., STATE CLIMATE SUMMARIES: RHODE ISLAND 1 (2022), https://statesummaries.ncics.org/downloads/RhodeIsland-StateClimateSummary2022.pdf [https://perma.cc/69JA-TQ6B].

[6] Rhode Island v. Shell Oil Prods. Co., 979 F.3d 50, 54 (1st Cir. 2020), *judgment vacated*, 141 S. Ct. 2666, *aff'd*, 35 F.4th 44 (1st Cir. 2022).

[7] Rhode Island v. Chevron Corp., 393 F. Supp. 3d 142, 146 (D.R.I. 2019), *aff'd sub nom.* Rhode Island v. Shell Oil Prods. Co., 979 F.3d 50 (1st Cir. 2020), *judgment vacated*, 141 S. Ct. 2666, *aff'd sub nom.* Rhode Island v. Shell Oil Prods. Co., 35 F.4th 44 (1st Cir. 2022).

[8] *See, e.g.*, *id.*; Connecticut v. Exxon Mobil Corp., No. 20-CV-1555, 2021 WL 2389739, at *1 (D. Conn. June 2, 2021); City of Annapolis v. BP P.L.C., No. CV ELH-21-772, 2021 WL 2000469, at *1 (D. Md. May 19, 2021); County of San Mateo v. Chevron Corp., 294 F. Supp. 3d 934, 937 (N.D. Cal. 2018), *aff'd in part, appeal dismissed in part*, 960 F.3d 586 (9th Cir. 2020), *judgment vacated sub nom.* Chevron Corp. v. San Mateo County, 141 S. Ct. 2666 (2021), *aff'd*, 32 F.4th 733 (9th Cir. 2022).

[9] Plaintiffs in these climate lawsuits have been careful to explain to courts that they are not seeking to regulate greenhouse gas (GHG) emissions, consciously avoiding political question objections. Defendants' deceptive activities towards consumers, investors, and the public would remain unlawful even if the legislative and executive branches delivered on climate regulation. I advance here that the current regulatory gap that results in catastrophic climate change forces plaintiffs to resort to claims

have a common objective: "to ensure that the parties who have profited from externalizing the responsibility for [climate change] bear the costs of those impacts."[10]

Just a decade ago, claims against greenhouse gas emitters for the consequences of climate change were received with considerable skepticism. Climate change was deemed an "anti-tort" or "a collective action problem so pervasive and so complicated as to render at once both all of us and none of us responsible."[11] Indeed, climate change complicates core elements of a traditional tort claim, presenting challenges to defining plaintiffs and defendants; to establishing duty, foreseeability, and causation; and to devising remedies and apportioning damages. However, recent innovations in climate attribution, a subfield of climate science, provide tools that address some of these challenges, thereby improving the prospects of success for climate tort claims. Climate attribution methods fill critical gaps in our understanding of the sources and impacts of human-induced climate change and provide a tool to define climate harms and assign responsibility to specific sources.[12]

Climate attribution models can now be used to distinguish human contributions to climate change from "natural disasters" or "acts of God."[13] In recent years, climate scientists have developed methods to discern the impact of human contributions on both the intensity and frequency of extreme weather events like heatwaves, floods, droughts, and hurricanes and on more gradual climate events like glacier retreat and sea level rise. Moreover, recent studies model the contribution of specific emitters, including individual countries and corporations, to a range of climate events and impacts.[14] These methods enable

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grounded in private law to compensate the resulting damages and not that these lawsuits are a regulatory workaround or a substitute to GHG regulation.

[10] *Shell Oil Prods. Co.*, 979 F.3d at 54 (quoting Rhode Island Complaint, *supra* note 1, at 5).

[11] Douglas A. Kysar, *What Climate Change Can Do About Tort Law*, 41 ENV'T L. 1, 4 (2011). *See generally* Maxine Burkett, *Litigating Climate Change Adaptation: Theory, Practice, and Corrective (Climate) Justice*, 42 ENV'T L. REP. 11144 (2012) (summarizing the "skepticism regarding the viability of [climate tort] claims" from legal scholars); Maxine Burkett, *Climate Justice and the Elusive Climate Tort*, 121 YALE L.J. ONLINE 115 (2011), https://www.yalelawjournal.org/pdf/1002_d3vqzbuq.pdf [https://perma.cc/EBA6-4NHH] (noting that courts have endorsed regulation rather than tort litigation as a solution to climate change); Eric A. Posner, *Climate Change and International Human Rights Litigation: A Critical Appraisal*, 155 U. PA. L. REV. 1925 (2007) (critiquing international human rights as a successful avenue for addressing climate change).

[12] *See, e.g.*, B. Ekwurzel et al., *The Rise in Global Atmospheric CO_2, Surface Temperature, and Sea Level from Emissions Traced to Major Carbon Producers*, 144 CLIMATIC CHANGE 579, 581 (2017) (tracing emissions from industrial carbon producers to specific climate impacts).

[13] The first paper to describe methods for doing so was published in early 2003. *See* Myles Allen, *Liability for Climate Change*, 421 NATURE 891, 891 (2003) (discussing how to determine responsibility for the harms caused by anthropogenic climate change).

[14] *See, e.g.*, Richard Heede, *Tracing Anthropogenic Carbon Dioxide and Methane Emissions to Fossil Fuel and Cement Producers, 1854–2010*, 122 CLIMATIC CHANGE 229, 229 (2014) (identifying ninety carbon emitters that account for 63% of global emissions since 1965). This research builds on assessments of corporate and state contributions to global greenhouse gas emissions. *See id.* at 229–

scientists to determine, almost in real time, the extent to which a climate disaster is attributable to human contributions rather than to natural conditions. These findings reframe climate change impacts, like extreme heat, hurricanes, or flooding, from unavoidable natural occurrences to preventable tragedies that cost lives and livelihoods. When the Pacific Northwest experienced a historic heatwave in June 2021, climate scientists concluded that those extreme temperatures would have been "virtually impossible without human-caused climate change."[15] More than six hundred associated deaths have been attributed to human-induced climate change.[16] When Hurricane Harvey devastated large parts of Texas and Louisiana in 2017, climate models projected that three-fourths of its damage, or $67 billion, was attributable to the human influence on climate change.[17]

These methods bring about an epistemic shift, rendering climate change not only legible but litigable.[18] Plaintiffs can make use of attribution methods to assign net annual carbon dioxide and methane emissions to specific defendants,[19] to calculate climate responses to greenhouse gas emissions, and to attribute impacts such as "increases in ambient (surface) temperature, ocean temperature, sea level, droughts, extreme precipitation events, [and] heat waves" to defendants on an individual and aggregate basis.[20]

The consequences of using novel scientific methods to advance tort law claims premised on complex causal arguments are well established in toxic tort precedent.[21] In the latter half of the twentieth century, epidemiological advancements in the science of cancer attribution supported toxic tort claims

30; Robbie M. Andrew & Glen P. Peters, *The Global Carbon Project's Fossil CO2 Emissions Dataset*, ZENODO (Oct. 14, 2021), https://zenodo.org/record/5569235 [https://perma.cc/5MQ5-JGMU] (attributing global carbon emissions by country).

[15] *Western North American Extreme Heat Virtually Impossible Without Human-Caused Climate Change*, WORLD WEATHER ATTRIBUTION (July 7, 2021), https://www.worldweatherattribution.org/western-north-american-extreme-heat-virtually-impossible-without-human-caused-climate-change/ [https://perma.cc/CAJ2-NPEF].

[16] Nadja Popovich & Winston Choi-Schagrin, *Hidden Toll of the Northwest Heat Wave: Hundreds of Extra Deaths*, N.Y. TIMES (Aug. 11, 2021), https://www.nytimes.com/interactive/2021/08/11/climate/deaths-pacific-northwest-heat-wave.html [https://perma.cc/JQ2T-VBVW].

[17] David J. Frame, Michael F. Wehner, Ilan Noy & Suzanne M. Rosier, *The Economic Costs of Hurricane Harvey Attributable to Climate Change*, 160 CLIMATIC CHANGE 271, 276 (2020) (estimating about $90 billion in damages, with a best estimate of $67 billion attributable to human influence and a lower bound of at least $30 billion).

[18] *See generally* Solomon Hsiang et al., *Estimating Economic Damage from Climate Change in the United States*, 356 SCIENCE 1362 (2017) (discussing the methods used to calculate economic damages from climate change).

[19] *See, e.g.*, Rhode Island Complaint, *supra* note 1, at 4, 7 (attributing approximately fifteen percent of GHG emissions to the oil and gas industry defendants).

[20] *Id.* at 47–49.

[21] *See infra* notes 199–315 and accompanying text (examining toxic tort precedent).

against manufacturers of asbestos, lead paint, and pharmaceuticals.[22] Plaintiffs relied on epidemiological methods to support causal claims linking chemical exposures to health injuries. Epidemiological methods share key features with climate attribution methods, most significantly their use of statistical measures to establish probabilistic causation.[23] Should courts recognize climate attribution evidence and its methods of probabilistic causation, a new wave of climate tort litigation is not merely foreseeable but imminent.

In this Article I make two main contributions to a growing literature on climate litigation.[24] First, I show how the most up-to-date climate science can be used to solve problems that have to this point frustrated many tort lawsuits against greenhouse gas emitters.[25] I focus on preliminary judgments concerning causation, redressability, and justiciability, and anticipate future obstacles to causation and damages allocation that plaintiffs are likely to confront on the merits. I draw on a systematic analysis of the use of attribution science in past and ongoing climate tort lawsuits, including complaints, orders, and opinions, and on an assessment of the state of climate science referenced or relied on to support or contest legal claims. My analysis demonstrates that the use of climate attribution science remains limited in climate tort cases, despite its considerable relevance.[26]

Second, I show how the use of climate attribution science is analogous to the types of scientific and legal techniques developed in toxic tort litigation and already accepted by courts.[27] I argue that these similarities provide grounds for the courts' acceptance of climate attribution evidence to overcome procedural and doctrinal obstacles. These contributions have implications be-

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[22] *See* Bert Black & David E. Lilienfeld, *Epidemiologic Proof in Toxic Tort Litigation*, 52 FORDHAM L. REV. 732, 755–64 (1984) (discussing attribution of risk in the realm of disease research).

[23] *See infra* notes 208–229 and accompanying text.

[24] I situate this Article in a line of scholarship begun by Douglas Kysar in 2011, identifying theoretical and doctrinal obstacles to climate tort litigation. *See generally* Kysar, *supra* note 11. Kysar's work has been elaborated by Mike Burger, Jessica Wentz, and Radley Horton in their encyclopedic survey of the relevance of climate attribution science for climate change policymaking and litigation. Burger and his coauthors identified the types of arguments that had been advanced in preliminary judgments in climate lawsuits. Their article highlights illustrative climate lawsuits, including two tort cases. *See generally* Michael Burger, Jessica Wentz & Radley Horton, *The Law and Science of Climate Change Attribution*, 45 COLUM. J. ENV'T L. 57, 156–60 (2020) (discussing climate attribution in *Connecticut v. American Electric Power Co.*, 582 F.3d 309 (2d Cir. 2009) and *Native Village of Kivalina v. Exxon Mobil Corp.*, 663 F. Supp. 2d 863 (N.D. Cal. 2009)). In this Article, I conduct a systematic review of these cases, as well as all other U.S. tort cases (and associated filings) that deal with climate attribution. I show how the analytical claims introduced by Burger, asserting the relevance of climate attribution science for climate litigation, may be supported by specific studies and methods popularized in recent years. Beyond the claim that attribution science is relevant to these cases, I argue that, based on toxic tort precedent, courts can accept these methods and doctrinal arguments.

[25] *See infra* notes 78–198 and accompanying text.

[26] This is because some claims, like consumer protection claims, do not rely on attribution, and because many damages claims have not yet reached the merits.

[27] *See infra* notes 199–315 and accompanying text.

yond their immediate relevance to U.S. climate tort lawsuits or even global climate litigation. Developments in attribution science advancing causal linkages for climate change have direct implications for domestic climate regulation and for international actors attempting to allocate costs for climate change.[28]

This Article offers a descriptive and analytical contribution grounded in case law. Taken seriously, these arguments have considerable implications. Climate attribution science provides a tool to advance public goals of tort law concerned with internalizing costs of climate change into the activities of major greenhouse gas producers.[29] From this perspective, climate tort litigation can shift the costs of climate change from cities, states, communities, and individuals to companies and industries that have profited from creating it. These include fossil fuel producers, automobile manufacturers, and power plants. Climate attribution methods also further private goals of tort law concerned with enunciating relational norms, righting wrongs, and refereeing reasonable and unreasonable activities. The adoption of attribution science can overcome procedural hurdles and allow litigants to have their day in court, before a jury of their peers, thereby facilitating the democratic deliberation of new norms in an era of climate crisis.

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[28] An agreement reached at COP27 established a fund for loss and damage resulting from climate change in vulnerable countries. Press Release, U.N. Climate, COP27 Reaches Breakthrough Agreement on New "Loss and Damage" Fund for Vulnerable Countries (Nov. 20, 2022), https://unfccc.int/news/cop27-reaches-breakthrough-agreement-on-new-loss-and-damage-fund-for-vulnerable-countries [https://perma.cc/FZL6-G5QR].

[29] To be sure, innovations in science do not resolve the normative questions embedded in climate tort claims, but they do advance new ways of framing and conceiving of the normative questions. For example, Richard Heede's 2014 study identifying the "carbon major[s]" enabled the types of claims now advanced by lawsuits against fossil fuel companies. Heede, *supra* note 14, at 229. Heede's study identified ninety carbon emitters that account for 63% of global emissions since 1854. *Id.* It was a paradigm shift from countries as the source of emissions to focusing on emitting companies, whether state owned or privately owned. *Id.* at 229–30. Heede's publication, and the subsequent Carbon Disclosure Project inspired by his findings, reframed the unit of responsibility from territorial sources to public or private entities with the ability to pay for the costs of climate change. *See Who We Are*, CARBON DISCLOSURE PROJECT, https://www.cdp.net/en/info/about-us [https://perma.cc/6HQA-CT4A] (stating that the non-profit CDP charity maintains the "richest and most comprehensive dataset on corporate and city action" in the global community). To buy into Heede's premise, which the body of climate attribution scholarship, and now tort claims, has done, is to advance a governance gap-filling function for tort law, supporting findings of liability in terms of ability to pay and accounting for externalities. Heede's findings are also premised on accepting that Scope 3 emissions resulting from the burning of fossil fuel products are attributable to their industrial producers. Heede, *supra* note 14, at 231; *see also Scope 3 Inventory Guidance*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/climateleadership/scope-3-inventory-guidance#:~:text=Scope%203%20emissions%20are%20the,scope%201%20and%202%20boundary [https://perma.cc/6DGZ-5D23] (Feb. 14, 2023) ("Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly affects in its value chain."). Defendants will likely argue that liability for Scope 3 emissions is confounded by intervening causes, including the plaintiff's own burning of the fossil fuel product, for example. *See infra* note 73 (defining in greater detail Scope 1, 2, and 3 emissions). Whether an act is intervening will hinge on whether a fact finder would determine that Scope 3 emissions are a foreseeable, ordinary use of the defendant's product or an independent cause.

This Article proceeds in four parts. Part I introduces U.S. climate tort litigation and provides background on the methods of climate attribution science.[30] Part II identifies five obstacles to climate tort claims and elaborates the contribution that climate attribution science makes to overcoming them.[31] It observes that attribution science does not overcome a legal challenge of causal uncertainty, or uncertainty about the exact emitter among several possible sources of emissions, that results from the fungible nature of greenhouse gases and from the numerosity of potential emitters. Part III proposes that causal uncertainty can be overcome by adopting standards used in toxic tort precedent where litigants confronted a similar challenge due to the fungibility of toxic chemicals and market diffusion among defendants.[32] It observes that the epidemiological methods adopted to deal with those challenges are analogous to the methods of climate attribution. Accordingly, doctrinal precedent supports courts' reliance on attribution evidence for probabilistic causation in place of but-for causation for climate tort claims. Part IV contextualizes tort litigation as an intervention for dealing with climate damages, evaluating its possibilities and implications.[33]

I. LITIGATING CLIMATE TORTS

Climate litigation began in the United States nearly two decades ago.[34] Inspired by the federal government's failure to regulate climate change and a growing awareness and experience of its impacts, litigants turned to the courts for redress. Section A of this Part discusses the history of climate suits, which involves two waves of litigation advancing differing approaches based on federal and state law claims.[35] Climate science is relevant to many of these claims: it explains climate dynamics and identifies how these are modified by human-induced climate change. Attribution science methodologies, including

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[30] *See infra* note 34–77 and accompanying text.

[31] *See infra* note 78–198 and accompanying text.

[32] *See infra* note 199–315 and accompanying text.

[33] *See infra* note 316–359 and accompanying text.

[34] *See* Leah Aronowsky, *The Limits of Climate Change Litigation*, N.Y. REV. (Nov. 3, 2021), https://www.nybooks.com/online/2021/11/03/the-limits-of-climate-change-litigation/ [https://perma.cc/X2DL-ZLQ6] (pinpointing the start of climate litigation as 2003). In this Article, I focus on climate litigation that alleges a connection between climate change and damages to plaintiffs, but a broader interpretation of climate litigation in the United States dates back even farther to the mid-1980s. Climate lawsuits of the 1980s and 90s mostly concerned challenges to environmental impact statements and agency actions that failed to take into account the effects of climate change. *See, e.g.*, City of Los Angeles v. Nat'l Highway Traffic Safety Admin., 912 F.2d 478, 481 (D.C. Cir. 1990) (per curiam) (challenging the National Highway Traffic Safety Administration's decision "not to prepare Environmental Impact Statement (EIS) covering its Corporate Average Fuel Economy (CAFE) standards for model years [1987–1989]"), *overruled by* Fla. Audubon Soc'y v. Bentsen, 94 F.3d 658, 669 (D.C. Cir. 1996); Found. on Econ. Trends v. Watkins, 794 F. Supp. 395, 396 (D.D.C. 1992) (challenging actions approved by agencies that did not take into account effects on climate change).

[35] *See infra* notes 39–48 and accompanying text.

extreme weather event attribution, provide new tools for understanding and modeling relationships between greenhouse gas emitters, weather events, and climate impacts.[36] Section B provides an overview of these developments in the field of attribution science.[37] Finally, Section C presents the methodology and results of my survey of climate tort litigation, analyzing legal documents associated with claims through May 2022.[38]

A. Climate Change in the Courts

A first wave of climate lawsuits in the early 2000s featured claims under the National Environmental Policy Act (NEPA), the Clean Air Act (CAA), and the Endangered Species Act (ESA). In the 2007 landmark case, *Massachusetts v. EPA*, several states sued the Environmental Protection Agency for its failure to regulate greenhouse gas (GHG) emissions under the CAA.[39] The case reached the U.S. Supreme Court, which ruled in Massachusetts's favor and compelled the EPA to regulate GHG emissions from motor vehicles if they were found to endanger public health and welfare.[40] Climate tort lawsuits began during the same timeframe. In 2004, in *American Electric Power Co. v. Connecticut*, Connecticut and seven other states filed public nuisance claims against the American Electric Power Company.[41] When the case finally reached the Supreme Court seven years later, the Court held that the CAA preempted any federal common-law nuisance claims and thus dismissed the case.[42]

American Electric and successive cases represented a first wave of climate tort litigation based on federal common-law claims.[43] Plaintiffs in these cases confronted obstacles pertaining to Article III standing, justiciability under the political question doctrine, and displacement by federal common law. These cases were, on the whole, unsuccessful.[44]

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[36] For instance, in sea levels or average temperatures.

[37] *See infra* notes 49–66 and accompanying text.

[38] *See infra* notes 67–77 and accompanying text.

[39] Massachusetts v. EPA, 549 U.S. 497, 505 (2007).

[40] *Id.* at 533–34.

[41] Am. Elec. Power Co. v. Connecticut, 564 U.S. 410, 418 (2011).

[42] *Id.* at 426–27. Although the *Massachusetts v. EPA* decision decided in favor of the plaintiffs, it ironically led to preemption of federal common-law suits like *American Electric* despite the EPA never adequately regulating greenhouse gases (GHGs), thus representing a practical victory for the defendants. *See id.* at 415–16.

[43] Karen C. Sokol, *Seeking (Some) Climate Justice in State Tort Law*, 95 WASH. L. REV. 1383, 1386–87 (2020) (distinguishing climate torts by identifying two waves: the first wave beginning with *American Electric* and ending when the Supreme Court dismissed the states' claims in 2011; the second wave beginning in 2017 and continuing to the present).

[44] Geetanjali Ganguly, Joana Setzer & Veerle Heyvaert, *If at First You Don't Succeed: Suing Corporations for Climate Change*, 38 OXFORD J. LEGAL STUD. 841, 846–49 (2018) (summarizing the cases making up the first wave of climate tort cases and their results).

Beginning in 2017, a second wave of climate tort cases adopted a different approach.[45] These cases make exclusively state law claims, and all but one have been filed in state courts.[46] Plaintiffs are mostly cities, states, and municipalities seeking remedies from major fossil fuel producers for their contributions to climate damages.[47] Defendants repeat across these cases, and the typi-

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[45] Sokol, *supra* note 43, at 1386–87. These lawsuits have been filed by cities, counties, and states, and one lawsuit was filed by a fishermen's trade association. *See, e.g.*, County of San Mateo v. Chevron Corp., 960 F.3d 586, 593 (9th Cir. 2020), *judgment vacated sub nom.* Chevron Corp. v. San Mateo County, 141 S. Ct. 2666 (2021); City of Oakland v. BP PLC, 960 F.3d 570, 575 (9th Cir.), *opinion amended and superseded on denial of reh'g*, 969 F.3d 895 (9th Cir. 2020), *cert. denied sub nom.* Chevron Corp. v. City of Oakland, 141 S. Ct. 2776 (2021); City of New York v. BP P.L.C., 325 F. Supp. 3d 466, 468 (S.D.N.Y. 2018), *aff'd sub nom.* City of New York v. Chevron Corp., 993 F.3d 81 (2d Cir. 2021); King County v. BP P.L.C., No. C18-758-RSL, 2018 WL 9440497, at *1 (W.D. Wash. Oct. 17, 2018); Bd. of Cnty. Comm'rs v. Suncor Energy (U.S.A.) Inc., 25 F.4th 1238, 1246 (10th Cir. 2022); Rhode Island v. Chevron Corp., 393 F. Supp. 3d 142, 146 (D.R.I. 2019), *aff'd sub nom.* Rhode Island v. Shell Oil Prods. Co., 979 F.3d 50 (1st Cir. 2020), *judgment vacated*, 141 S. Ct. 2666 (2021); Mayor & City Council of Baltimore v. BP P.L.C., 952 F.3d 452, 457 (4th Cir.), *vacated*, 141 S. Ct. 1532 (2021); City & County of Honolulu v. Sunoco LP, 39 F.4th 1101, 1106 (9th Cir. 2022), *petition for cert. filed*, 39 F.4th 1101 (2022); Minnesota v. Am. Petrol. Inst., No. CV 20-1636, 2021 WL 3711072, at *1 (D. Minn. Aug. 20, 2021); City of Hoboken v. Exxon Mobil Corp., 558 F. Supp. 3d 191, 296 (D.N.J. 2021), *aff'd*, 45 F.4th 699 (3d Cir. 2022); City of Charleston v. Brabham Oil Co., No. 2020-CP-10-3975 (S.C. Ct. Com. Pl. Sept. 9, 2020); Delaware v. BP Am., Inc., 578 F. Supp. 3d 618, 625 (D. Del. 2022), *aff'd sub nom.* City of Hoboken v. Chevron Corp., 45 F.4th 699 (3d Cir. 2022); Connecticut v. Exxon Mobil Corp., No. 20-CV-1555, 2021 WL 2389739, at *1 (D. Conn. June 2, 2021); City of Annapolis v. BP P.L.C., No. CV ELH-21-772, 2021 WL 2000469, at *1 (D. Md. May 19, 2021).

[46] Five federal circuit courts (the First, Third, Fourth, Ninth, and Tenth) have denied defendants' motions to remove claims to federal court under a variety of theories and remanded them to state courts. In October 2020, the First Circuit remanded *Rhode Island v. Shell Oil Products. Co.* 979 F.3d at 53. In February 2022, the Tenth Circuit remanded *Board of County Commissioners of Boulder County v. Suncor Energy (U.S.A.) Inc.* and the Ninth Circuit remanded *County of San Mateo v. Chevron Corp*. *See Bd. of Cnty. Comm'rs*, 25 F.4th at 1246; *County of San Mateo*, 960 F.3d at 593. In August 2022, the Third Circuit remanded *Delaware v. BP America Inc.* and *City of Hoboken v. Exxon Mobil Corp*. *City of Hoboken*, 45 F.4th at 706. The move to state courts holds more favorable prospects for plaintiffs, should they eventually be heard before state juries. However, the Second Circuit's dismissal of *City of New York v. Chevron Corp.* in April 2021 due to federal preemption under the Clean Air Act (CAA) created a circuit split. 993 F.3d at 85. The Eighth Circuit recently addressed similar questions in *Minnesota v. American. Petroleum Institute*, No. 21-8005, 2023 BL 99162, at *4–5 (8th Cir. Mar. 23, 2023). For further analysis of the circuit split, see Matthew Blaschke, Rachel Rubens, & Oliver Thoma, *The Widening Circuit Split on State Court Climate Claims*, LAW360 (July 11, 2022), https://www.law360.com/articles/1509964/the-widening-circuit-split-on-state-court-climate-claims [https://perma.cc/SA5Z-ACB9]. The defendants in *Board of County Commissioners* petitioned the Supreme Court to review the Tenth Circuit's remand order. Petition for Writ of Certiorari, Suncor Energy (U.S.A.) Inc. v. Bd. of Cnty. Comm'rs, No. 21-1550 (June 10, 2022). In early October 2022, the Supreme Court solicited input from the Solicitor General on these climate liability cases. Supreme Court Order 21-1550 (Oct. 3, 2022), https://www.supremecourt.gov/orders/courtorders/100322zor_fcgj.pdf [https://perma.cc/5XUP-5X4E].

[47] One case, *California v. General Motors* targeted car manufacturers, alleging that their vehicles were a substantial source of greenhouse gas emissions that caused climate change and resulted in millions of dollars of damage to the State of California. No. C06-05755, 2007 WL 2726871, at *1 (N.D. Cal. Sept. 17, 2007).

cal defendant class accounts for about fifteen percent of anthropogenic greenhouse gas emissions since 1965.[48] In this second wave, climate tort litigants base their claims in public and private nuisance, negligence, and failure to warn. None of these cases have yet been adjudicated on the merits; some have been dismissed and the rest are in pre-trial stages.

Across the first and second waves of climate tort litigation, preliminary judgments reflect outdated assumptions about attribution science, including that climate damages cannot be attributed to specific emissions. These judgments are correct only if the assumptions made in these cases about climate attribution are valid. I plan to show that, often, they are not.

B. Developments in Climate Change Attribution

Climate science has advanced considerably in the last sixty years with the development of increasingly sophisticated models simulating climate dynamics and providing improved understanding of the mechanisms of climate change.[49] The subfield of climate attribution science, pioneered in the early 2000s, specifically deals with linking climate-related harms to GHG emissions.[50] Three general types of studies investigate and model these relationships: source attribution, climate change attribution, and impact attribution studies.[51] Source attribution[52] studies link GHG emissions to specific emitting sources, such as corporations, industry sectors, or countries.[53] A groundbreaking study published in 2014 provides an example of source attribution.[54] The study traced the contributions of ninety fossil fuel and cement producers to anthropogenic GHG emissions from 1854 to 2010 and determined that they accounted for sixty-three percent of cumulative worldwide emissions.[55]

Climate change attribution, a second category of climate attribution studies, links GHG emissions to the likelihood or intensity of extreme weather events and quantifies the effect of climate change on long-term climatic ef-

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[48] *See* Appendix G.

[49] Hervé Le Treut et al., *Historical Overview of Climate Change Science*, *in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 93, 100–02 (Susan Solomon et al. eds., 2007).

[50] *See* Renee Cho, *Attribution Science: Linking Climate Change to Extreme Weather*, COLUM. CLIMATE SCH.: STATE OF THE PLANET (Oct. 4, 2021), https://news.climate.columbia.edu/2021/10/04/attribution-science-linking-climate-change-to-extreme-weather/ [https://perma.cc/E3EH-FNAB] ("A 2004 paper entitled 'Human Contribution to the European Heat Wave of 2003' is generally considered to be the first attribution science study." (citing Peter A. Stott, D.A. Stone, & M.R. Allen, Letter, *Human Contribution to the European Heatwave of 2003*, 432 NATURE 610, 610–14 (2004))).

[51] Burger et al., *supra* note 24, at 67.

[52] This is also called "carbon accounting."

[53] *See* Burger et al., *supra* note 24, at 75 (discussing source attribution in the context of documentary evidence, which is used in source attribution studies).

[54] Heede, *supra* note 14, at 231–32 (describing the methodology for climate attribution to various fossil fuel producers).

[55] *Id.* at 235 tbl.2.

fects, such as rising sea levels.[56] This is the type of analysis conducted by the World Weather Attribution Network, a collaboration among leading climate scientists worldwide that provides almost real-time assessments of the role of climate change in extreme weather events.[57]

A third category of studies advances impact attribution,[58] linking the physical manifestations of human-induced climate change, such as storm intensity, to specific physical, economic, ecological, and public health impacts.[59] These are the types of assessments conducted by the United Nations Intergovernmental Panel on Climate Change (IPCC). A 2021 article estimated that more than one-hundred thousand such studies have been conducted documenting a broad range of climate impacts.[60]

Attribution studies model the likelihood of occurrence or the severity of a specific weather event or condition under current and counterfactual climate conditions. Scientists can model the contribution of anthropogenic emissions to the intensity or likelihood of extreme weather events like floods and heatwaves or to slow-onset events like sea level rise or glacial retreat.[61] They do this first by modeling conditions in the absence of anthropogenic GHGs, then using that model to quantify the impact that anthropogenic GHGs have on the likelihood of occurrence and intensity of a specific climate event.[62] Today, at-

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[56] Burger et al., *supra* note 24, at 77.

[57] *World Weather Attribution Initiative*, WORLD WEATHER ATTRIBUTION, https://www.worldweatherattribution.org/about/ [https://perma.cc/A885-N9E3].

[58] *See* Burger et al., *supra* note 24, at 74, 111. Impact attribution is also called "damage attribution." *See generally* Christopher W. Callaghan & Justin S. Mankin, *National Attribution of Historical Climate Damages*, CLIMATIC CHANGE, July 12, 2022, at 1, 14, 16 (discussing "attributable damages"); Max Callaghan et al., *Machine-Learning-Based Evidence and Attribution Mapping of 100,000 Climate Impact Studies*, 11 NATURE CLIMATE CHANGE 966, 966 (2021) (evaluating quantitatively the impact of climate change).

[59] *See* Callaghan et al., *supra* note 58, at 966.

[60] *Id.* at 967.

[61] *See, e.g.*, Sihan Li & Friederike E.L. Otto, *The Role of Human-Induced Climate Change in Heavy Rainfall Events Such as the One Associated with Typhoon Hagibis*, CLIMATIC CHANGE, May 18, 2022, at 1, 4 ("[W]e use a range of weather station observed and reanalysis products . . . as well as a range of climate models . . . to assess whether and to what extent anthropogenic climate change altered the likelihood of the extreme precipitation event . . . to occur."); Noah S. Diffenbaugh, *Verification of Extreme Event Attribution: Using Out-of-Sample Observations to Assess Changes in Probabilities of Unprecedented Events*, SCI. ADVANCES, Mar. 18, 2020, at 1, 1 ("The purpose of this study is to examine whether independent 'out-of-sample' observations can be used to assess the accuracy of changes in extreme event return intervals that are either explicitly or implicitly predicted by attribution frameworks."); Alexander Nauels et al., *Attributing Long-Term Sea-Level Rise to Paris Agreement Emission Pledges*, 116 PROC. NAT'L ACAD. SCIS. 23487, 23487 (2019) ("Our findings demonstrate that global and individual country emissions over the first decades of the 21st century alone will cause substantial long-term sea-level rise.").

[62] Notably, attribution studies are more accurate for specific types of climate events than they are for others, and for regions where the temperature record is more complete. Attribution studies are more accurate for climate events that are closely connected to global and regional temperatures, like increased risks of extreme heat or extreme precipitation, but have greater uncertainty when they con-

tribution methods can model counterfactual scenarios, removing the contributions of specific parties or sources at a national or even individual company level. Indeed, a 2017 study established that it is "now possible to quantitatively determine the contribution of individual countries to global mean temperature change."[63] More recent studies attribute contributions to individual emitters.[64]

Yet, in my previous coauthored study surveying global climate lawsuits that allege some causal link between GHG emissions and climate damages, our research team found that almost seventy-five percent of cases made no use of attribution science.[65] Moreover, those cases that did reference attribution science did so to establish general links between greenhouse gas emissions and climate impacts, rather than to attribute specific harms to emissions or to defendants.[66] As a consequence, courts have yet to deal with climate attribution science; they are, however, likely to do so given the growing popularity of climate tort claims and plaintiffs' improved strategies that avoid past procedural pitfalls.

C. Surveying the Law and Science of Climate Torts

The focus of this Article is on U.S. tort lawsuits making claims in public nuisance, private nuisance, trespass, or products liability, and alleging a relationship between greenhouse gas emissions and climate change impacts occurring in the past, present, and future.[67] I conducted an in-depth analysis of the scientific and legal arguments related to a causal link between greenhouse gas emissions and climate damages, drawing on complaints, motions, orders, opinions, and briefs through May 2022.[68]

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cern the interaction of climate change with impacts like biodiversity where climate change is synergistic with factors like habitat destruction. *See* NAT'L ACADS. OF SCIS., ENG'G & MED., ATTRIBUTION OF EXTREME WEATHER EVENTS IN THE CONTEXT OF CLIMATE CHANGE 2 (2016) ("[R]esults remain subject to substantial uncertainty, with greater levels of uncertainty for events that are not directly temperature related.").

[63] Friederike E.L. Otto et al., Commentary, *Assigning Historic Responsibility for Extreme Weather Events*, 7 NATURE CLIMATE CHANGE 757, 757 (2017).

[64] *See, e.g.*, R. Licker et al., *Attributing Ocean Acidification to Major Carbon Producers*, ENV'T RSCH. LETTERS, Dec. 11, 2019, at 1, 7 fig.3 (linking the contribution of major carbon emitters to the ocean acidification); Heede, *supra* note 14, at 237 tbl.3 (identifying ninety carbon emitters that account for 63% of global emissions since 1854); Ekwurzel et al., *supra* note 12, at 581 (tracing emissions from industrial carbon producers to a variety of climate impacts).

[65] Rupert F. Stuart-Smith et al., *Filling the Evidentiary Gap in Climate Litigation*, 11 NATURE CLIMATE CHANGE 651, 651–52 (2021) (examining 73 cases across 14 jurisdictions that referred directly to attribution science or that used evidence linking climate change to specific damages, including tort, human rights, public trust, takings, contract, judicial review, and federal statutory claims).

[66] *Id.* at 652.

[67] For a list of cases and number of relevant filings, see Appendix A.

[68] See Appendix C for type and strength of attribution evidence used and Appendix D for emissions included and attributed damages.

1. Methodology

When reviewing scientific evidence,[69] I analyzed: 1) the type of attribution evidence used and sources referenced by plaintiffs, 2) the strength of attribution evidence presented compared with evidence available, 3) the scope of emissions considered, 4) the types of damages attributed, 5) any reliance on expert evidence or testimony, and 6) defendants' responses to attribution evidence.[70] The primary objective of this analysis was to identify and assess the types of scientific evidence introduced to support plaintiffs' claims, including the specificity of studies cited to the alleged impacts.[71] This analysis demonstrates that attribution methods and evidence were used in limited contexts and to varying degrees, and that attribution evidence has not yet been outcome determinative in climate tort lawsuits.[72]

2. Findings

For the most part, complaints referred to a general connection between GHG emissions and global warming without relying on specific attribution studies. Of the twenty-nine climate tort cases examined, nine referred to peer-reviewed attribution studies to some extent, two extrapolated attribution from regional or global attribution statements, eight presumed attribution based on consistency with climate projections, and nineteen presumed or implied attribution with no supporting evidence. Fifteen cases referred to confidence assessments for global warming and none of the cases referred to a relevant uncertainty assessment. Nineteen cases did not quantify human influence on climate impacts, presuming the impacts to be entirely attributable to human contributions, while ten provided some quantification of relative risk contribution of anthropogenic GHGs or made a claim about the change in magnitude due to human contribution. Cases did not specify what scope of emissions were in-

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[69] "Evidence" is a term of art with distinct scientific and legal meanings. *See, e.g.*, *Evidence*, BLACK'S LAW DICTIONARY (11th ed. 2019). Here, "evidence" is used consistent with its scientific meaning, to refer to scientific material and supporting arguments included in the documents analyzed. Pleadings do not include evidence in the legal sense, but they do rely on scientific argumentation, materials, and examples, which are considered here as they inform preliminary determinations of standing and justiciability, general causation, duty, and foreseeability.

[70] See Appendix E for expert evidence and defendants' responses.

[71] These considerations included whether plaintiffs were citing peer-reviewed journal articles, IPCC reports, reports published by governmental or nongovernmental organizations, or other types of documents. The specificity of studies with respect to the harms suffered by plaintiffs might include studies that evaluate the effect of climate change on the specific circumstances of the plaintiffs' losses and those that provide regional or global assessments of the effect that climate change has on physical events of the type resulting in the harm suffered by plaintiffs.

[72] Obstacles to the success of climate litigation have typically been procedural or have concerned admissibility. *See, e.g.*, City of Oakland v. BP P.L.C., No. C 17-06011, 2018 WL 3609055, at *4 (N.D. Cal. July 27, 2018) (dismissing for failure to establish personal jurisdiction).

cluded in their claims, implying inclusion of Scope 1, 2, and 3 emissions[73] or referring to downstream emissions generally.

With respect to damage attribution, twenty-four cases presumed the entire cost of climate damages attributable to defendants, one attributed damages according to the change in storm intensity, and three did not provide a clear account of how damages would be determined. The most common physical impacts alleged were sea level rise (referenced in twenty-one cases) and extreme precipitation (referenced in fourteen cases), with additional references to other impacts like wildfires, droughts, coastal erosion, ocean warming and acidification, and heatwaves. For the most part, defendants have not yet discussed attribution or responsibility for climate impacts.[74]

An overriding finding from this analysis is that plaintiffs typically do not capitalize on developments in attribution science in formulating their legal claims. As a general matter, physical processes and their impacts were presumed to be attributable to human influence on the climate as a whole, or on the actions of individual defendants. This indicates a clear opportunity for the introduction of more specific evidence that would interrogate the factual basis for causal claims.[75] In several cases where causal evidence was referenced or analyzed, courts found that plaintiffs had not demonstrated a sufficiently direct causal link between defendants' emissions and plaintiffs' injuries.[76] In other cases, courts did not find a causal link due to variations of the "drop in the ocean" problem—the widely dispersed global nature of the problem that makes any one party's emissions merely a drop in the ocean of atmospheric GHGs.[77] The next Part

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[73] Scope 1 emissions are direct emissions from sources owned or controlled by the reporting entity, Scope 2 refers to emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the reporting company, and Scope 3 refers to all other indirect emissions, including emissions from sold fossil fuel products. *See Scope 3 Emissions*, U.N. GLOB. COMPACT NETWORK, https://www.unglobalcompact.org.uk/scope-3-emissions/ [https://perma.cc/JH5U-QJH9] (describing Scope 1, 2, and 3 emissions as used in the Greenhouse Gas Protocol Corporate Standard).

[74] *See* Appendices B, C & D.

[75] *See* Stuart-Smith et al., *supra* note 65, at 652 (describing the gap in causal connection in climate tort litigation and the opportunity to introduce climate attribution science).

[76] *See, e.g.*, *City of Oakland*, 2018 WL 3609055, at *3 ("[P]laintiffs fail to sufficiently explain how these 'slices' of global-warming-inducing conduct causally relate to the worldwide activities alleged in the amended complaints."); Native Village of Kivalina v. ExxonMobil Corp., 663 F. Supp. 2d 863, 882 (N.D. Cal. 2009) ("Plaintiffs lack standing . . . based on their inability to establish causation under Article III."); Comer v. Murphy Oil USA, Inc., 839 F. Supp. 2d 849, 862 (S.D. Miss. 2012) ("The Court finds that the plaintiffs have not alleged injuries that are fairly traceable to the defendants' conduct, and thus, the plaintiffs do not have standing to pursue this lawsuit."), *aff'd*, 718 F.3d 460 (5th Cir. 2013).

[77] *See, e.g.*, California v. Gen. Motors Corp., No. C06-05755, 2007 WL 2726871, at *14 (N.D. Cal. Sept. 17, 2007) ("Defendants also point to the difficulty associated in evaluating the essential elements of causation and injury, given the myriad sources of global greenhouse gas emissions and the '[s]ubstantial scientific uncertainties [that] limit [the] ability to . . . separate out those changes resulting from natural variability from those that are directly the result of increases in anthropogenic [greenhouse gases].'" (quoting Control of Emissions from New Highway Vehicles and Engines: No-

elaborates on these observations and, where relevant, demonstrates where climate attribution science may be responsive to these claims.

II. Attribution for Climate Torts

This Part examines previously identified obstacles to successful climate tort claims, including determinations of justiciability, standing, duty and breach, causation, and damages.[78] It elaborates anticipated legal challenges, considers how they have played out in nearly two decades of climate tort litigation, and, where relevant, identifies opportunities for existing attribution science methods to address these obstacles. Because most of the cases examined were not, or have not yet been, considered on the merits, climate science has only been relevant for preliminary determinations including arguments pertaining to standing, duty, and justiciability rather than in evidence submission or evidentiary hearings. Nevertheless, the remand of several recent cases from federal to state courts anticipates a more consequential role for scientific evidence.

Section A of this Part discusses how the political question doctrine was an obstacle to prior climate litigants and how attribution science can address it.[79] Section B examines obstacles to standing in prior climate lawsuits and the potential role for attribution science in avoiding these pitfalls.[80] Section C presents the contributions of attribution science to establishing duty, foreseeability, and breach.[81] Section D elaborates the contributions of climate attribution to the question of causation in climate lawsuits.[82] Finally, Section E discusses how climate attribution contributes to connecting specific damages to specific defendants.[83]

A. Political Question

In order for a court to exercise jurisdiction over a case, as a preliminary matter, it must be justiciable.[84] Of the justiciability doctrines, political question is most readily identified as an obstacle in climate cases. In 1962, in *Baker v.*

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tice of Denial of Petition for Rulemaking, 68 Fed. Reg. 52922, 52930 (Sept. 8, 2003)). More generally, see Jacqueline Peel, *Issues in Climate Change Litigation*, 5 Carbon & Climate L. Rev. 15 (2011) (providing a discussion of the drop in the ocean problem).

[78] *See infra* notes 78–198 and accompanying text.

[79] *See infra* notes 84–107 and accompanying text.

[80] *See infra* notes 108–148 and accompanying text.

[81] *See infra* notes 149–167 and accompanying text.

[82] *See infra* notes 168–182 and accompanying text.

[83] *See infra* notes 183–198 and accompanying text.

[84] *See* Erwin Chemerinsky, *A Unified Approach to Justiciability*, 22 Conn. L. Rev. 677, 677 (1990) ("[T]he case must not present an advisory opinion; there must be standing; the case must be ripe; it must not be moot; and it must not present a political question.").

Carr, the Supreme Court enumerated six independent tests that render a claim non-justiciable as a political question.[85] Thus far, two of these have been directly implicated in climate tort claims: "a lack of judicially discoverable and manageable standards for resolving [a claim]" and "impossibility of deciding without an initial policy determination of a kind clearly for nonjudicial discretion."[86]

Defendants have invoked, and courts have supported, the political question doctrine to dismiss some climate tort claims. In 2005, in *Connecticut v. American Electric Power Co.*, the U.S. District Court for the Southern District of New York held that climate change fell outside the jurisdiction of federal courts.[87] Similarly, in 2009, in *Native Village of Kivalina v. ExxonMobil Corp.*, the U.S. District Court for the Northern District of California held that claims were non-justiciable because they forced the court to resolve the dispute through a "policy judgment of a legislative nature, rather than resolving the dispute through legal and factual analysis."[88] The court determined that, to adjudicate plaintiffs' claims, it would have to undertake a comprehensive cost-benefit analysis of the potential benefits of energy-producing alternatives weighed against the risk that increasing GHG emissions would increase flooding in the remote Alaskan region where plaintiffs resided.[89]

In 2012, in *Comer v. Murphy Oil USA*, the U.S. District Court for the Southern District of Mississippi held that there were "no judicially discoverable and manageable standards for resolving the issues presented."[90] In this case, the court refused to consider how the defendants' "unreasonable" level of emissions contributed to global warming, and thus led to conditions that formed hurricanes and caused sea level rise.[91] The court determined that allegations of unreasonable endangerment to "environment, public health, and public and private property" required a policy determination establishing at a baseline what a reasonable level of emissions should be.[92] Other cases have adopted similar rea-

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[85] Baker v. Carr, 369 U.S. 186, 217 (1962).

[86] *Id.*

[87] *See* Connecticut v. Am. Elec. Power Co., 406 F. Supp. 2d 265, 274 (S.D.N.Y. 2005) (stating that because resolution of the issues presented required identification and balancing of economic, environmental, foreign policy, and national security interests, "an initial policy determination of a kind clearly for non-judicial discretion" was required (quoting Vieth v. Jubelirer, 541 U.S. 267, 278 (2004))), *vacated*, 582 F.3d 309 (2d Cir. 2009), *rev'd*, 564 U.S. 410 (2011).

[88] Native Village of Kivalina v. ExxonMobil Corp., 663 F. Supp. 2d 863, 873, 876 (N.D. Cal. 2009) (quoting EEOC v. Peabody W. Coal Co., 400 F.3d 774, 784 (9th Cir. 2005)).

[89] *Id.* at 874–75. The court explained that it would be forced to consider "the energy-producing alternatives that were available in the past" and "their respective impact on far ranging issues such as their reliability as an energy source, safety considerations and the impact of the different alternatives on consumers and business at every level," as well as "the benefits derived from those choices." *Id.*

[90] Comer v. Murphy Oil USA, Inc., 839 F. Supp. 2d 849, 865 (S.D. Miss. 2012), *aff'd*, 718 F.3d 460 (5th Cir. 2013).

[91] *Id.* at 864.

[92] *Id.* at 864–65.

soning, including *California v. General Motors Corp.*,[93] *City of Oakland v. British Petroleum P.L.C.*,[94] and *New York v. British Petroleum P.L.C.*[95]

The claims in *American Electric*, *Kivalina*, and *Comer* allege harms resulting from a general link between defendants' unquantified GHG emissions and the general impacts of global warming. In *American Electric*, the plaintiffs sought "an order requiring defendants to reduce their emissions of carbon dioxide, thereby abating their contribution to global warming, a public nuisance."[96] In *Kivalina*, the plaintiffs alleged that "[d]efendants' emissions of carbon dioxide and other greenhouse gases, by contributing to global warming, constitute a substantial and unreasonable interference with public rights."[97] In *Comer*, the plaintiffs' claims against fossil fuel companies advanced a three-part chain of causation: first, they alleged that the defendants' emissions were a direct and proximate cause of increased global warming; second, that this warming produced the conditions for a hurricane the size and strength of Hurricane Katrina; and third, that the hurricane's strength caused extensive death and destruction.[98]

The generality of an alleged causal link between emissions and damages reflects a contemporaneous state of climate science at the time of filing that

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[93] California v. Gen. Motors Corp., No. C06-05755, 2007 WL 2726871, at *8 (N.D. Cal. Sept. 17, 2007) ("This distinction is unconvincing because regardless of the relief sought, the Court is left to make an initial decision as to what is unreasonable in the context of carbon dioxide emissions. Such an exercise would require the Court to create a quotient or standard in order to quantify any potential damages that flow from Defendants' alleged act of contributing thirty percent of California's carbon dioxide emissions."). The court cited *Connecticut v. American Electric Power Co.* for the proposition that "the adjudication of Plaintiff's claim would require the Court to balance the competing interests of reducing global warming emissions and the interests of advancing and preserving economic and industrial development . . . . [This] type of initial policy determination [is] to be made by the political branches . . . ." *Id.* (internal citation omitted) (citing Connecticut v. Am. Elec. Power Co., 406 F. Supp. 2d 265, 274 (S.D.N.Y. 2005), *vacated*, 582 F.3d 309 (2d Cir. 2009), *rev'd*, 564 U.S. 410 (2011)).

[94] City of Oakland v. BP P.L.C., 325 F. Supp. 3d 1017, 1026 (N.D. Cal. 2018) ("But questions of how to appropriately balance these worldwide negatives against the worldwide positives of the energy itself, and of how to allocate the pluses and minuses among the nations of the world, demand the expertise of our environmental agencies, our diplomats, our Executive, and at least the Senate."), *vacated and remanded*, 960 F.3d 570 (9th Cir. 2020). The court explained that various tort lawsuits throughout the country may in fact "interfere with reaching a worldwide consensus," rather than "solve the problem." *Id.*

[95] City of New York v. BP P.L.C., 325 F. Supp. 3d 466, 475–76 (S.D.N.Y. 2018). In addition to the political question, defendants also use foreign policy as an argument against redressability. *Id.* at 476 ("To litigate such an action for injuries from foreign greenhouse gas emissions in federal court would severely infringe upon the foreign-policy decisions that are squarely within the purview of the political branches of the U.S. Government."), *aff'd sub nom.* City of New York v. Chevron Corp., 993 F.3d 81 (2d Cir. 2021).

[96] Complaint at 1, *Am. Elec. Power Co.*, 406 F. Supp. 2d 265 (S.D.N.Y. 2005) (No. 21-1446).

[97] Complaint for Damages & Demand for Jury Trial at 62, Native Village of Kivalina v. ExxonMobil Corp., 663 F. Supp. 2d 863 (N.D. Cal. 2009) (No. 08-cv-01138).

[98] Class Action Complaint at 13–14, Comer v. Murphy Oil USA, Inc., 839 F. Supp. 2d 849 (S.D. Miss. 2012) (No. 11-cv-220).

could not yet account for emissions from specific sources and that compelled plaintiffs to rely on general linkages between emissions and harms.[99] Defendants' and courts' invocation of the political question doctrine reflects an implied understanding that the plaintiffs' harms could only be remedied by a global reduction in GHGs and that such interventions require public policy that weighs societal benefits against harms.[100]

Alternatively, claims based on fact-specific links between a defendant's specific and quantifiable emissions and activities and a contribution to a plaintiff's injury would reflect the features of a typical private nuisance claim.[101] A private nuisance claim is further removed from a political question defense than a public nuisance claim because it makes a narrower assertion that a defendant has violated a right specific to a plaintiff rather than a right general to the public.[102] This narrowed framing is enabled by the tools of climate attribution. Developments in attribution science allow plaintiffs to present a plausible causal chain from GHG emissions to specific climate change impacts.[103] These

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[99] *American Electric* was filed in 2004, *Kivalina* in 2008, and *Comer* in 2011. *See supra* notes 96–98. The first attribution science study is generally considered to be the 2004 *Nature* paper "Human Contribution to the European Heat Wave of 2003," and the field of study and methodologies have evolved considerably since then. Stott et al., *supra* note 50, at 610–14. For example, 2011 was the first year that the American Meteorological Society included attribution science in its annual climate change report. Jane C. Hu, *The Decade of Attribution Science*, SLATE (Dec. 19, 2019), https://slate.com/technology/2019/12/attribution-science-field-explosion-2010s-climate-change.html [https://perma.cc/RXU8-KYWL].

[100] In *City of Oakland*, Judge Alsup discussed some of these costs and benefits in general terms. With respect to balancing the social utility against the gravity of the anticipated harm, it is true that carbon dioxide released from fossil fuels has caused (and will continue to cause) global warming. But against that negative, we must weigh this positive: our industrial revolution and the development of our modern world has literally been fueled by oil and coal. Without those fuels, virtually all of our monumental progress would have been impossible. All of us have benefitted. Having reaped the benefit of that historic progress, would it really be fair to now ignore our own responsibility in the use of fossil fuels and place the blame for global warming on those who supplied what we demanded? Is it really fair, in light of those benefits, to say that the sale of fossil fuels was unreasonable? *See* City of Oakland v. BP P.L.C., 325 F. Supp. 3d 1017, 1023–24 (N.D. Cal. 2018), *vacated and remanded*, 960 F.3d 570 (9th Cir. 2020). Notably, Judge Alsup's reasoning does not acknowledge the existence of non-fossil fuel sources of energy and inaccurately implies that Plaintiffs' claims extend back to the industrial revolution. *See id.*

[101] *See* RESTATEMENT (SECOND) OF TORTS § 822 (AM. L. INST. 1979) (stating the elements of a private nuisance claim).

[102] *See id.* cmt. c. Furthermore, the most recent wave of lawsuits hinges on defendants' deceptive conduct towards consumers, investors, and the public. *See* Sokol, *supra* note 43, at 1434–35 (describing the recent proliferation of claims arguing deceitful conduct). Plaintiffs have made clear that they are not seeking to regulate CO_2. Their claims concern harms resulting from defendants' deceptive practices, removing such claims further still from political question objections.

[103] *See, e.g.*, Fraser C. Lott et al., *Quantifying the Contribution of an Individual to Making Extreme Weather Events More Likely*, ENV'T RSCH. LETTERS, Oct. 12, 2021, at 1, 2 ("[I]n this paper we examine the data and calculations required for dividing up responsibility for (and associated cost of) an example event amongst individuals according to their personal emissions.").

methods enable plaintiffs to frame their injuries in specific terms, connecting harms to emissions sources.

For example, a 2017 study modeled the contributions of individual countries' historic emissions to specific extreme weather events.[104] The study examined the contributions of individual countries' emissions to a 2013–2014 heat wave in Argentina that witnessed the highest temperatures on record for some parts of the country.[105] Earlier research had established that the heat wave was made five times more likely by anthropogenic GHG emissions; however, the 2017 study further simulated the actual conditions observed and compared them to counterfactual conditions in the absence of anthropogenic GHGs.[106] Through this comparison, and by removing individual countries' GHG contributions from the present-day simulation, the authors estimated the change in heatwave frequency attributable to GHG emissions by individual countries. They further analyzed how individual countries' emissions would have increased the likelihood of a heatwave of this intensity relative to its likelihood in a natural climate without human influence.[107]

These modeling methods, which have been used to assess the emissions of individual corporations, have considerable implications for the attribution of damages not only to individual countries but also to other large-scale emitters. The impacts of specific sources are all the more observable where emissions are concentrated, as in the case of power plants or fossil fuel companies. Where defendants and courts argue that a plaintiff's claims constitute a request for judicial policymaking, this type of evidence can support alternative arguments.

B. Standing

In addition to establishing justiciability, plaintiffs must establish standing as a preliminary matter before proceeding with a substantive claim.[108] This Section considers the contribution of climate attribution methods to establishing standing under both state and federal requirements.[109]

For federal claims, Article III standing under the U.S. Constitution requires 1) an "injury in fact" that is "concrete and particularized" and "actual or imminent," 2) a causal connection between the injury and defendant's conduct,

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[104] Otto et al., *supra* note 63, at 757.

[105] *Id.* at 757–58 & fig.1.

[106] *Id.*

[107] *Id.* at 758.

[108] Chemerinsky, *supra* note 84, at 677.

[109] Since 2017, plaintiffs have filed climate tort claims in eleven state courts: California, Connecticut, Colorado, Delaware, Hawaii, Illinois, Maryland, Minnesota, New Jersey, Rhode Island, South Carolina, Washington. For a full list of jurisdictions, see Appendix B. A review of federal standing is relevant as many state standing requirements refer at least in part to Article III standing requirements. For a summary of state standing requirements, see Wyatt Sassman, *A Survey of Constitutional Standing in State Courts*, 8 KY. J. EQUINE AGRIC. & NAT. RES. L. 349, 353–98 (2015).

and 3) redressability of the injury.[110] The availability of scientific methods linking GHG emissions to climate damages bears on a plaintiff's ability to meet each of these requirements.

In 2007, in *Massachusetts v. EPA*, the Supreme Court issued its first ruling on standing in the context of climate change.[111] The Court acknowledged "special solicitude" given to states, leaving unaddressed the question of whether individuals also have standing to bring climate change claims.[112] Today, state courts adopt different interpretations of the Court's holding and diverge in their determinations of standing for private individual plaintiffs. Some courts have interpreted the standing judgment narrowly, holding that it applies only to states and focusing on the "special solicitude" that the Court granted to Massachusetts.[113] Some interpretations are narrower still. For example, the Department of Justice has proposed that special solicitude applies only in the context of a procedural right, rather than a substantive right.[114]

In the district courts, recent decisions have concluded that private plaintiffs may have Article III standing to challenge government regulation of climate change.[115] Today, nearly all pending climate tort claims feature state, city,

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[110] Lujan v. Defs. of Wildlife, 504 U.S. 555, 560–61 (1992); *id.* at 564 ("Past exposure to illegal conduct does not in itself show a present case or controversy regarding injunctive relief . . . if unaccompanied by any continuing, present adverse effects." (quoting City of Los Angeles v. Lyons, 461 U.S. 95, 102 (1983))). State standing statutes include variations of these elements, with state standing requirements generally more permissive than Article III requirements. *See* Sassman, *supra* note 109, at 353–98 (surveying state standing requirements).

[111] Massachusetts v. EPA, 549 U.S. 497, 520 (2007).

[112] *Id.*

[113] *See, e.g.*, Wash. Env't Council v. Bellon, 732 F.3d 1131, 1145 (9th Cir. 2013) ("In contrast to *Massachusetts v. EPA*, the present case neither implicates a procedural right nor involves a sovereign state. Rather, Plaintiffs are private organizations, and therefore cannot avail themselves of the 'special solicitude' extended to Massachusetts by the Supreme Court." (citing Amnesty Int'l USA v. Clapper, 667 F.3d 163, 197 n.2 (2d Cir. 2011) (Livingston, J., dissenting from denial of rehearing en banc))). For discussion of the distinction between standing for states versus private plaintiffs, see generally Bradford C. Mank, *Article III Standing for Private Plaintiffs Challenging Greenhouse Gas Regulations*, 53 SAN DIEGO L. REV. 287 (2016), and Bradford Mank, *Standing for Private Parties in Global Warming Cases: Traceable Standing Causation Does Not Require Proximate Causation*, 2012 MICH. ST. L. REV. 869.

[114] *See* Brief for the Petitioners at 29–31, United States v. Texas, 136 S. Ct. 2271 (2016) (No. 15-674); Reply in Support of Emergency Motion for Stay Pending Appeal at 1–3, Washington v. Trump, 847 F.3d 1151 (9th Cir. 2017) (No. 17-35105).

[115] *See, e.g.*, Ctr. for Biological Diversity v. EPA, 90 F. Supp. 3d 1177, 1190 (W.D. Wash. 2015) ("CBD's members' injuries are traceable to EPA's conduct and redressable by a favorable ruling to the extent that coastal waters improperly not identified as acidified-impaired are influenced by sources that can be mitigated by local actions."); Murray Energy Corp. v. McCarthy, No. 5:14-CV-39, 2016 WL 6083946, at *10 (N.D. W. Va. Oct. 17, 2016) ("[T]his Court finds that the plaintiffs have established standing to proceed with this action and will not alter its prior decision finding standing. In so doing, this Court is aware that '[w]hen the plaintiff is not himself the object of the government action or inaction he challenges, standing is not precluded, but it is ordinarily substantially more difficult to establish.'" (quoting Summers v. Earth Island Inst., 555 U.S. 488, 493–94 (2009))), *vacated and remanded sub nom.* Murray Energy Corp. v. Adm'r of the EPA, 861 F.3d 529 (4th Cir. 2017).

or municipal plaintiffs and do not directly implicate the question of disparate treatment between private plaintiffs and states when making determinations about standing. Nonetheless, other standing obstacles have prevented cases from proceeding to the merits stage.

1. Injury in Fact

In order to satisfy the injury in fact requirement of standing, a plaintiff must establish that the injury was both particularized and concrete.[116] An injury is particularized where the plaintiff is "affected in a 'personal and individual way.'"[117] The particularity requirement presents a significant challenge for climate tort cases; however, in *Massachusetts v. EPA*, the Supreme Court briefly explained that the "widely-shared" nature of the risks of climate change did not necessarily diminish the state's interest in preventing or redressing particularized injuries.[118] In 2018, in *Juliana v. United States*, the U.S. District Court for the District of Oregon expanded on the standing element in the context of private plaintiffs, as opposed to state plaintiffs.[119] The court held that, to meet the injury in fact requirement, a private plaintiff may allege that a defendant's activity "impairs his or her economic interests or aesthetic and environmental well-being."[120]

The court reiterated that a plaintiff's injuries—including harms resulting from the impacts of fossil-fuel-induced global warming—were not a "generalized grievance" just because these harms were widely shared, so long as a party could demonstrate injury in a concrete and personalized way.[121] The court further elaborated that, even if the experience of harm alleged in the complaint were "shared by virtually every American," a standing inquiry only concerns whether that experience caused the plaintiff a "concrete and particular" injury.[122] Although the Ninth Circuit agreed with the lower court's determination that an injury requirement had been met and that "[a]t least some plaintiffs" had claimed "particularized injuries," it dismissed the case on redressability grounds.[123]

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[116] *Massachusetts v. EPA*, 549 U.S. at 517 ("[A] litigant must demonstrate that it has suffered a concrete and particularized injury that is either actual or imminent . . . .").

[117] *Id*. at 540 (Roberts, C.J., dissenting) (quoting Lujan v. Defs. of Wildlife, 504 U.S. 555, 560 n.1 (1992)).

[118] *Id.* at 522 (majority opinion).

[119] Juliana v. United States, 339 F. Supp. 3d 1062, 1087 (D. Or. 2018), *rev'd*, 947 F.3d 1159 (9th Cir. 2020).

[120] *Id.* (quoting Wash. Env't Council v. Bellon, 732 F.3d 1131, 1140 (9th Cir. 2013)).

[121] *Id.* at 1088–89.

[122] *Id.* at 1089 (quoting Juliana v. United States, 217 F. Supp. 3d 1224, 1243–44 (D. Or. 2016), *rev'd*, 947 F.3d 1159).

[123] *Juliana*, 947 F.3d at 1168 ("The district court correctly found the injury requirement met. At least some plaintiffs claim concrete and particularized injuries.").

Another requirement for establishing injury in fact is that it must be concrete and not merely speculative.[124] Claims for equitable relief, such as those seeking injunctions against defendants' emissions, for example, raise an additional question concerning whether a future injury is "likely" or merely "speculative."[125] The Supreme Court's decision in 1992, in *Lujan v. Defenders of Wildlife*, remains influential in environmental standing jurisprudence and has been cited in key climate cases. Though the case did not pertain to climate change damages, the Court's injury in fact analysis distinguished between concrete injuries and those that are conjectural or hypothetical.[126]

Nonetheless, in a subsequent Clean Water Act (CWA) case, *Friends of the Earth v. Laidlaw Environmental Services, Inc.*, the Supreme Court narrowed the scope of "speculative" future activities by distinguishing "conditional statements" concerning the plaintiffs' enjoyment of a river free of defendants' pollution from the "speculative" intentions of the *Lujan* plaintiffs "to visit endangered species halfway around the world."[127] The distinction between speculation and likelihood or conditionality appears to hinge on a judgment about the probability of a plaintiff engaging in a particular activity that has allegedly been harmed by the defendant's interference.

Fulfilling the requirements of standing in a climate tort case thus turns on a plaintiff's ability to frame past injuries in specific and particularized terms and to establish the probability or likelihood of imminent injury (in cases seeking forward-looking remedies). Attribution methods support this requirement. Existing attribution science methods can link human contributions to atmospheric GHGs to specific climate impacts, including sea level rise, drought, and precipitation.[128] For example, a 2017 study advanced methodologies for tracing emissions from industrial carbon producers to specific climate impacts.[129] The study modeled the contributions of ninety major industrial carbon produc-

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[124] Lujan v. Defs. of Wildlife, 504 U.S. 555, 561 (1992).

[125] *Id.* (quoting Simon v. E. Ky. Welfare Rts. Org., 426 U.S. 26, 41–42 (1976)).

[126] *Id.* The Court dismissed the plaintiffs' claims as speculative where they alleged that government funding of development projects in Egypt and Sri Lanka could harm endangered species in those areas, preventing plaintiffs from future enjoyment obtained by visiting these areas and viewing those endangered animals. *Id.* at 578.

[127] Friends of the Earth, Inc. v. Laidlaw Env't Servs. (TOC), Inc., 528 U.S. 167, 184 (2000) (citing *Lujan*, 504 U.S. at 564).

[128] *See, e.g.*, Felicia Chiang, Omid Mazdiyasni & Amir AghaKouchak, *Evidence of Anthropogenic Impacts on Global Drought Frequency, Duration, and Intensity*, NATURE COMMC'NS, May 12, 2021, at 1, 1 (linking greenhouse gas emissions to global droughts); E.M. Fischer & R. Knutti, *Anthropogenic Contribution to Global Occurrence of Heavy-Precipitation and High-Temperature Extremes*, 5 NATURE CLIMATE CHANGE 560, 560 (2015) (linking human contributions of GHGs to increases in precipitation worldwide); Xuebin Zhang et al., *Detection of Human Influence on Twentieth-Century Precipitation Trends*, 448 NATURE 461, 461 (2007) (linking human contributions of GHGs to changes in precipitation trends).

[129] Ekwurzel et al., *supra* note 12, at 580–81.

ers to the rise in global atmospheric CO_2, surface temperature, and sea level.[130] For the period from 1880 to 2010, emissions traced to these producers contributed approximately 57% of the observed rise in atmospheric CO_2, 42 to 50% of the rise in global mean surface temperature (GMST), and 26 to 32% of global sea level rise (GSL).[131] For the shorter period between 1980 and 2010, contributions were 43% of atmospheric CO_2, 29 to 35% of the rise in GMST, and 11 to 14% of GSL.[132] Other studies have similarly modelled the contributions of major carbon producers to ocean acidification,[133] and the responsibility of major emitters for country-level warming and extreme hot years.[134] These models support the framing of injuries in particularized terms linking a defendant's proportional contributions to specific impacts.

2. Causal Connection

For toxic torts and environmental claims, courts have treated the causation prong of standing with considerable variation. Although some courts analyze causation as part of the standing inquiry, others presume causation to be part of a claim.[135] Still others distinguish two stages of a causation analysis: first, the general causation determined at the standing stage, and second, specific causation on the merits.[136] This variation has major implications in climate tort claims for the level and type of scientific evidence required to overcome a standing determination.

Establishing general causation as part of a standing determination for climate damages does not present a major challenge as a matter of existing science. Plaintiffs merely have to establish that harms of the type that caused their injuries can generally be attributed to GHG emissions without having to establish a direct causal link to defendants' specific emissions until a later stage of

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[130] *Id.* at 584.

[131] *Id.* at 583.

[132] *Id.*

[133] Licker et al., *supra* note 64, at 7 fig.3.

[134] Lea Beusch et al., *Responsibility of Major Emitters for Country-Level Warming and Extreme Hot Years*, COMMC'NS EARTH & ENV'T, Jan. 6, 2022, at 1, 4 & figs.2, 3.

[135] *See, e.g.*, Steel Co. v. Citizens for a Better Env't, 523 U.S. 83, 88–89 (1998) (noting that the standing inquiry comes before any merits inquiries and analyzing causation as a component of Article III standing); Norris v. Baxter Healthcare Corp., 397 F.3d 878, 885–88 (10th Cir. 2005) (affirming summary judgment for defendants based on insufficient evidence of causation). *See generally* Note, *Causation in Environmental Law: Lessons from Toxic Torts*, 128 HARV. L. REV. 2256 (2015) (discussing courts' differing treatment of causation analysis in environmental and toxic torts cases).

[136] *See, e.g.*, Heller v. Shaw Indus., Inc., No. Civ. A. 95-7657, 1997 WL 535163, at *6 (E.D. Pa. Aug. 18, 1997) ("General causation addresses whether products of the same nature as [the] defendant's product are capable of causing the type of injuries alleged . . . [while] specific causation addresses whether [the] defendant's product more likely than not caused injuries in this particular case.").

adjudication on the merits.[137] The relationship between anthropogenic GHG emissions, changes in global temperatures, and associated impacts is now well settled, and reports from the IPCC provide a scientific reference that has been reviewed and approved by international consensus.[138]

The use of scientific evidence becomes more complicated where courts consider specific causation as part of a standing determination or on the merits. Establishing specific causation requires a but-for causal link between a specific defendant's (or set of defendants') emissions or conduct more generally,[139] and specific harms alleged by the plaintiff. The forthcoming discussion of causation in Section D elaborates further on the possible role for attribution science in addressing this obstacle.[140]

3. Redressability

The redressability prong of standing concerns the possibility of a plaintiff obtaining relief as a result of court intervention.[141] Similar to the particularity prong of injury in fact, challenges to the redressability of climate tort claims arise out of the understanding that the problem of climate change is so diffuse and so pervasive that even a judgment against defendants would not abate a plaintiff's harms. The reasoning goes that, even if emissions from a particular defendant-source were eliminated, the scale of global emissions and the diffuse nature of global GHG emissions would remain an enduring source of plaintiffs' injury. The defendant in *Juliana v. United States* adopted this reasoning and argued that even if the court found in plaintiffs' favor, its remedy would not redress plaintiffs' harms "because fossil fuel emissions from other entities would still contribute to continuing global warming."[142] The Oregon District Court was not sympathetic to this reasoning, relying instead on a prior holding from the Ninth Circuit that "the mere existence of multiple causes of an injury does not defeat redressability."[143] The district court found that the plaintiffs

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[137] *See, e.g.*, Juliana v. United States, 947 F.3d 1159, 1169 (9th Cir. 2020) ("The causal chain here is sufficiently established. The plaintiffs' alleged injuries are caused by carbon emissions from fossil fuel production, extraction, and transportation.").

[138] *See, e.g.*, RAJENDRA K. PACHAURI, IPCC, CLIMATE CHANGE 2014: SYNTHESIS REPORT 40 (Rajendra K. Pachauri et al. eds., 2015), https://www.ipcc.ch/report/ar5/syr/ [https://perma.cc/Y7RP-6X5H] ("Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.").

[139] Such as deceptive conduct leading to increased fossil fuel consumption.

[140] *See infra* notes 168–182 and accompanying text.

[141] Lujan v. Defs. of Wildlife, 504 U.S. 555, 560–61 (1992).

[142] Juliana v. United States, 339 F. Supp. 3d 1062, 1094 (D. Or. 2018), *rev'd*, 947 F.3d 1159 (9th Cir. 2020).

[143] *Id.* (quoting WildEarth Guardians v. U.S. Dep't of Agric., 795 F.3d 1148, 1157 (9th Cir. 2015).

offered sufficient evidence that the alleged injuries could be redressed through a change in the defendants' actions.[144]

Such reasoning, as advanced by the defendant in *Juliana*, only holds for a specific type of threshold injury. If there is a threshold above which injury occurs and below which injury does not, and if injury still would have occurred in the absence of defendant's emissions, then the statement that a court's order cannot redress the injury is true. But if, as is often the case, the more emissions there are, the worse the harm, then the conclusion no longer holds. Because all emissions contribute partially to losses, injury may well have been reduced in the absence of the defendant's emissions. In *Massachusetts v. EPA*, the Supreme Court acknowledged this nuance and held that the plaintiff's "risk would be reduced *to some extent* if petitioners received the relief they seek."[145] Moreover, one U.S. district court recently emphasized the crucial difference between a plaintiff seeking redress for the "incremental impacts" of the defendant's alleged practices on increased petroleum product production, as opposed to "cumulative" impacts of the petroleum industry as a whole.[146]

As a scientific matter, plaintiffs may overcome these objections to redressability under specific conditions. A defendant class could be assembled to account for a portion of GHG emissions that result in a threshold, in whose absence the alleged climate impact might have been prevented altogether. Industrial GHG emissions are indeed highly concentrated, with nearly two-thirds of total emissions traceable to just ninety major producers.[147] This concentration among emitters supports the possibility of assembling defendant classes that, collectively, reach thresholds of climate impact.[148]

C. Duty, Foreseeability, and Breach

A tort law claim requires establishing that defendants owed plaintiffs a duty of care and that they breached this duty. The kind of claim will determine the duty of care standard. For negligence claims, defendants have a duty to act reasonably.[149] For nuisance claims, defendants have an obligation not to inter-

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[144] *Id.* at 1095.

[145] Massachusetts v. EPA, 549 U.S. 497, 526 (2007) (emphasis added).

[146] Delaware v. BP Am. Inc., 578 F. Supp. 3d 618, 635–36 (D. Del. 2022) ("Plaintiff's claims are not based on the 'impacts caused by the *cumulative production* of petroleum products,' as contended by Defendants, but are, instead, premised on the 'incremental impacts' caused by Defendants' purported disinformation and the resulting increased production and consumption of petroleum product."), *aff'd sub nom.* City of Hoboken v. Chevron Corp., 45 F.4th 699 (3rd Cir. 2022).

[147] Ekwurzel et al., *supra* note 12, at 585. The study found that "[e]missions traced to seven investor-owned and seven majority state-owned carbon producers were consistently among the top twenty largest individual company contributors" to the global climate impacts examined. *Id.* at 579.

[148] Appendix F identifies five repeat defendants and Appendix G includes their contributions to global emissions and revenue.

[149] RESTATEMENT (THIRD) OF TORTS: PHYSICAL & EMOTIONAL HARM § 7 (AM. L. INST. 2010).

fere unreasonably or knowingly with the use and enjoyment of plaintiffs' property.[150] For public nuisance claims, defendants must not contribute unreasonably or knowingly to an interference with the public's resources.[151] The core duty question pertaining to climate torts claims concerns whether and when defendants acquired a duty to plaintiffs to prevent the harmful effects of GHG emissions. A breach of duty requires analyzing the reasonableness of a defendant's conduct and the foreseeability of resulting harms.[152] GHG emissions predating knowledge about the harms of climate change would thus merit different legal treatment from those that postdate foreseeability. In the United States, pending tort claims cite research detailing fossil fuel industry defendants' historical knowledge of the cause-and-effect relationship between GHG emissions produced by use of their products, global climate change, and resulting impacts and damages.[153]

Recent cases articulate the foreseeability of harms for defendants acting in the past. For example, in *Anne Arundel County v. British Petroleum*, the plaintiffs alleged that the defendants' activities caused "an enormous, foreseeable, and avoidable increase in global greenhouse gas pollution."[154] Similarly, in *City of Charleston v. Brabham Oil Co.*, the plaintiff alleged that foreseeability flows to the defendants from the internal informational transfer of the climate effects resulting from the normal use and operation of their fossil fuel products.[155]

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[150] RESTATEMENT (SECOND) OF TORTS § 822(a)–(b) (AM. L. INST. 1979).

[151] *Id.* § 821B(1) ("A public nuisance is an unreasonable interference with a right common to the general public.").

[152] Scott v. Dyno Nobel, Inc., 967 F.3d 741, 744 (8th Cir. 2020) (per curiam) ("Whether a duty of care exists is a question of law; whether a defendant owed a duty to a particular plaintiff depends in part on whether the risk in question was foreseeable." (citing Lopez v. Three Rivers Elec. Coop., Inc., 26 S.W.3d 151, 156 (Mo. 2000) (en banc)).

[153] *See, e.g.*, Complaint at 51, Anne Arundel County v. BP P.L.C., No. 21-cv-000565 (Md. Cir. Ct. Apr. 26, 2021) [hereinafter Anne Arundel Complaint] (citing Benjamin Franta, *Early Oil Industry Knowledge of CO_2 and Global Warming*, 8 NATURE CLIMATE CHANGE 1024, 1024–25 (2018)); Complaint at 57, City of Charleston v. Brabham Oil Co., No. 20-CP-10-3975 (S.C. Ct. Com. Pl. Oct. 9, 2020) [hereinafter Charleston Complaint]; First Amended Complaint at 35, City & County of Honolulu v. Sunoco LP, No. 1CCV-20-0000380 (Haw. Cir. Ct. Mar. 22, 2021) ("Defendants Went to Great Lengths to Understand, and Either Knew or Should Have Known About the Dangers Associated with Their Fossil Fuel Products.").

[154] Anne Arundel Complaint, *supra* note 153, at 1; Complaint at 6, City of Annapolis v. BP P.L.C., No. 1:21-cv-00772 (Md. Cir. Ct. Feb. 22, 2021).

[155] Summons at 127, 138, City of Charleston v. Brabham Oil Co., No. 20-CP-10-3975 (S.C. Ct. Com. Pl. Sept. 9, 2020). The plaintiffs asserted that foreseeability is "based on information passed to [the defendants] from their internal research divisions and affiliates, trade associations and industry groups, and/or from the international scientific community" concerning climate effects. *Id.* at 129. This foreseeability includes "the likelihood and likely severity of global warming, global and local sea level rise, more frequent and extreme drought, more frequent and extreme precipitation events, increased frequency and severity of heat waves and extreme temperatures" as well as the consequences of these changes. *Id.* at 130.

Although climate change as a scientific matter presents unique and complicated challenges for tort litigants, it also presents some features that are helpful for litigants. The science of climate change is subject to an unprecedented level of global collaboration, review, and authorization, making it easier to identify a point of international consensus and therefore foreseeability. The United Nations established the IPCC in 1988 to assess the science of climate change.[156] The IPCC published its first assessment report in 1990, marking the culmination of an international recognition of the harmful effects of anthropogenic GHGs.[157] The report served as the basis of the 1992 United Nations Framework Convention on Climate Change (UNFCC), or the "Earth Summit," which was the first treaty addressing human interference in the climate system. The IPCC has published five Assessment Reports since its founding, summarizing knowledge about the causes, potential impacts, and responses to climate change, providing a uniquely valuable scientific reference for the foreseeability of climate change impacts and harms. These are considered the most comprehensive and consensual scientific accounts of the state of "scientific, technical and socio-economic knowledge on climate change, its impacts and future risks."[158]

The IPCC Assessment Reports provide a useful reference for establishing foreseeability. Litigants in *Connecticut v. Exxon Mobil Corp.*, *Rhode Island v. Chevron Corp.*, and *County of San Mateo v. Chevron Corp.*, for example, cite to and reference the IPCC reports.[159] If courts recognize the IPCC's First Assessment Report as the consensus of an international recognition of the harmful effects of anthropogenic GHGs, then this could reasonably mark the start of a general legal duty to protect against the harms of GHGs.[160] From this per-

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[156] *About the IPCC*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, https://www.ipcc.ch/about/ [https://perma.cc/43H2-FYPM].

[157] *History of the IPCC*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, https://www.ipcc.ch/about/history/ [https://perma.cc/VQE7-U3GJ].

[158] *The Intergovernmental Panel on Climate Change*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, https://www.ipcc.ch/ [https://perma.cc/ZTF4-D7XA]. There are some notable limitations of the IPCC reports worth mentioning: summaries are political consensus documents and not purely scientific; they are not entirely comprehensive and exclude developments from cutting-edge science; and they allow input from non-scientific and conflicted parties including fossil fuel producers. *See, e.g.*, Justin Rowlatt & Tom Gerken, *COP26: Document Leak Reveals Nations Lobbying to Change Key Climate Report*, BBC (Oct. 21, 2021), https://www.bbc.com/news/science-environment-58982445 [https://perma.cc/G9ED-EV9Y] (discussing the political pressures exerted on the IPCC by groups seeking less stringent emission-reduction recommendations).

[159] Complaint at 18–19, 34, Connecticut v. Exxon Mobil Corp., No. 3:20-CV-1555 (Conn. Super. Ct. Sept. 14, 2020) [hereinafter Connecticut Complaint]; Rhode Island Complaint, *supra* note 1, at 2, 28–30, 33–35, 38, 42, 45, 72, 84; Complaint at 2 n.4, 24–25, 27–29, 32, 48–49, 59, County of Marin v. Chevron Corp., No. 17-04935 (Cal. Super. Ct. July 17, 2017) [hereinafter San Mateo Complaint].

[160] Although this data establishes a generalized legal duty, internal company documents indicating the foreseeability of harm to specific defendants could shift the date of the emergence of a duty as far back as the 1970s, or even earlier. *See, e.g.*, Christophe Bonneuil, Pierre-Louis Choquet & Benja-

spective, emissions predating and postdating June 1992 would have different legal significance.

This distinction between emissions predating and postdating emitters' duty can be accounted for using existing modeling methods. Attribution models can disaggregate a source's emissions based on the period of emission and simulate the contribution of those emissions for which a duty attaches apart from those for which no duty attaches. For example, one study differentiated between the impact of GHGs emitted during a 130-year period between 1880 and 2010 from emissions in a shorter thirty-year period between 1980 and 2010, representing "the period of growing awareness in the scientific, fossil energy industry, and policy communities of climate change risks associated with anthropogenic carbon emissions."[161] It found that total emissions since 1880 traced to ninety carbon producers, accounted for 26–32% of GSL rise and 42–50% rise in GMST.[162] For a shorter thirty-year period, from 1980 to 2010, it found that emissions from the same sources accounted for 11–14% of GSL rise and 29–35% of GMST rise.[163] Similar methodologies could discriminate between emissions for which a duty attaches and those for which it does not. Because emissions predating duty and those postdating it have distinct legal significance, attribution approaches could be applied to assess the contribution to emissions produced after the onset of legal duties.[164]

Although discussion thus far has focused on the foreseeability of present harms by defendants acting in the past, foreseeability is also relevant to the present foreseeability of future harms that were previously considered unpredictable. As attribution models become more sophisticated, linking attribution to climate impacts and not just to climate change, this informs the foreseeability of future harms. For example, attribution studies can simulate the future frequency and intensity of droughts and flash floods.[165] It is conceivable that

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min Franta, *Early Warnings and Emerging Accountability: Total's Responses to Global Warming, 1971–2021*, GLOB. ENV'T CHANGE, Nov. 2021, at 1, 1 (discussing how large fossil fuel producers learned of climate change and mobilized against regulatory reforms to address the climate crisis).

[161] Ekwurzel et al., *supra* note 12, at 581.

[162] *Id.* at 583.

[163] *Id.* at 579.

[164] When accounting for the effects of emissions, it is relevant that, although some effects take place at the time of emission, others have lagged responses. This obstacle can be overcome using attribution science methods that account for the lagged effects of GHGs and aerosols over time. CO_2 warming equivalencies convert different GHGs into their CO_2 equivalencies to account for the variability in characteristics and atmospheric warming potential of different gases, specifically for the differences between long-lived and short-lived climate pollutants and their differentiated impact on GMST. *See generally* Michelle Cain et al., *Improved Calculation of Warming-Equivalent Emissions for Short-Lived Climate Pollutants*, CLIMATE & ATMOSPHERIC SCI., Sept. 4, 2019, at 1.

[165] *See, e.g.*, Wei Li et al., *Future Changes in the Frequency of Extreme Droughts Over China Based on Two Large Ensemble Simulations*, 34 J. CLIMATE 6023, 6023 (2021) ("The results show that the frequency of extreme droughts increases with the continued global warming . . . . The China-averaged probability of 100-[year] droughts that occur once in a century in the current climate in-

attribution models can project defendants' contributions to the risks of future harms. Claims for equitable relief could be supported by allegations of harm that are not merely speculative, but predictive. In recent cases, plaintiffs are advancing these types of claims. In the *San Mateo* complaint, for example, the plaintiff alleged that the defendants were "directly responsible for 227.6 gigatons of CO_2 emissions between 1965 and 2015, representing 20.3% of total emissions of that potent greenhouse gas during that period."[166] The plaintiffs linked this contribution to sea level rise, as well as to "extreme flooding events [that] will more than double in frequency on California's Pacific coast . . . by 2050."[167] Such claims could be demonstrated using existing attribution science methods.

D. Causation

Causation presents the most significant obstacle to successful climate tort claims.[168] The difficulty in establishing causation stems from the fungibility, or interchangeable quality, of GHG molecules and from the aggregate nature of climate impacts. GHGs diffuse upon emission and "comingle in the atmosphere."[169] Individual molecules do not bear unique markers and cannot be

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crease by a factor of 1.52 (1.44) and 1.90 (2.02) under 1.5°C and 2°C warming levels . . . respectively."); Chiang et al., *supra* note 128, at 1 ("[W]e show that the presence of anthropogenic forcing has increased the drought frequency, maximum drought duration, and maximum drought intensity experienced in large parts of the Americas, Africa, and Asia."); Jonathan Spinoni et al., *Will Drought Events Become More Frequent and Severe in Europe?*, 38 INT'L J. CLIMATOLOGY 1718, 1718 (2018) ("Under the moderate emission scenario (RCP4.5), droughts are projected to become increasingly more frequent and severe in the Mediterranean area, western Europe, and Northern Scandinavia, whereas the whole European continent, with the exception of Iceland, will be affected by more frequent and severe extreme droughts under the most severe emission scenario (RCP8.5), especially after 2070."); Zhi Li et al., *The Conterminous United States Are Projected to Become More Prone to Flash Floods in a High-End Emissions Scenario*, COMMC'NS EARTH & ENV'T, Apr. 6, 2022, at 1, 1 (tracking new "flash flood hot spots" in the United States and advocating for "climate-resilient mitigation measures").

[166] San Mateo Complaint, *supra* note 159, at 3.

[167] *Id.*; *see also* Complaint for Damages and Declaratory Judgment at 3, California v. Gen. Motors Corp., No. C06-05755 (N.D. Cal. Sept. 20, 2006), 2007 WL 2726871 ("California already has begun to expend money and other resources to address the declining snow pack and earlier melting of the snow pack in order to avert future water shortages and flooding . . . . Damages caused by global warming are cognizable, ongoing, and increasing. Defendants are aware of the impacts and have chosen to continue to produce products that generate enormous quantities of carbon dioxide, to the detriment of California."); Complaint at 69, Delaware v. BP Am. Inc., No. CV 20-1429-LPS (Del. Super. Ct. Sept. 10, 2020) ("Without Defendants' exacerbation of global warming caused by their conduct as alleged herein, the current physical and environmental changes caused by global warming would have been far less than those observed to date. Similarly, effects that will occur in the future would also be far less, or would be avoided entirely.").

[168] *See* Posner, *supra* note 11, at 1926 ("Domestic tort litigation involving American plaintiffs and defendants seems questionable because of causation problems . . . .").

[169] Charleston Complaint, *supra* note 153, at 126. An important nuance is that there are also local-only effects on climate from aerosol emissions, but these aren't typically accounted for in approaches for attributing to individual emitters and counteracting some effects of climate change on local scales.

traced to their specific sources, and, even if they did, it would remain the case that any climate change impact is a result of the combined effect of all GHG emissions.[170] The relationship between GHGs and global temperature rise is continuous—this means that every ton of carbon dioxide added to the atmosphere raises GMSTs.

Many effects of climate change also increase continuously with emissions such that every additional ton of emissions increases the harm. For example, epidemiological research has shown that progressively higher temperatures cause greater heat-related mortality.[171] For other physical impacts of climate change, however, emissions will ultimately reach a threshold beyond which specific impacts occur.[172] For example, such a threshold might correspond to the height of coastal flood defenses. Once sea-level rise reaches a certain level, these defenses will no longer prevent high-tide flooding. Exceeding such a threshold is a consequence of cumulative GHG emissions, rather than of any one entity's emissions. In principle, it may be scientifically feasible to identify emissions comprising the proverbial straw that broke the camel's back—those emissions without which the threshold injury would not have occurred.

Courts have adopted different tests for proximate causation in the environmental context. In *Comer v. Murphy Oil USA, Inc.*, the plaintiffs alleged that the defendant's emissions "contributed to the kinds of injuries that they suffered," relying on CWA precedent for this causal connection.[173] The U.S. District Court for the Southern District of Mississippi referred to the Fifth Circuit's opinion in *Friends of the Earth v. Crown Central Petroleum Corp.*, in which plaintiffs alleged that downstream waterflow led to their exposure after defendants released a pollutant into a very large waterway. The Fifth Circuit found this rationale insufficient to show causation.[174] Indeed, in a very large body of water, the effect of a point source pollutant might be sufficiently diluted such that it can no longer be the presumed source of a downstream plaintiff's injuries; as such, the court explained that such conditions require a "more

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[170] *Id.*

[171] Ana M. Vicedo-Cabrera, Francesco Sera & Antonio Gasparrini, *Hands-on Tutorial on a Modeling Framework for Projections of Climate Change Impacts on Health*, 30 EPIDEMIOLOGY 321, 321 (2019).

[172] Noah S. Diffenbaugh & Elizabeth A. Barnes, *Data-Driven Predictions of the Time Remaining Until Critical Global Warming Thresholds Are Reached*, PNAS EARTH ATMOSPHERIC & PLANETARY SCIS., Jan. 30, 2023, at 1, 1 ("While these global temperatures may not represent absolute physical thresholds, they are relevant for a broad range of climate risks, including impacts on human health, economic growth, crop yields, coastal and small island communities, terrestrial and marine ecosystems, and the frequency, intensity, and cost of extreme climate events." (internal citations omitted)).

[173] Comer v. Murphy Oil USA, Inc., 839 F. Supp. 2d 849, 859 (S.D. Miss. 2012) (emphasis omitted), *aff'd*, 718 F.3d 460 (5th Cir. 2013).

[174] *Id.* (citing Friends of the Earth, Inc. v. Crown Cent. Petrol. Corp., 95 F.3d 358, 361 (5th Cir. 1996)).

specific geographic nexus" to satisfy the causation element of standing.[175] In 2009, in an earlier case, *Native Village of Kivalina v. ExxonMobil Corp.*, the U.S. District Court for the Northern District of California adapted the water pollution example to an atmospheric context in which GHGs became well-mixed.[176] The court distinguished global warming claims from water pollution claims, noting that although federal CWA standards establish discharge limits, no similar federal limit exists for GHGs.[177] The court explained that, due to the diffusion of emissions, plaintiffs could not attribute their injuries to any specific defendant's conduct.[178]

Moreover, establishing but-for causation in traditional terms—but-for an individual defendant's emissions plaintiff would not have suffered the alleged harm—is exceedingly difficult in the climate context.[179] For slow-onset processes like sea-level rise and glacial retreat that would not have occurred without climate change, any single defendant will have made only a partial contribution to the overall change. It is at least theoretically possible to envision scenarios where an event is of a magnitude that just exceeds some impact threshold, like a river that bursts its banks but that might not have done so if a rainstorm was only slightly less intense. In this scenario, it could be established that, but-for the defendant's emissions, the observed impact might not have occurred. Such scenarios, although conceivable, are uncommon.

More plausibly, attribution methods can isolate a specific defendant's contribution to a climate event quantified in proportion to its GHG emis-

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[175] *Id.* (quoting *Friends of the Earth*, 95 F.3d at 360–61).

[176] Native Village of Kivalina v. ExxonMobil Corp., 663 F. Supp. 2d 863, 880 (N.D. Cal. 2009) (holding that the village lacked constitutional standing because injuries were not fairly traceable to defendants' emissions). The court noted that "[p]laintiffs essentially concede that the genesis of global warming is attributable to numerous entities which individually and cumulatively over the span of centuries created the effects they are now experiencing." *Id.*

[177] *Id.* at 881 ("[Plaintiffs'] reasoning, . . . suggests that every inhabitant on this Earth is within the zone of discharge, thereby effectively eliminating the issue of geographic proximity in any case involving harms caused by global warming.").

[178] *Id.*; *see also Comer*, 839 F. Supp. 2d at 861 ("The plaintiffs cannot allege that the defendants' particular emissions led to their property damage. At most, the plaintiffs can argue that the types of emissions released by the defendants, when combined with similar emissions released over an extended period of time by innumerable manmade and naturally-occurring sources encompassing the entire planet, may have contributed to global warming, which caused sea temperatures to rise, which in turn caused glaciers and icebergs to melt, which caused sea levels to rise, which may have strengthened Hurricane Katrina, which damaged the plaintiffs' property.").

[179] *See, e.g.*, City of Oakland v. BP P.L.C., No. C 17-06011, 2018 WL 3609055, at *3 (N.D. Cal. July 27, 2018) ("Nonetheless—and although plaintiffs list significant fossil-fuel related activities that defendants have allegedly conducted in California—plaintiffs fail to sufficiently explain how these 'slices' of global-warming-inducing conduct causally relate to the worldwide activities alleged in the amended complaints. And, notably, nowhere do plaintiffs contend that sea level rise would not occur absent defendants' California contacts.").

sions.[180] Climate science has evolved over the past two decades to explain causal linkages between aggregate, and, more recently, source-specific anthropogenic GHG emissions and climate change. Recent attribution studies have further linked anthropogenic GHG emissions and specific climate impacts. The relationship can be characterized as follows:

> GHG emissions → global temperature rise → regional temperature/ circulation changes → specific physical impacts [→ losses]

These same methods can be used to attribute emissions impacts to the individual person. One study quantified the contribution of an individual to increasing the probability or intensity of extreme weather events.[181] The study examined how a portion of the cost of a specific weather event—the 2018 summer heatwave in eastern China—may be attributed to an individual according to age and nationality.[182] Although the average individual's contribution to impacts will be minor, for the carbon majors, or for specific sectors, the contribution from a single source can be demonstrably consequential.

E. Damages

Climate tort plaintiffs commonly seek damages for direct harms resulting from the physical impacts of climate change.[183] A key challenge to claiming damages is the indeterminacy of the marginal damage attributable to a specific defendant's emissions. Such a determination requires distinguishing between damages that would have resulted from non-man-made or non-negligent emissions (preceding the existence of a legal duty of care) and those resulting from negligent emissions, and also attributing damages among defendants. A second key challenge is determining the plaintiff's proper share of damages for phenomena that have global reach.[184]

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[180] A growing body of scholarship attributes and projects changes in climate-related processes and events to individual emitters. *See, e.g.*, Beusch et al., *supra* note 134, at 4; Lott et al., *supra* note 103, at 1; Sophie C. Lewis et al., *Assessing Contributions of Major Emitters' Paris-Era Decisions to Future Temperature Extremes*, 46 GEOPHYSICAL RSCH. LETTERS 3936, 3939–40 (2019).

[181] Lott et al., *supra* note 103, at 1.

[182] *Id.* at 3.

[183] They may also seek damages for present risks of future harm, but this is less common.

[184] Scholars have debated the merits of damages versus equitable relief in climate lawsuits. *See, e.g.*, Kirsten H. Engel, *Damages, Injunctions, and Climate Justice: A Reply to Jonathan Zasloff*, 58 UCLA L. REV. DISCOURSE 189, 196–97 (2011), https://www.uclalawreview.org/damages-injunctions-and-climate-justice-a-reply-to-jonathan-zasloff/ [https://perma.cc/L7NN-JAQF] ("[P]laintiffs confront the problem that scientists cannot say with any degree of certainty that a particular weather or climatic event was caused by the buildup of greenhouse gases resulting from anthropogenic emissions, as opposed to natural variability. The most that scientists can tell us is the likelihood that a given climatic trend, such as an increase in global average temperature or a given amount of sea level rise, is caused by human-generated emissions." (footnote omitted)).

In recent cases, plaintiffs have alleged harms resulting from the physical impacts of climate change, instead of from the general effects of global warming, as their predecessors tended to do. In *Connecticut v. Exxon Mobil Corp.*, the plaintiffs detailed the impacts of climate change rather than the mere fact of climate change, citing increases in public health issues, infrastructure destruction, and economic losses for businesses impacted by extreme weather events.[185] In *Rhode Island v. Chevron Corp.*, plaintiffs referred to substantial sea level rise, more frequent and severe flooding, extreme precipitation events, drought, and a warmer and more acidic ocean.[186] The First Circuit opinion remanding the case to state court further acknowledged these impacts, recognizing that "rising sea levels have already increased erosion and the damage of storm surges along Rhode Island's coast."[187]

Plaintiffs have also emphasized the impact of compensation in redressing present and future harms. The plaintiffs in *City of Hoboken v. Exxon Mobil Corp.* sought "compensation to offset the costs it has and will continue to incur to protect itself from the effects of global warming."[188] In *Pacific Coast Federation of Fishermen's Associations v. Chevron Corp.*, the plaintiffs alleged that marine heatwaves along the West Coast have created aquatic conditions that are toxic to crab fisheries.[189] Although these claims have yet to be considered on the merits,[190] the focus on consequences and impacts of climate events rather than merely on the occurrence of climate change will test how far a chain of causation may be accepted by judges, and, perhaps eventually, by juries as a foreseeable consequence of the negligent act.

Attribution studies increasingly model the impacts of climate change, including economic losses, mortality, and health impacts, rather than merely

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[185] *See* Connecticut Complaint, *supra* note 159, at 35–36 (alleging effects such as "an increase in illness, infectious disease and death"; "serious damage to existing infrastructure, including but not limited to coastal and inland development, roadways, railways, dams, water and sewer systems, and other utilities"; and "detrimental economic impacts on the State of Connecticut, its people, businesses and municipalities, including but not limited to heat-related productivity losses, increased energy cost and consumption, and agriculture, tourism, and recreation losses").

[186] Rhode Island Complaint, *supra* note 1, at 139.

[187] Rhode Island v. Shell Oil Prods. Co., 979 F.3d 50, 54 (1st Cir. 2020), *judgment vacated*, 141 S. Ct. 2666.

[188] City of Hoboken v. Exxon Mobil Corp., 558 F. Supp. 3d 191, 196 (D.N.J. 2021).

[189] *See* Complaint at 4, Pac. Coast Fed'n of Fishermen's Ass'ns v. Chevron Corp., No. 18-cv-571285 (Cal. Super. Ct. Nov. 14, 2018) (noting that climate change impacts have "created the ideal conditions for [toxic algae] to increase in abundance and invade the marine regions that correspond with some of the most productive Dungeness crab fishery grounds").

[190] Defendants have removed the case to federal courts, which have remanded them back to state courts. In *Rhode Island v. Shell Oil Products Co.*, 35 F.4th 44 (1st Cir. 2022), the remand order was appealed by defendants and affirmed by the First Circuit. In *Connecticut v. Exxon Mobil*, No. 20-CV-1555, 2021 WL 2389739 (D. Conn. June 2, 2021), and in *City of Hoboken v. Exxon Mobil*, 558 F. Supp. 3d 191 (D.N.J. 2021), defendants have appealed the remand to the Second and Third Circuit Courts, respectively.

hazards like the strength of a heat wave or the amount of sea level rise.[191] For example, impact attribution studies examine the relationship between climate change, an extreme weather event, and a resulting impact. Models might consider the relationship between climate change and sea level rise, and, in turn, morbidity or economic losses due to flooding. This allows us to determine the extent to which human-induced climate change caused or contributed to a particular health or economic outcome.

One such study used data covering the period 1991 to 2018, from 732 locations in 43 countries, to estimate mortality burdens associated with heat exposure caused by anthropogenic warming.[192] It concluded that 37% of heat-related deaths (dozens to hundreds of deaths per year) were attributable to human-induced warming.[193] Another study evaluated the effect of human-caused climate change on heat-related mortality for the 2003 Paris and London heatwave, and found that it increased the risk of mortality by about 70% in Paris, directly contributing to an estimated 506 deaths.[194] A 2020 study used a probabilistic event attribution framework to estimate the costs associated with Hurricane Harvey in the United States that are attributable to human influence on the climate.[195] It concluded that damages attributable to human influence on climate change accounted for an estimated three-fourths, or $67 billion, of the cumulative $90 billion cost of damage.[196] A similar model looked at the portion of economic damages from Hurricane Sandy attributable to sea level rise resulting from anthropogenic climate change.[197] It found that approximately $8.1 billion of an estimated $60 billion in damages were attributable to sea level rise resulting from anthropogenic climate change.[198] These types of studies and the specificity of impacts alleged provide more concrete and comprehensible pathways connecting emissions to damages.

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[191] *See, e.g.*, Kristie L. Ebi, Nicholas H. Ogden, Jan C. Semenza & Alistair Woodward, *Detecting and Attributing Health Burdens to Climate Change*, 125 ENV'T HEALTH PERSPS. 085004-1, 085004-1 (2017) (modeling the impacts of climate change on health); Daniel Mitchell et al., *Attributing Human Mortality During Extreme Heat Waves to Anthropogenic Climate Change*, ENV'T RSCH. LETTERS, July 8, 2016, at 1, 1 (linking mortality due to heat waves to anthropogenic climate change); Nikolaos Christidis, Dann Mitchell & Peter A. Stott, *Anthropogenic Climate Change and Heat Effects on Health*, 39 INT'L J. CLIMATOLOGY 4751, 4751 (2019) (same); A.M. Vicedo-Cabrera et al., *The Burden of Heat-Related Mortality Attributable to Recent Human-Induced Climate Change*, 11 NATURE CLIMATE CHANGE 492, 495–97 (2021) (same).

[192] Vicedo-Cabrera et al., *supra* note 191, at 492.

[193] *Id.*

[194] Mitchell et al., *supra* note 191, at 1, 7.

[195] Frame et al., *supra* note 17, at 272.

[196] *Id.*

[197] Benjamin H. Strauss et al., *Economic Damages from Hurricane Sandy Attributable to Sea Level Rise Caused by Anthropogenic Climate Change*, NATURE COMMC'NS, May 18, 2021, at 1, 1.

[198] *Id.* at 1–2.

III. OVERCOMING CAUSAL UNCERTAINTY

As elaborated in the preceding Section, the impacts of climate change present novel legal questions for tort claimants. Nonetheless, key elements that make human-induced climate change such a legally complex problem, including the numerosity of defendants, complex causal pathways, and sophisticated scientific methods are precedented in the adjudication of toxic tort claims. Since the 1970s, litigants have claimed damages from pharmaceutical and chemical manufacturers of asbestos, the anti-miscarriage drug diethylstilbestrol (DES), a gasoline additive, tobacco, opioids, lead paint, and a whole host of other industries for health injuries.[199] Plaintiffs in these cases encountered legal challenges due to causal uncertainty and complex disease etiology. Nonetheless, they successfully relied on the methods of epidemiological science to overcome general and proximate causation challenges.[200]

This Part argues that established doctrinal precedent in the toxic tort context[201] offers an instructive analogue for novel climate torts.[202] Toxic tort litigants confronted legal obstacles similar to the ones that climate litigants now face, and courts innovated to overcome these obstacles by adopting new causation standards and embracing novel evidence. Just as courts have accepted the methods of epidemiology to support findings of probabilistic causation in the toxic tort context, they might accept climate attribution evidence to overcome

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[199] *See, e.g.*, Ashby Jones, *Is Climate-Change Litigation the New Asbestos?*, WALL ST. J. (Jan. 27, 2010), https://www.wsj.com/articles/BL-LB-24263 [https://perma.cc/5FFW-N2V3] (behind paywall) (discussing how litigants received damages for asbestos-related harms); Bobby Magill, *Climate Lawsuits Poised to Create 'Tobacco Moment' for Big Oil*, BLOOMBERG L. (Nov. 6, 2021), https://news.bloomberglaw.com/environment-and-energy/climate-lawsuits-poised-to-create-tobacco-moment-for-big-oil [https://perma.cc/SU72-UBSJ] (comparing climate lawsuits to the successful tobacco litigation); Maxine Joselow, *$26B Opioid Settlement May Foreshadow Big Oil Climate Payout*, E&E NEWS: CLIMATEWIRE (Aug. 11, 2021), https://www.eenews.net/articles/26b-opioid-settlement-may-foreshadow-big-oil-climate-payout/ [https://perma.cc/9XSE-UVXX] ("Under the proposed agreement, the three opioid distributors would pay $21 billion over 18 years, while Johnson & Johnson would contribute $5 billion over nine years.").

[200] *See, e.g.*, *In re* Silicone Gel Breast Implants Prod. Liab. Litig., 318 F. Supp. 2d 879, 892 (C.D. Cal. 2004) ("When [epidemiological] studies are available and relevant, and particularly when they are numerous and span a significant period of time, they assume a very important role in determinations of questions of causation." (quoting Richardson v. Richardson-Merrell, Inc., 857 F.2d 823, 830 (D.C. Cir. 1988))); Brock v. Merrell Dow Pharms., Inc., 874 F.2d 307, 311 (5th Cir.) ("Undoubtedly, the most useful and conclusive type of evidence in a case such as this is epidemiological studies."), *modified on reh'g*, 884 F.2d 166 (5th Cir. 1989).

[201] *See generally* Christopher McKeon, *Climate Change and Product Liability*, INS. THOUGHT LEADERSHIP (Sept. 8, 2021), https://www.insurancethoughtleadership.com/resilience-sustainability/climate-change-and-product-liability [https://perma.cc/7N2S-NAQC] (suggesting that product liability lawsuits are a precursor to climate change tort litigation).

[202] *See infra* notes 208–285 and accompanying text; *see, e.g.*, Daniel A. Farber, *How Legal Systems Deal with Issues of Responsibility for Past Harmful Behavior* (exploring the similarities between products liability suits and liability for climate change), *in* CLIMATE JUSTICE AND HISTORICAL EMISSIONS 80, 92 (Lukas H. Meyer & Pranay Sanklecha eds., 2017).

causation challenges in climate torts. This Part evaluates reasoning adopted by courts in assigning joint and several as well as proportional liability for toxic torts, and considers the relevance of this reasoning to the apportionment of damages in the climate tort context.[203]

Section A of this Part builds the analogy between toxic torts and climate torts and advances that toxic tort precedent offers valuable insights for ongoing climate lawsuits.[204] Section B identifies similarities between epidemiological methods advanced by toxic tort claimants to deal with the challenges of establishing a traditional causal relationship between defendant's act and plaintiff's injury, and climate attribution methods that could overcome a comparable challenge for climate torts.[205] Section C focuses on the specific challenge of causal uncertainty[206] and Section D discusses legal remedies from toxic tort precedent, including joint and several liability and market share liability, that can be adopted in the climate context to allocate damages among multiple tortfeasors.[207]

A. Toxic Torts as an Analogue to Climate Torts

Health injuries resulting from toxic exposures and climate harms resulting from GHG emissions share some important characteristics that make toxic tort precedent a compelling analogue. First, the harms of toxic exposure and greenhouse gas emissions typically appear after a time lag of years or even decades, creating a gap between a defendant's action and a plaintiff's injury.[208] For toxic torts, there is a time lag between exposure and injury that may be years or decades long. Asbestos exposure, for example, accumulates over some duration before a party develops mesothelioma—the average latency period is 20 to 40 years.[209] A pregnant woman takes DES during pregnancy but the health consequences for her child do not appear until after she gives birth.[210]

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[203] *See infra* notes 291–299 and accompanying text.

[204] *See infra* notes 208–229 and accompanying text.

[205] *See infra* notes 230–257 and accompanying text.

[206] *See infra* notes 258–285 and accompanying text.

[207] *See infra* notes 286–315 and accompanying text.

[208] *See, e.g.*, ROBIN KUNDIS CRAIG, MICHAEL D. GREEN, ANDREW R. KLEIN & JOSEPH SANDERS, TOXIC AND ENVIRONMENTAL TORTS: CASES AND MATERIALS 230 (2010) ("Asbestos has many of the characteristics of toxic torts that distinguish them from other personal injury litigation . . . [for example,] the diseases from which plaintiffs suffer have long latencies—the time from first exposure until the disease manifests itself . . . .").

[209] *See, e.g.*, Jacek M. Mazurek et al., *Malignant Mesothelioma Mortality—United States, 1999–2015*, 66 MORBIDITY & MORTALITY WKLY. REP. 214, 214 (2017) ("The latency period from first causative exposure to malignant mesothelioma development typically ranges from 20 to 40 years but can be as long as 71 years.").

[210] *See* Linda Titus-Ernstoff et al., *Birth Defects in the Sons and Daughters of Women Who Were Exposed in Utero to Diethylstilbestrol (DES)*, 33 INT'L J. ANDROLOGY 377, 377–78 (2010) (studying the defects in children born to mothers who took DES).

Latency period is a function of the health pathways involved, some of which might be explained by current scientific methods and others not. Similarly, this lag between exposure and injury is a key feature of climate impacts including ocean thermal expansion, melting glaciers, and melting ice sheets, which respond to warming on multiple time scales.[211] This time lag complicates the determination of a causal link between action and outcome and creates a window for potential intervening causes and for synergistic effects between the alleged tortious act and other behaviors.

Second, toxic exposures and greenhouse gas emissions are not binary, but rather additive, meaning that for some diseases or climate effects an increase in exposure reaches a certain threshold beyond which injury occurs.[212] This notion is commonly captured by the expression "the dose makes the poison,"[213] such that aggregate exposures or emissions accumulate until exceeding a threshold that results in injury.[214] In the asbestos context, for example, the threshold results in mesothelioma.[215] For GHG emissions, some increment of emissions contributes to a climate forcing, meaning a change in the Earth's energy balance and surface temperature. This additive effect makes it difficult, and in some cases impossible, to pinpoint the exact source of a plaintiff's injury.[216]

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[211] *See, e.g.*, Katharine L. Ricke & Ken Caldeira, *Maximum Warming Occurs About One Decade After a Carbon Dioxide Emission*, ENV'T RSCH. LETTERS, Dec. 2, 2014, at 1, 1 (finding that "the median time between an emission and maximum warming is 10.1 years"); Nauels et al., *supra* note 61, at 23487 (asserting that "[t]he main contributors to sea-level rise (oceans, glaciers, and ice sheets) respond to climate change on timescales ranging from decades to millennia").

[212] The threshold theory of disease has a long and contested history. Robert Proctor examines the theory's origins and development in depth, observing that polluting companies themselves advanced and developed the theory to avoid liability for part of the exposure. *See generally* ROBERT PROCTOR, CANCER WARS: HOW POLITICS SHAPES WHAT WE KNOW AND DON'T KNOW ABOUT CANCER (1995). For a number of substances, the theory has been discredited and they are found to be harmful even in very low doses.

[213] Bernard D. Goldstein & Mary Sue Henifin, *Reference Guide on Toxicology* ("There are three central tenets of toxicology. First, 'the dose makes the poison'; this implies that all chemical agents are intrinsically hazardous—whether they cause harm is only a question of dose. Even water, if consumed in large quantities, can be toxic." (footnote omitted)), *in* REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 401, 403 (2d ed. 2000); *see also* David L. Eaton, *Scientific Judgment and Toxic Torts—A Primer in Toxicology for Judges and Lawyers*, 12 J.L. & POL'Y 5, 11 (2003) ("Dose is the single most important factor to consider in evaluating whether an alleged exposure caused a specific adverse effect.").

[214] *See, e.g.*, Timothy M. Lenton et al., *Climate Tipping Points—Too Risky to Bet Against*, 575 NATURE 592, 592 (2019) ("[T]hese 'large-scale discontinuities' in the climate system were considered likely only if global warming exceeded 5°C above pre-industrial levels. Information summarized in the two most recent IPCC Special Reports . . . suggests that tipping points could be exceeded even between 1 and 2°C of warming." (footnotes omitted)).

[215] *See generally* E.B. Ilgren & K. Browne, *Asbestos-Related Mesothelioma: Evidence for a Threshold in Animals and Humans*, 13 REGUL. TOXICOLOGY & PHARMACOLOGY 116 (1991).

[216] *Climate Change Indicators: Climate Forcing*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/climate-indicators/climate-change-indicators-climate-forcing [https://perma.cc/P7PQ-7MJK] (Aug. 1, 2022). Although the source of injury is the aggregate exposure, in theory some specific increment

Third, the harms of toxic exposure or GHG emissions due to a defendant's actions are complicated by a natural background rate of occurrence for health or environmental outcomes that are independent of the exposure in question. For example, in DES litigation alleging a causal relationship between exposure and birth defects, the Fifth Circuit recognized that "[b]irth defects are known to be caused by mercury, nicotine, alcohol, radiation, and viruses, among other factors."[217] Similarly, in the climate context, weather events have a natural rate of occurrence, meaning that an event in question might have happened if not for climate change, though perhaps with a lower intensity or probability. This makes it difficult to distinguish the contribution of a specific defendant to a resulting harm from its natural rate of occurrence.[218]

In some rare cases, however, this determination is quite simple, as the background rate may be virtually zero. These are considered signature diseases. For example, mesothelioma has almost no background incidence rate in a population unexposed to asbestos.[219] Signature weather events also exist in the climate context. Extreme weather event attribution is increasingly identifying weather patterns that are outside the feasible range of natural variability, including climate events like the 2022 U.K. heatwave and the 2021 Portland heatwave, which would have been virtually impossible in the absence of human contribution to climate change.[220]

Fourth, disease etiology and climate pathways can be complex, and the state of scientific knowledge might only account for them to a limited degree. Scientific development is generally incremental and self-correcting with new models and experiments leading to more refined understandings of the interactions between various factors. In cancer research, for example, epidemiological studies, clinical trials, and animal testing improve understanding of how cancer cells develop and spread. Research on mesothelioma has developed greater understanding of which asbestos fibers can cause cancer, how they do so, and

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would result in a climate forcing or achieving a threshold effect for some specific types of climate impacts.

[217] Brock v. Merrell Dow Pharms., Inc., 874 F.2d 307, 311 (5th Cir.), *modified on reh'g*, 884 F.2d 166 (5th Cir. 1989).

[218] Although it may be difficult or impossible to ascertain a defendant's individual contribution to the increased likelihood or average intensity of an event, it is feasible to ascertain a specific defendant's contribution to that increased risk through carbon accounting.

[219] *In re* Asbestos Litig., 911 A.2d 1176, 1189 (Del. Super. Ct. 2006).

[220] *Western North American Extreme Heat Virtually Impossible Without Human-Caused Climate Change*, *supra* note 15; *Without Human-Caused Climate Change Temperatures of 40°C in the UK Would Have Been Extremely Unlikely*, WORLD WEATHER ATTRIBUTION (July 28, 2022), https://www.worldweatherattribution.org/without-human-caused-climate-change-temperatures-of-40c-in-the-uk-would-have-been-extremely-unlikely/ [https://perma.cc/R7DS-QFTX].

the levels of exposure that are considered dangerous.[221] Likewise, over the past three decades, developments in climate science have dramatically advanced our understanding of climate change.[222]

Fifth, for any injury there are several possible defendants whose individual contributions to fungible exposures may not be distinguishable from one another, making it difficult or impossible to attribute an exposure or an emission to its point source. In the toxic tort context these range from a few to several thousand. For example, the Big Tobacco settlement included just 45 companies,[223] while asbestos litigation has named more than 11,000 defendants.[224] In the climate context, even if human-induced climate change is substantially or fully to blame for some identified climate impact resulting in harms, the actions of all other GHG emitters worldwide, including the plaintiffs themselves, will have, even to a minimal degree, raised the likelihood of a climate event or increased its intensity.[225]

Sixth, the extent of a plaintiff's injury may be mitigated or exacerbated by a plaintiff's own behaviors and lifestyle.[226] In the toxic tort context, a plaintiff's cancer might have been exacerbated by comorbidities such as obesity or smoking.[227] In the climate context, mortality or infrastructure damage resulting from a weather event may have been exacerbated by poor urban planning and

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[221] *What's New in Malignant Mesothelioma Research?*, AM. CANCER SOC'Y, https://www.cancer.org/cancer/malignant-mesothelioma/about/new-research.html [https://perma.cc/A593-5YT3] (May 28, 2019).

[222] For a review of developments in climate science since the first IPCC assessment report in 1990, see Le Treut et al., *supra* note 49, at 95.

[223] *The Master Settlement Agreement*, NAT'L ASS'N OF ATT'YS GEN., https://www.naag.org/our-work/naag-center-for-tobacco-and-public-health/the-master-settlement-agreement/ [https://perma.cc/G2JH-7VP9].

[224] Mark A. Behrens & Mary Margaret Gay, *Illinois Asbestos Litigation: Common Sense Reforms for the Nation's Leading State for Asbestos Filings*, GAY JONES & KUHN PLLC: MEALEY'S LITIG. REP. (Apr. 28, 2021), https://www.gayjoneslaw.com/il-asbestos-litigation-common-sense-reforms [https://perma.cc/GMJ8-YQ7G].

[225] Notably, some jurisdictions adopt a substantial factor test which recognizes liability for contributions to harm that exceed negligible or theoretical levels. *See, e.g.*, Rutherford v. Owens-Illinois, Inc., 941 P.2d 1203, 1214 (Cal. 1997) ("[A] force which plays only an 'infinitesimal' or 'theoretical' part in bringing about injury, damage, or loss is not a substantial factor." (citing People v. Caldwell, 681 P.2d 274, 280 (Cal. 1984))). Such tests could distinguish a consumer's negligible contribution to the harm from a fossil fuel producer's substantial contribution.

[226] *See, e.g.*, F.D.K. Liddell, *The Interaction of Asbestos and Smoking in Lung Cancer*, 45 ANNALS OCCUPATIONAL HYGIENE 341, 342 (2001) (discussing the interplay between cigarette smoking and asbestos exposure in causing lung cancer).

[227] *See, e.g.*, Sonja Klebe, James Leigh, Douglas W. Henderson & Markku Nurminen, *Asbestos, Smoking and Lung Cancer: An Update*, INT'L J. ENV'T RSCH. & PUB. HEALTH, Jan. 2020, at 1, 1 (finding that smoking cigarettes greatly increases the chances of lung cancer in patients exposed to asbestos).

infrastructure, inadequate forest management in the case of wildfires, or insufficient seawalls in the case of flooding, for example.[228]

Each of these features contributes to the main challenge of causal uncertainty[229] that presents an obstacle to a finding of legal causation. The next Section elaborates on the ways in which epidemiology and climate attribution provide similar scientific tools that can be used to overcome the legal obstacles resulting from these characteristics of toxic tort injuries and climate harms.

B. Epidemiology and Climate Attribution Methods

The significance of scientific evidence and argumentation to the climate tort context may be compared to epidemiological evidence in toxic tort litigation. Both epidemiology and climate attribution adopt statistical methods to create an epistemology of causation that is probabilistic, as contrasted with traditional but-for causation. This Section elaborates on how courts' treatment of epidemiological methods might extend to climate attribution methods, specifically to courts' treatment of probabilistic causation and relative risk, uncertainty and confidence intervals, and contested expertise and evidentiary hearings.

1. Relative Risk

Epidemiology attempts to define the relationship between a disease and its suspected causes.[230] Studies compare the incidence of disease among those exposed to the agent in question and those who are unexposed among a general population. Statistical methods and reasoning are then used to draw an inference between a disease agent and disease etiology. The results of this analysis are presented as a relative risk of harm resulting from exposure to a particular agent, expressed in the form of a relative risk ratio (RR).[231] For epidemiological results, probability p0 represents the risk of disease in an unexposed comparison group, while factual probability p1 is the risk of disease in the group of

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[228] *See* Sophie Marjanac & Lindene Patton, *Extreme Weather Event Attribution Science and Climate Change Litigation: An Essential Step in the Causal Chain?*, 36 J. ENERGY & NAT. RES. L. 265, 271 (2018) (noting that weather events can be "influenced by human activity such as forest management (in the case of wildfires)"). For liability purposes, a plaintiff's activities exacerbating, or failing to mitigate harm are only relevant insofar as the plaintiff had a duty to mitigate, or negligently contributed to the harm.

[229] *See generally* David Rosenberg, *The Causal Connection in Mass Exposure Cases: A "Public Law" Vision of the Tort System*, 97 HARV. L. REV. 849 (1984) (acknowledging the difficulty of proving causation when many defendants have contributed to the creation of a problem).

[230] *What Is Epidemiology?*, CDC, https://www.cdc.gov/careerpaths/k12teacherroadmap/epidemiology.html#:~:text=By%20definition%2C%20epidemiology%20is%20the,state%2C%20country%2C%20global [https://perma.cc/9MJR-K7HR] (June 17, 2016).

[231] *Lesson 3: Measures of Risk*, CDC, https://www.cdc.gov/csels/dsepd/ss1978/lesson3/section5.html [https://perma.cc/NTX3-EZYY] (May 18, 2012).

primary interest, and RR=p1/p0.[232] Courts have embraced the notion of relative risk to overcome causation in the toxic tort context. In 2004, in *In re Silicone Gel Breast Implants*, the U.S. District Court for the Central District of California explained that "if a study found that 10 out of 1000 women with breast implants were diagnosed with breast cancer and 5 out of 1000 women without implants (the 'control' group) were diagnosed with breast cancer, the relative risk of implants is 2.0, or twice as great as the risk of breast cancer without implants."[233]

In the climate attribution context, evidence is similarly presented as a risk ratio, where p0 refers to a scenario in the absence of specific anthropogenic GHGs and p1 refers to a scenario including anthropogenic GHGs.[234] Where RR=p1/p0, a risk ratio of 1.0 means that risk is identical between both groups, RR>1 indicates increased risk for the exposed group, and RR<1 indicates that exposure has an inverse relationship to the harm's occurrence.[235] India and Pakistan's March 2022 heatwave provides an instructive example. Temperatures reached 112 degrees Fahrenheit in what forecasters declared the hottest month in more than a century.[236] In the absence of human-induced climate change, the odds of a heatwave of this magnitude would have been 1 in 3000 years.[237] In the presence of human-induced climate change the odds increased to 1 in 100 years, meaning that the probability of the event occurring increased by a factor of 30 due to human-induced climate change—a relative risk that exceeds the doubling of the risk standard manifold.[238] As Section C will elaborate, relative

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[232] *Id.*

[233] *In re* Silicone Gel Breast Implants Prod. Liab. Litig., 318 F. Supp. 2d 879, 892 (C.D. Cal. 2004).

[234] Gabriele C. Hegerl et al., *Understanding and Attributing Climate Change* ("If P_1 is the probability of a climatic event (such as a heat wave) occurring in the presence of anthropogenic forcing of the climate system, and P_0 is the probability of it occurring if anthropogenic forcing had not been present."), *in* CLIMATE CHANGE 2007, *supra* note 49, at 663, 698.

[235] *See* Philippe Naveau, Alexis Hannart & Aurélien Ribes, *Statistical Methods for Extreme Event Attribution in Climate Science*, 7 ANN. REV. STAT. & ITS APPLICATION 89, 92 (2020) (defining fraction of attributable risk, and risk ratio).

[236] Hari Kumar & Mike Ives, *The Extreme Heat Pummeling India and Pakistan Is About to Get Worse*, N.Y. TIMES (Apr. 28, 2022), https://www.nytimes.com/2022/04/28/world/asia/india-extreme-heat-wave.html [https://perma.cc/7DV7-JTVS].

[237] *Id.*; *Deadly South Asia Heatwave a Once-in-3,000-Year Event Before Climate Change, Experts Say*, S. CHINA MORNING POST (May 24, 2022), https://www.scmp.com/news/asia/south-asia/article/3178877/deadly-south-asia-heatwave-once-3000-year-event-climate-change [https://perma.cc/W67C-YVXU].

[238] *Climate Change Made Devastating Early Heat in India and Pakistan 30 Times More Likely*, WORLD WEATHER ATTRIBUTION (May 23, 2022), https://www.worldweatherattribution.org/climate-change-made-devastating-early-heat-in-india-and-pakistan-30-times-more-likely/ [https://perma.cc/W48M-EH27]; Jude Coleman, *Climate Change Made South Asian Heatwave 30 Times More Likely*, NATURE (May 23, 2022), https://www.nature.com/articles/d41586-022-01444-1 [https://perma.cc/EEY9-RP7T].

risk became the foundation for a new legal causation standard, with "doubling of the risk" representing a "more likely than not" standard.[239]

2. Uncertainty

Scientific results, whether in epidemiology or climate attribution, are subject to uncertainties resulting from a lack of complete information.[240] In epidemiology, uncertainty can arise from "inadequacies in available observational data, measurement methods, sampling regimes and models."[241] Repeated observations in the form of new population groups with different risk exposures can be used to mitigate uncertainty. Techniques have been developed to quantify, characterize, and communicate uncertainty, key among them the use of confidence intervals. In *Brock v. Merrell Dow Pharmaceuticals, Inc.*, the Fifth Circuit provided a primer on the use of confidence intervals to interpret relative risk.[242] The court explained that a confidence interval "attempts to express mathematically the magnitude of possible error" due to sources such as uneven distribution of factors between compared groups, a dependent relationship between other factors and the factor in question, or selective recall among study participants.[243] Many courts consider confidence intervals alongside relative risk to make causation judgments.[244]

Similarly, uncertainty arises from data sampling, event definition, and model selection in the climate attribution context. As the quality of observational data improves, uncertainty is reduced. The instrumental temperature record, which is a record of air and ocean temperatures, is generally more complete for heavily populated areas with a high density of measurements, and

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[239] *See infra* notes 258–285 and accompanying text. It is worth noting that a "more likely than not" standard more accurately corresponds to the statistical p value (1-p) associated with an effect size rather than the effect size itself.

[240] NAT'L RSCH. COUNCIL OF THE NAT'L ACADS., SCIENCE AND DECISIONS: ADVANCING RISK ASSESSMENT 6 (2009) ("Uncertainty can be reduced by the use of more or better data.").

[241] David J. Briggs, Clive E. Sabel & Kayoung Lee, *Uncertainty in Epidemiology and Health Risk and Impact Assessment*, 31 ENV'T GEOCHEMISTRY & HEALTH 189, 189 (2009).

[242] Brock v. Merrell Dow Pharms., Inc., 874 F.2d 307, 312 (5th Cir.), *modified on reh'g*, 884 F.2d 166 (5th Cir. 1989).

[243] *Id.*

[244] *See, e.g.*, Turpin v. Merrell Dow Pharms., Inc., 959 F.2d 1349, 1353 n.1 (6th Cir. 1992) ("To gauge the reliability and credibility of their reports when repeated randomly, statisticians use a device known as the *confidence interval.* The confidence interval is not a 'burden of proof' in the legal sense; rather, it is a common sense mechanism upon which statisticians rely to confirm their findings and to lend persuasive power within their profession."); King v. Burlington N. Santa Fe Ry. Co., 762 N.W.2d 24, 38 (Neb. 2009) ("[R]esearchers often express a study's results through confidence intervals. Confidence intervals show the association's magnitude and how statistically stable the association is." (first citing Michael D. Green, D. Mical Freedman & Leon Gordis, *Reference Guide on Epidemiology*, *in* REFERENCE MANUAL ON SCIENTIFIC EVIDENCE, *supra* note 213, at 333, 360; and then citing KENNETH J. ROTHMAN, MODERN EPIDEMIOLOGY 119 (1986))).

reliable records with nearly global coverage begin around 1850.[245] Nonetheless, contrary to the epidemiological context, where repeated observations can reduce uncertainty, in the climate context, "we do not have repeated samples of the world."[246] Instead, analysis relies on simulated models of the climate system. Repeated observations take the form of simulations of the climate system, with a greater number of simulations reducing uncertainty and improving validation of results. For example, in order to quantify the anthropogenic GHG contribution to flood risk in Wales in the fall of 2000, one study generated thousands of climate model simulations for the studied period "both under realistic conditions, and under conditions as they might have been had these greenhouse gas emissions and the resulting large-scale warming never occurred."[247] In climate attribution, studies similarly present their results while quantifying uncertainty in the form of confidence intervals.[248]

3. Disputed Evidence

Where scientific methods are complex or the methods novel, experts may adopt different techniques or assumptions, and reach different conclusions. The case of *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, offers the paradigmatic example of this pervasive dynamic.[249] *Daubert* concerned allegations that birth defects were caused by pregnant mothers ingesting the drug Bendectin.[250] Expert witnesses brought forth by the plaintiffs and the defendant disputed whether maternal use of Bendectin was a risk factor for birth defects.[251] Defendant's expert, a physician and epidemiologist, concluded upon review of more than thirty published studies that maternal ingestion of Bendectin during the first trimester was not a risk factor for birth defects.[252] Plaintiffs responded with testimony from eight separate experts who found that Bendectin could

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[245] *Why Does the Temperature Record Shown on Your "Vital Signs" Page Begin at 1880?*, NASA: GLOB. CLIMATE CHANGE, https://climate.nasa.gov/faq/21/why-does-the-temperature-record-shown-on-your-vital-signs-page-begin-at-1880/ [https://perma.cc/3ZF5-G3G4] (Mar. 27, 2023).

[246] Christopher J. Paciorek, Dáithí A. Stone & Michael F. Wehner, *Quantifying Statistical Uncertainty in the Attribution of Human Influence on Severe Weather*, 20 WEATHER & CLIMATE EXTREMES 69, 69 (2018).

[247] Pardeep Pall et al., *Anthropogenic Greenhouse Gas Contribution to Flood Risk in England and Wales in Autumn 2000*, 470 NATURE 382, 382 (2011).

[248] *See, e.g.*, Daniel M. Gilford et al., *A Multi-method Framework for Global Real-Time Climate Attribution*, 8 ADVANCES STAT. CLIMATOLOGY METEOROLOGY & OCEANOGRAPHY 135, 140 (2022) ("This allows the attribution framework to provide not only median attribution estimates but also confidence intervals quantifying the robustness of attribution estimates and enabling inter-method statistical comparisons."); Paciorek et al., *supra* note 246, at 70 ("We present several statistical methods for estimating uncertainty via confidence intervals . . . .").

[249] *See generally* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579 (1993) (setting an evidentiary standard for the admission of expert testimony).

[250] *Id.* at 582.

[251] *Id.*

[252] *Id.*

cause birth defects, relying on in vitro and in vivo animal studies, pharmacological analysis of the chemical structure of Bendectin, and a reanalysis of previous studies.[253]

The question of acceptable scientific techniques went to the Supreme Court, resulting in the controlling *Daubert* standard for expert evidence.[254] *Daubert* established trial court judges as gatekeepers of expert opinion testimony: judges determine whether expert scientific testimony is reliable enough to be admitted to a jury by considering factors including whether a method can be and has been tested, whether it has been subject to peer review and publication, whether it is generally accepted among the scientific community, and its known or potential error rate.[255] Climate attribution would likely overcome these criteria. Its methods are widely recognized by the scientific community and by international bodies like the IPCC, and it informs global and domestic policies. Courts also consider peer review, among other criteria, when evaluating acceptance. Attribution studies are published in leading peer-reviewed journals including *Nature*, *Science*, *Geophysical Research Letters, Climatic Change*, and the *International Journal of Climatology*.[256] The similarities between epidemiology and climate attribution, and courts' decades long reliance on epidemiological evidence suggests that, as it has gained acceptance as a method of climate science, climate attribution too will be a key feature in climate tort litigation.[257]

C. Causal Uncertainty and Theories of Liability

In the toxic tort context, courts have adapted traditional "but-for" causation paradigms to determine liability when faced with causal uncertainty. In the late 1980s and early 1990s, reliance on epidemiological evidence to establish causation challenged existing standards and led to judicial innovation.[258] In place of but-for causation, courts developed two alternative probabilistic tests: doubling of the risk (RR>2) and substantial contribution.[259] Some courts adopt these tests to establish general causation as part of a standing determination

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[253] *Id.* at 583.

[254] *Id.* at 582.

[255] *Id.* at 593–94.

[256] *See generally* Piecuch et al., *supra* note 4, at 400–04 (discussing the causes for variation in the severity of sea level rise along the east coast); Lewis et al., *supra* note 180 (estimating the climate impacts of pledged GHG emissions reductions by the United States, the European Union, and China); Ekwurzel et al., *supra* note 12, at 581 (discussing attribution of responsibility for climate change to specific parties); Spinoni et al., *supra* note 165.

[257] Whether courts are the proper venue for refereeing scientific expertise remains highly contested. *See generally* DAVID H. KAYE ET AL., THE NEW WIGMORE: A TREATISE ON EVIDENCE § 12.2 (3d ed. 2021) (discussing court-appointed experts and other potential improvements to expert testimony).

[258] *See, e.g.*, Joshua E. Muscat & Michael S. Huncharek, *Causation and Disease: Biomedical Science in Toxic Tort Litigation*, 31 J. OCCUPATIONAL MED. 997, 997–98 (1989).

[259] *See infra* notes 261–280 and accompanying text.

and to establish specific causation on the merits.[260] Other courts, however, use these tests to establish general causation only and rely on traditional but-for causation to establish specific causation.

1. Doubling of the Risk (RR>2)

Relative risk appears as a key element of courts' determinations of general and specific causation.[261] Throughout the 1980s and 1990s, courts began adopting the RR>2 standard.[262] However, courts treat the RR>2 variably. Some require relative risk of two or greater to support causation, reasoning that RR>2 means a disease was more likely than not caused by the event in question.[263] Other courts accept a relative risk greater than two as supporting an inference of specific causation and not just general causation.[264] Some courts adopt relative risk only for specific causation and accept a lesser standard for general causation. For example, the Ninth Circuit applies a "capable of causing" standard for general causation instead of the doubling of the risk standard that it applied in *Daubert v. Merrell Dow Pharms., Inc.* (*Daubert II*) and *Schudel v. General Electric Co*.[265] In *In re Hanford Nuclear Reservation Litigation*, the Ninth Circuit distinguished *Daubert* and *Schudel* as requiring doubling of the risk for a general or "generic causation" determination because, in

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[260] *See, e.g.*, Neely v. Union Carbide Corp., 619 S.W.3d 839, 844 (Tex. App. 2021); Merrell Dow Pharms., Inc. v. Havner, 953 S.W.2d 706, 715 (Tex. 1997).

[261] *See, e.g.*, *Havner*, 953 S.W.2d at 716 (agreeing with previous courts that "the requirement of a more than 50% probability means that epidemiological evidence must show that the risk of an injury or condition in the exposed population was more than double the risk in the unexposed or control population").

[262] Russellyn S. Carruth & Bernard D. Goldstein, *Relative Risk Greater Than Two in Proof of Causation in Toxic Tort Litigation*, 41 JURIMETRICS J. 195, 197–99 (2001) (analyzing 31 court opinions referring to RR>2 between 1982 and 1999).

[263] *See, e.g.*, DeLuca v. Merrell Dow Pharms., Inc., 911 F.2d 941, 958 (3d Cir. 1990) (stating that "the relative risk of limb reduction defects arising from the epidemiological data . . . will, at a minimum, have to exceed '2'"), *overruled in part by* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579 (1993); Daubert v. Merrell Dow Pharms., Inc. (*Daubert II*), 43 F.3d 1311, 1321 (9th Cir. 1995) (citing *DeLuca*, 911 F.2d at 958); *In re* Breast Implant Litig., 11 F. Supp. 2d 1217, 1226 (D. Colo. 1998) ("The threshold for concluding that an agent was more likely the cause of a disease than not is a relative risk greater than 2.0." (quoting Hall v. Baxter Healthcare Corp., 947 F. Supp. 1387, 1403 (D. Or. 1996))).

[264] King v. Burlington N. Santa Fe Ry. Co., 762 N.W.2d 24, 37 (2009) ("If a study shows a relative risk of 2.0, 'the agent is responsible for an equal number of cases of disease as all other background causes.' This finding 'implies a 50% likelihood that an exposed individual's disease was caused by the agent.' If the relative risk is greater than 2.0, the study shows a greater than 50–percent likelihood that the agent caused the disease. Thus, some courts have permitted a relative risk greater than 2.0 to support an inference of specific causation." (footnotes omitted) (quoting Green et al., *supra* note 244, at 384).

[265] *In re* Hanford Nuclear Rsrv. Litig., 292 F.3d 1124, 1136–37 (9th Cir. 2002) (distinguishing *Daubert II*, 43 F.3d at 1311, 1320 and *Schudel v. General Electric Co.*, 120 F.3d 991, 996 (9th Cir. 1997)).

both cases, there was no preexisting evidence establishing a causal relationship between a chemical and the resulting harm.[266] Other courts have similarly recognized a relative risk below two as supporting general causation and greater than two as supporting specific causation.[267]

For some climate impacts, the doubling of the risk standard can be met. For example, attribution scientists determined that the UK heatwave of 2022 was 10 times more likely due to human contributions to climate change,[268] and another study concluded that the 2022 heatwave in India and Pakistan was made 30 times more likely due to human contributions to climate change.[269] For others, the contribution to risk may be statistically significant but fall below the RR>2 threshold. For example, one study concluded that human contributions to climate change made extensive forest fires in Sweden in 2018 10% more likely[270] and another study found that the 2019–2020 Australian bushfire season was made 30% more likely.[271] Nonetheless, the terms of these findings track the relative risk metrics presented by litigants and adopted by courts in toxic tort contexts.

2. Substantial Contribution

When multiple defendants are responsible for a plaintiff's exposure to a harmful substance, courts require demonstrating that a specific defendant's product was a proximate cause of the plaintiff's injury.[272] A common example is litigation involving a plaintiff's asbestos exposure from multiple sources, with a later contraction of lung cancer or asbestosis. A plaintiff must be able to show that the disease was more likely than not caused by asbestos exposure,

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[266] *Id.* ("[P]laintiffs in *Daubert II* had no scientific evidence that Bendectin was capable of causing birth defects (generic causation), and therefore were required to produce epidemiological studies to prove that Bendectin more likely than not caused their own particularized injuries . . . . Similar considerations motivated the court in *Schudel*.").

[267] *See, e.g.*, *In re* Bextra & Celebrex Mktg. Sales Pracs. & Prod. Liab. Litig., 524 F. Supp. 2d 1166, 1172 (N.D. Cal. 2007) ("In general, epidemiology studies are probative of general causation: a relative risk greater than 1.0 means the product has the capacity to cause the disease . . . . Such studies can also be probative of specific causation, but only if the relative risk is greater than 2.0, that is, the product more than doubles the risk of getting the disease.").

[268] *Without Human-Caused Climate Change Temperatures of 40ºC in the UK Would Have Been Extremely Unlikely*, *supra* note 220.

[269] *Climate Change Made Devastating Early Heat in India and Pakistan 30 Times More Likely*, *supra* note 238.

[270] Folmer Krikken et al., *Attribution of the Role of Climate Change in the Forest Fires in Sweden 2018*, 21 NAT. HAZARDS & EARTH SYS. SCIS. 2169, 2169 (2021).

[271] Geert Jan van Oldenborgh et al., *Attribution of the Australian Bushfire Risk to Anthropogenic Climate Change*, 21 NAT'L HAZARDS & EARTH SYS. SCIS. 941, 941 (2021).

[272] RESTATEMENT (SECOND) OF TORTS § 431 (AM. L. INST. 1965) ("The actor's negligent conduct is a legal cause of harm to another if (a) his conduct is a substantial factor in bringing about the harm, and (b) there is no rule of law relieving the actor from liability because of the manner in which his negligence has resulted in the harm.").

and that the specific defendant's product was a proximate cause of injury.[273] In these types of cases, courts have adopted a "substantial factor" test showing that the defendant's product was a substantial factor in causing the plaintiff's disease. Courts differ in their interpretations of what comprises a substantial factor, with theories such as "every exposure," "any exposure," "and "cumulative exposure" receiving different treatment.[274]

Some courts accept an "every exposure" theory, which alleges that any exposure to asbestos fibers contributes to a cumulative dose and establishes proximate causation.[275] The principle behind this theory is that it is impossible to determine which specific exposure to a carcinogen caused an illness.[276] One court found that a defendant who accounted for less than three percent of a plaintiff's asbestos exposure met the "substantial factor" test.[277] In another case, *Borel v. Fibreboard Paper Products Corp.*, the Fifth Circuit's reasoning was consistent with an "each and every exposure theory."[278] The court observed that the "effect of disease may be cumulative," the defendant's exposure over many years contributes to an overall effect, and "these factors combine to make it impossible, as a practical matter, to determine which exposure or exposures to asbestos dust caused the disease."[279] Other courts supplement the every exposure theory with a "proximity" factor. To support a reasonable inference of substantial causation, courts require a plaintiff to present "evidence of exposure to a specific product on a regular basis over some extended period of time in proximity to where the plaintiff actually worked," rather than merely

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[273] *Cf. id.* cmt. c (stating that factors in tort litigation "in themselves or in combination with one another [were] important in determining whether the actor's conduct [was] a substantial factor").

[274] *See, e.g.*, Spain v. Owens Corning Fiberglass Corp., 710 N.E.2d 528, 535 (Ill. App. Ct. 1999) (using the "every exposure" theory to limit evidence of asbestos exposures to those caused by the defendant), *overruled by* Nolan v. Weil-McLain, 910 N.E.2d 549, 564 (Ill. 2009); *In re* Asbestos Litig., 911 A.2d 1176, 1208–09 (Del. Super. Ct. 2006) ("[T]he question of whether an injury has occurred as a result of a minimal exposure to asbestos as part of an ongoing, cumulative exposure is for the jury to decide . . . .").

[275] *See, e.g.*, *Spain*, 710 N.E.2d at 535 (referring to Illinois's test as a "*de minimis*" test and noting that Illinois courts ban the admission of evidence that the plaintiff was exposed to asbestos from sources other than the defendant); Hoerner v. ANCO Insulations, Inc., 812 So. 2d 45, 56 (La. Ct. App. 2002) (holding that a defendant's source of asbestos could satisfy the substantial factor test even if it was not a proximate cause of the plaintiff's injury).

[276] *See, e.g.*, Shelton v. Old Ben Coal Co., 933 F.2d 504, 508 (7th Cir. 1991) ("On this record, we cannot say, as a matter of law, that the requisite causation could not be established upon an assessment of *all* the evidence."); *Nolan*, 910 N.E.2d at 559–64 (allowing defendants to submit evidence of other potential exposures to asbestos to rebut causation).

[277] *See, e.g.*, Thacker v. UNR Indus., Inc., 603 N.E.2d 449, 457 (Ill. 1992) ("In light of plaintiff's medical evidence which indicated that even slight exposure would adversely affect the decedent's health . . . and in light of the total volume of asbestos at the . . . facility, we cannot say that 3% is insignificant as a matter of law.").

[278] 493 F.2d 1076, 1083 (5th Cir. 1973).

[279] *Id.*

to show that the asbestos-containing product was in the same general location of the workplace as the plaintiff.[280]

Asbestos exposure is similar to GHG exposure in that its effect is cumulative, making the "substantial contribution" and "cumulative exposure" tests potentially applicable. Nonetheless, the additional proximity requirement that some courts impose in the asbestos context would not carry over to climate claims where the proximity of a specific defendant's emissions is considered irrelevant due to the fungibility and diffusion of GHGs in the atmosphere.

3. Contributory Negligence and Intervening Causation

Assuming that causal uncertainty is overcome through the adoption of probabilistic causation in reliance on climate attribution methods, courts will also face questions of legal causation, necessitating judgments about intervening causation and contributory negligence.

Impact attribution studies rely on the seminal "carbon majors" study that identified ninety major private and state-owned GHG emitters that account for nearly two thirds of global GHG emissions.[281] This study begins with the premise that Scope 3 emissions—indirect emissions including those from retail fossil fuel products—are attributable to a producing source rather than a directly emitting source.[282] This means that emissions from the burning of fossil fuels are attributed to those who extract and sell those fossil fuel products rather than those who burn them in a vehicle's combustion engine and directly emit GHGs into the atmosphere. Attributing these emissions to producers rather than to drivers, for example, assumes that pumping gas and driving a car are not independent volitional acts breaking the chain of causation from production to emission, but rather the ordinary and foreseeable uses of the product[283]—thus collapsing the succeeding chain of events into the original act.

One anticipated objection by defendants in response to liability for harms resulting from use of their products will concern contributory negligence or intervening causation stemming from a plaintiff's use of the fossil fuel products. Defendants might look to gun liability lawsuits that failed in holding gun manufacturers liable for deaths resulting from use of firearms. These two types of cases can be distinguished based on intervening cause and the scope of ordinary and foreseeable use. Killing an innocent civilian is not an ordinary and foreseeable use of a gun and is not within the scope of foreseeable or intended

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[280] Lohrmann v. Pittsburgh Corning Corp., 782 F.2d 1156, 1162–63 (4th Cir. 1986).

[281] Heede, *supra* note 14, at 230.

[282] *Id.*

[283] 15 U.S.C. § 7903(5)(A)(v) (excluding "an action for death, physical injuries or property damage resulting directly from a defect in design or manufacture of the product, when used as intended or in a reasonably foreseeable manner" in defining the term "qualified civil liability action").

use.[284] It also requires an external act. Plaintiffs anticipate these types of arguments by adopting language in complaints referring to the "ordinary and foreseeable use" of defendants' fossil fuel products. Indeed, the burning of fossil fuels is more easily conceived as within the scope of an act than as an external intervening act.

Although legislative preemption is conceivable, the arguments for intervening causation are different for gun litigation than for fossil fuels. It can be argued that use of a gun manufacturer's firearm in a homicide is foreseeable given national crime statistics, but it is not an ordinary or intended use of the product.[285] For the fossil fuel industry, however, the products themselves are designed for the ordinary combustion in car engines that results in GHG emissions. The nexus between harmful effect and product design is much closer and the boundaries of an ordinary use of a product more obviously contain activities like pumping gas in a car to commute to work. Intervening causation becomes more tenuous when considering activities like driving an SUV on a cross-country road trip, but even this consideration involves a matter of degree and not *kind* of activity. It will be for common-law courts to decide whether these relatively de minimis contributory activities are enough to comprise contributory negligence.

D. Causal Uncertainty and Legal Remedies

Supposing that causal uncertainty in climate tort claims is overcome through the doctrinal innovations advanced in toxic tort lawsuits, there remains a question of remedies and the challenge of allocating damages among multiple tortfeasors. For this legal challenge, too, the toxic tort context provides useful parallels to the climate context. It advances two potential schemes of damage allocation among multiple tort-feasors—joint and several liability and market share liability.

Theories of alternative liability were devised as a solution to the problem of causal uncertainty. Alternative liability originated in 1948 in the seminal California Supreme Court case *Summers v. Tice*.[286] The case involved a hunting accident where two quail hunters shot in the plaintiff's direction at the

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[284] *See generally* Timothy D. Lytton, *Introduction: An Overview of Lawsuits Against the Gun Industry*, *in* SUING THE GUN INDUSTRY: A BATTLE AT THE CROSSROADS OF GUN CONTROL AND MASS TORTS 1–35 (Timothy D. Lytton ed., 2006); Timothy D. Lytton, *Tort Claims Against Gun Manufacturers for Crime-Related Injuries: Defining a Suitable Role for the Tort System in Regulating the Firearms Industry*, 65 MO. L. REV. 1 (2000) (arguing in favor of limited use of tort claims against gun manufacturers).

[285] The Protection of Lawful Commerce in Arms Act (PLCAA) allows for actions brought against a seller for negligence and permits actions for injuries or property damage resulting directly from a defect in design or manufacture of a product, when used "as intended or in a reasonably foreseeable manner." Protection of Lawful Commerce in Arms Act, Pub. L. No. 109-92, 119 Stat. 2095 (2005) (codified at 15 U.S.C. §§ 7901–7903); H.R. REP. NO. 117-436, at 9 (2022).

[286] Summers v. Tice, 199 P.2d 1, 5 (Cal. 1948) (en banc).

same time and one hunter's pellet struck him in the eye, causing injury.[287] It was impossible to determine which of the two bullets, simultaneously fired, was responsible for the plaintiff's injury though only one of them had struck him.[288] The court's adoption of alternative liability allowed plaintiffs to hold any of the alleged tortfeasors liable and shifted the burden of proof to the defendants to absolve themselves or to apportion damages among themselves.[289] In the toxic tort context, courts have adopted variations of joint and several liability and market share liability as forms of alternative liability to allocate damages among potential tortfeasors.[290]

1. Joint and Several Liability

Joint and several liability has been adopted in toxic torts claims where multiple defendants are similarly situated and are held liable as a collective class with a capacity to cross-claim among co-defendants for recovery. Joint and several liability was widely applied in the asbestos context[291] where a plaintiff's cancer was determined to be an "indivisible injury" and where the burden of identifying nonparty tortfeasors shifted to defendants.[292] It has been similarly applied to other toxic tort contexts where it is impossible as a practi-

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[287] *Id.*

[288] *Id.* ("If defendants are independent tortfeasors and thus each liable for the damage caused by him alone, and, at least, where the matter of apportionment is incapable of proof, the innocent wronged party should not be deprived of his right to redress. The wrongdoers should be left to work out between themselves any apportionment." (citing Colonial Ins. Co. v. Indus. Accident Comm'n, 172 P.2d 884 (Cal. 1946))); *see* RESTATEMENT (SECOND) OF TORTS § 433B(3) (AM. L. INST. 1965) ("Where the conduct of two or more actors is tortious, and it is proved that harm has been caused to the plaintiff by only one of them, but there is uncertainty as to which one has caused it, the burden is upon each such actor to prove that he has not caused the harm.").

[289] *Summers*, 199 P.2d at 5.

[290] *See, e.g.*, Borel v. Fibreboard Paper Prods. Corp., 493 F.2d 1076, 1095 (5th Cir. 1973) ("Where several defendants are shown to have each caused some harm, the burden of proof (or burden of going forward) shifts to each defendant to show what portion of the harm he caused. If the defendants are unable to show any reasonable basis for division, they are jointly and severally liable for the total damages." (citing WILLIAM L. PROSSER, LAW OF TORTS §§ 319–320 (4th ed. 1971))); Collins v. Eli Lilly Co., 342 N.W.2d 37, 49 (Wis. 1984) ("[W]e consider market share, if determinable, to be a relevant factor in apportioning liability among defendants."); Lineaweaver v. Plant Insulation Co., 37 Cal. Rptr. 2d 902, 908 (Ct. App. 1995) ("When there are hundreds of suppliers of an injury-producing product, the probability that any of a handful of joined defendants is responsible for plaintiff's injury becomes so remote that it is unfair to require defendants to exonerate themselves." (citing Sindell v. Abbott Lab'ys, 607 P.2d 924, 931 (Cal. 1980)).

[291] *See, e.g.*, *Borel*, 493 F.2d at 1095 (finding joint and several liability where "defendants are unable to show any reasonable basis for division").

[292] *See, e.g.*, Carter v. Wallace & Gale Asbestos Settlement Tr., 96 A.3d 147, 159 (Md. 2014) (stating that "if an injury is indivisible, any tortfeasor joined in the litigation whose conduct was a substantial factor in causing the plaintiff's injury would be legally responsible for the entirety of the plaintiff's damages").

cal matter to discern the specific manufacturer of a petroleum product that, through cumulative exposure, caused cancer.[293]

States adopt different variations of joint and several liability. Pure joint and several liability places the burden of identifying nonparty tortfeasors on defendants. A second approach, pure several liability, allows a plaintiff to recover from each severally liable defendant only the portion of damages attributable to that defendant's fault. A third approach imposes joint and several liability on tortfeasors whose share of the harm exceeds a certain percentage of fault.[294]

Joint and several liability corresponds with the facts of climate change. Indeed, one court has already gestured to it in passing reference. In the context of its review of the claim's redressability in *Connecticut v. American Electric Power Co.*, the Second Circuit referred to the relevance of joint and several liability in dicta characterizing the case as "a federal common law of nuisance case involving air pollution, where the ambient air contains pollution from multiple sources and where liability is joint and several."[295] In the climate tort context, all GHG emitters are in some way contributors to the plaintiff's alleged injury—the uncertainty involves which defendant tipped a certain threshold resulting in the harm suffered. Emissions are indivisible and all identified defendants are liable, though for varying degrees of contribution.

One anticipated challenge to applying joint and several or proportional liability to the climate tort context is the numerosity of GHG emitters. If, however, courts were to distinguish between major emitters and de minimis sources, this obstacle could be overcome by the market concentration characteristic of high emitting sources. Nearly two-thirds of total industrial carbon dioxide and methane emissions have been traced to just ninety major industrial carbon producers and information about each emitter's share is generally available.[296] In the United States, about seventy-five percent of all GHG emis-

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[293] *See, e.g.*, James v. Chevron U.S.A., Inc., 694 A.2d 270, 282 (N.J. Super. Ct. App. Div. 1997) ("[T]he facts, at least at this point, establish that [Plaintiff] suffered an indivisible injury which was 'the product of a gradual process contributed to by multiple parties.'" (quoting Goodman v. Fairlawn Garden Assocs., 601 A.2d 766, 768 (N.J. Super. Ct. App. Div. 1992))), *aff'd and remanded sub nom.* James v. Bessemer Processing Co., 714 A.2d 898 (N.J. 1998).

[294] *See* RESTATEMENT (THIRD) OF TORTS: APPORTIONMENT OF LIABILITY § 17 cmt. a (AM. L. INST. 2000) ("The first Track—the 'A' series—presents a rule of pure joint and several liability . . . . The second Track—the 'B' series—presents a pure several-liability scheme and addresses the subsidiary questions posed by that premise. The first hybrid Track—the 'C' series—begins with a rule of joint and several liability for independent tortfeasors who cause an indivisible injury to a plaintiff.").

[295] Connecticut v. Am. Elec. Power Co., 582 F.3d 309, 349 (2d Cir. 2009), *rev'd*, 564 U.S. 410 (2011).

[296] Ekwurzel et al., *supra* note 12, at 585. The EPA's Greenhouse Gas Reporting Program requires reporting of greenhouse gas data from large emission sources exceeding 25,000 metric tons of CO_2 equivalencies per year or sources that supply products that would result in an excess of 25,000 metric tons of CO_2 if their products are released, combusted, or oxidized. Approximately 7,600 facilities are required to report annually, making up roughly half of the total U.S. GHG emissions. *See*

sions come from industry, electricity, and transportation.[297] In the oil and gas sector, based on 2020 emissions data, 29 companies are responsible for 50% of GHG emissions while 83 account for approximately 75%.[298] In the electricity sector, based on 2019 emissions data, the 100 largest power producers account for more than 80% of reported CO_2 emissions with just 17 companies accounting for 50% of emissions.[299]

2. Market Share Liability

Market share liability is a variation on several liability with an apportionment scheme based on defendant's market share. It allows plaintiffs to hold a class of defendants liable as a "market" and to obtain proportional damages from each, based on market share as an estimate of contribution to injury.[300] In *Sindell v. Abbott Labs*, the Supreme Court of California famously pioneered the market share approach in the case of DES drug litigation, holding that "[e]ach defendant will be held liable for the proportion of the judgment represented by its share of that market."[301] *Sindell* identified four requirements for adopting market share liability. First, a plaintiff must join in the action "the manufacturers of a substantial share" of the market.[302] This contrasts with alternative liability where all potential defendants must be joined. Second, the source of injury must be "fungible."[303] Third, all defendants must have been in

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Learn About the Greenhouse Gas Reporting Program (GHGRP), U.S. ENV'T PROT. AGENCY, https://www.epa.gov/ghgreporting/learn-about-greenhouse-gas-reporting-program-ghgrp [https://perma.cc/5QK2-SBZL] (Jan. 10, 2023). The Carbon Majors Database publishes GHG emissions data for the largest company-related sources of all time. *See Carbon Majors*, CLIMATE ACCOUNTABILITY INST., https://climateaccountability.org/carbonmajors.html [https://perma.cc/4KM8-RLHW].

[297] *Sources of Greenhouse Gas Emissions*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions [https://perma.cc/SWB4-B59N].

[298] TOM CURRY, LUKE HELLGREN, PYE RUSSELL & SIERA FRAIOLI, BENCHMARKING METHANE AND OTHER GHG EMISSIONS OF OIL AND NATURAL GAS PRODUCTION IN THE UNITED STATES 28 (2022), https://cdn.catf.us/wp-content/uploads/2022/07/14094726/oilandgas_benchmarkingreport2022.pdf [https://perma.cc/3W5Q-AKDP].

[299] CHRISTOPHER VAN ATTEN, AMLAN SAHA, LUKE HELLGREN & TED LANGLOIS, BENCHMARKING AIR EMISSIONS OF THE 100 LARGEST ELECTRIC POWER PRODUCERS IN THE UNITED STATES 13 (2021), https://www.nrdc.org/sites/default/files/benchmarking-air-emissions-20210720.pdf [https://perma.cc/76WB-GALD].

[300] *See* RESTATEMENT (THIRD) OF TORTS : LIABILITY FOR PHYSICAL & EMOTIONAL HARM § 28 cmt. p (AM. L. INST. 2010) ("In a narrow range of cases, courts have been confronted with plaintiffs who have similar proof problems to those who seek to invoke alternative liability. These cases involve exposure to a toxic substance and the plaintiff's understandable inability to prove which manufacturer sold the product, often many years or decades before any disease becomes clinically evident . . . . A number of courts nevertheless adopted a new 'market share' theory that permitted apportionment of liability among defendant-manufacturers based on each one's share of the relevant market.").

[301] Sindell v. Abbott Lab'ys, 607 P.2d 924, 937 (Ca. 1980).

[302] *Id.*

[303] *Id.* at 936.

the market within the timeframe of the incident. Fourth, causal uncertainty must not be the fault of the plaintiff.

Following *Sindell*, the highest courts in Wisconsin,[304] Washington,[305] New York,[306] and Florida[307] adopted market share liability in DES cases, and the Hawaiian Supreme Court adopted market share liability in a case involving a blood product.[308] Courts also adopted market share liability in methyl tertiary-butyl ether (MTBE) litigation,[309] but have declined to extend it to several other examples where the *Sindell* criteria were not met because the product in question was not sufficiently fungible, or because it could not be determined that defendants were in the market at the time of injury. For example, courts rejected arguments to extend market share liability to asbestos manufacturers[310] citing the numerosity of potential tortfeasors[311] and variation in the toxicities of different asbestos

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[304] *See* Collins v. Eli Lilly Co., 342 N.W.2d 37, 49 (Wis. 1984) ("[W]e consider market share, if determinable, to be a relevant factor in apportioning liability among defendants.").

[305] *See* Martin v. Abbott Lab'ys, 689 P.2d 368, 383 (Wash. 1984) (en banc) ("We recognize that the elimination of individual causal responsibility as an element of plaintiff's case is liability enhancing. However, it is also liability limiting insofar as it permits the defendants to apportion liability according to respective market share and further provides that the plaintiff may not be able to recover her entire damages.").

[306] *See* Hymowitz v. Eli Lilly & Co., 539 N.E.2d 1069, 1071–72 (N.Y. 1989) ("[W]e now resolve the issue twice expressly left open by this court, and adopt a market share theory, using a national market, for determining liability and apportioning damages in DES cases in which identification of the manufacturer of the drug that injured the plaintiff is impossible." (first citing Kaufman v. Lilly & Co., 482 N.E.2d 63 (N.Y. 1985); and then citing Bichler v. Lilly & Co., 436 N.E.2d 182 (N.Y. 1982))).

[307] *See* Conley v. Boyle Drug Co., 570 So. 2d 275, 283 (Fla. 1990) ("We agree with the United States District Court for the District of Massachusetts, which adopted the *Martin* market-share alternate theory of liability, that 'the magnitude of the physical and psychological injuries which are at issue in DES cases counsels toward permitting a remedy under some form of a market-share theory of liability.'" (quoting McCormack v. Abbott Lab'ys, 617 F. Supp. 1521, 1526 (D. Mass. 1985))).

[308] *See* Smith v. Cutter Biological, Inc., 823 P.2d 717, 727 (Haw. 1991) ("[W]e . . . endorse, market share liability, with modifications.").

[309] *In re* Methyl Tertiary-Butyl Ether ("MTBE") Prods. Liab. Litig., 379 F. Supp. 2d 348, 377 (S.D.N.Y. 2005) ("MTBE contamination presents as compelling a circumstance for the application of market share liability as does DES.").

[310] *See, e.g.*, Becker v. Baron Bros., Coliseum Auto Parts, Inc., 649 A.2d 613, 620 (N.J. 1994) ("Accordingly, a ruling that all asbestos products are the same appears to confound reality."); Vigiolto v. Johns-Manville Corp., 643 F. Supp. 1454, 1463 (W.D. Pa. 1986) ("[W]e conclude that the Pennsylvania Supreme Court will rule that market share liability is an inappropriate theory of relief for one seeking to recover damages for injuries sustained as a result of exposure to an asbestos-containing product."), *aff'd*, 826 F.2d 1058 (3d Cir. 1987); Blackston v. Shook & Fletcher Insulation Co., 764 F.2d 1480, 1483 (11th Cir. 1985) ("In *Starling*, a federal district court rejected an invitation to extend Georgia law by adopting the market-share theory of liability . . . . These reasons . . . militate against lowering the requirement that a plaintiff prove exposure in asbestos cases.").

[311] *See, e.g.*, Lineaweaver v. Plant Insulation Co., 37 Cal. Rptr. 2d 902, 907 (Cal. Ct. App. 1995) ("When there are hundreds of suppliers of an injury-producing product, the probability that any of a handful of joined defendants is responsible for plaintiff's injury becomes so remote that it is unfair to require defendants to exonerate themselves." (citing Sindell v. Abbott Lab'ys, 607 P.2d 924, 931 (Cal. 1980)).

products[312] that make burden shifting to defendants unfair. Courts have also declined to extend market share liability to lead paint where market participants for the period of exposure could not be accurately determined.[313]

Sindell criteria can generally be met for GHGs, but the "substantial share of the market" is subject to different interpretations. The market could be characterized as GHGs in the aggregate or sub-markets like the fossil fuel industry, the power sector, or the automotive industry, for example. Whether an aggregate market or smaller markets, plaintiffs could be assembled to represent a substantial share. As previously mentioned, in the United States, about seventy-five percent of all GHG emissions come from industry, electricity, and transportation.[314] In the automotive industry, for example, just 4 companies—GM, Toyota, Ford, and Stellantis (formerly Chrysler)—make up approximately fifty percent of the market.[315]

IV. CONTEXTUALIZING CLIMATE TORT LITIGATION

Climate change is multi-jurisdictional, global in scale, and scientifically complex. Major greenhouse-gas-emitting industries are also deeply embedded in our economies and lifestyles. We rely on them to travel, transport goods, heat our homes, and run our hospitals. This embeddedness complicates a weighing of costs and benefits implicated in common-law nuisance claims and related judgments about the "reasonableness" of GHG emitting activities. At the same time, advancements in climate science continually revise what is "foreseeable" as a matter of legal duty. In a world of perfect regulatory interventions, these features and associated challenges might be accounted for through comprehensive and collaborative regulation rather than through atomized and adversarial adjudication. Such interventions could take the form of an international treaty on GHG emissions, a domestic emissions policy, and a climate adaptation and mitigation fund.[316] Rather than rely on courts to shift

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[312] *See, e.g.*, *Vigiolto*, 643 F. Supp. at 1463 ("Asbestos products, on the other hand, have widely divergent toxicities, with some asbestos products presenting a much greater risk of harm than others." (quoting Celotex Corp. v. Copeland, 471 So. 2d 533, 537–38 (Fla. 1985)).

[313] *See, e.g.*, Santiago v. Sherwin Williams Co., 3 F.3d 546, 551 (1st Cir. 1993) ("[S]everal of the defendants were not in the white lead pigment market at all for significant portions of the period between 1917 and 1970, and therefore may well not have been market suppliers at the time the injury-causing paint was applied to the walls of plaintiff's home. This, of course, raises a substantial possibility that these defendants not only could be held liable for more harm than they actually caused, but also could be held liable when they did not, in fact, cause any harm to plaintiff at all.").

[314] *Sources of Greenhouse Gas Emissions*, *supra* note 297.

[315] *See, e.g.*, Ed Edwards, *The Biggest Car Manufacturers in the USA*, THOMAS, https://www.thomasnet.com/articles/top-suppliers/car-manufacturers-in-usa/ [https://perma.cc/9Y3U-Q38Z] (charting the market share of automotive manufacturers in Q3 of 2020).

[316] *See, e.g.*, Richard A. Epstein, *The Private Law Connections to Public Nuisance Law: Some Realism About Today's Intellectual Nominalism*, 17 J.L. ECON. & POL'Y 282, 300 (2022) ("[I]f there

the costs of climate change to contributing activities, we might instead have an economy-wide carbon tax that accounts for the costs of GHG emissions.

The current regulatory landscape, however, does not feature any of these interventions, in large part due to defendants' concerted efforts to prevent such regulation. The costs of climate change continue to mount. Within this context, climate tort litigation might be appreciated, not as a panacea for dealing with the impacts of climate change, but as a gap-filling, transitional regulatory solution. Common-law courts might provide a venue to examine and reinterpret new relational dynamics, duties, and judgments about what is reasonable, in response to novel climate science.[317] In this Part, I take a step back from the descriptive and interpretive analysis elaborated in earlier sections to put in context the possibilities and implications of using tort law to address harms from climate change.[318] I then elaborate upon concerns about the implications of climate tort litigation and offer some initial responses.[319]

Section A of this Part discusses implications of successful climate tort litigation, should the recommendations of this Article be adopted to overcome existing obstacles.[320] These include information-forcing consequences, torts functioning as a transitional regulatory regime, and new legal claims informed by discovery and information about internal corporate communications. Section B goes on to consider limitations and concerns that might arise as a consequence of successful climate tort litigation including policy displacement, emissions leakage, bankrupting of the fossil fuel industry, and distributional inequities.[321]

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is to be any attack on global warming it has to be done through a coordinated national program, not by piecemeal state actions.").

[317] Rival conceptions of tort law advance its private objectives, which are concerned with righting wrongs, or public objectives, which are concerned with distribution of risks and losses. The differences between these two accounts were thoughtfully debated by John Goldberg and Benjamin Zipursky, advancing the private function of tort law, and Catherine Sharkey, advancing its public function. For these rival accounts, see generally John C.P. Goldberg & Benjamin C. Zipursky, *Thoroughly Modern Tort Theory*, 134 HARV. L. REV. 184 (2021), and Catherine M. Sharkey, *Modern Tort Law: Preventing Harms, Not Recognizing Wrongs*, 134 HARV. L. REV. 1423 (2021) (reviewing JOHN C.P. GOLDBERG & BENJAMIN C. ZIPURSKY, RECOGNIZING WRONGS (2020)). Judge Guido Calabresi and Spencer Smith struck a compelling compromise between tort law's dualisms:

> There is the microlevel—that is, the level of the case—which is often, though not always, "private" in some sense, and which is often, though not always, explained by civil recourse or "wrongs and redress." Then there is the macrolevel—that is, the level of structure—which is often, though not always, "public" in some sense, and which is often, though not always, explained by various instrumentalist considerations, such as the distribution of risk or loss.

Guido Calabresi & Spencer Smith, *On Tort Law's Dualisms*, 135 HARV. L. REV. 184, 188 (2022).

[318] *See infra* notes 322–335 and accompanying text.

[319] *See infra* notes 336–359 and accompanying text.

[320] *See infra* notes 322–335 and accompanying text.

[321] *See infra* notes 336–359 and accompanying text.

A. Possibilities and Implications

The process of adjudication has many information-generating features. Pleadings, responses, discovery, and settlement negotiations can produce information about the risks and costs of climate change as well as the problem's causes and solutions. In this way, tort litigation can serve as a transitional regulatory regime for climate risk.[322] As courts encounter and accept new types of scientific evidence, litigation also prompts doctrinal innovations in response to newly conceptualized connections between emitters and injuries.

1. Information-Forcing and a Transitional Regulatory Function

Scholars have advanced compelling accounts of common-law tort's contribution to a dynamic regulatory response. One scholar describes a temporal role for tort law in "creat[ing] incentives to develop additional information about potential risks and stimulat[ing] innovation to mitigate and/or adapt to these risks."[323] In this way, tort law is not merely a gap-filler, but a transitional regulatory regime for emerging and poorly understood risks like those resulting from climate change. This account emphasizes information-forcing possibilities of tort law that facilitate experimentation with "remedial approaches until optimal approaches emerge which could then be enshrined in more uniform regulations."[324]

In the context of climate tort litigation, for example, public nuisance plaintiffs include information about climate mitigation and adaptation plans in their pleadings, putting these strategies into a public record that regulators can reference when needed.[325] Information produced through discovery also provides regulators with insights concerning the scope of emerging climate risks and causal links to harms, as well as additional risk response plans that might not have been included in initial pleadings. Another example of the payoff of this information-forcing function is in pricing the social cost of carbon (SCC), a metric introduced by the Obama administration in 2013 to quantify the social

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[322] Catherine M. Sharkey, *Common Law Tort as a Transitional Regulatory Regime: A New Perspective on Climate Change Litigation* 1 (N.Y. Univ. Sch. of L., Working Paper No. 22-26, 2022), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4107970 [https://perma.cc/L49T-L2CZ] ("In this model, common law tort, rather than a relic of the past, emerges as relevant to the future of environmental risk regulation, as indeed superior to legislation and/or regulation in terms of addressing newly-emergent risks.").

[323] *Id.*

[324] *Id.*

[325] *See id.* at 4 ("With regard to global climate change litigation, public nuisance plaintiffs seeking damages and/or abatement note in their pleadings various mitigation and/or adaptation plans (past, present, and future), thereby making a public record of potential remedial strategies regulators can observe and collect data from.").

costs of a metric ton of carbon emitted into the atmosphere.[326] Today the Biden administration prices the SCC at $51/ton.[327] A recent *Nature* publication, however, puts that number at $185/ton,[328] more than three times the value that is currently used to inform federal policy. One effect of tort litigation is that courts will be presented with different models for claiming and assigning damages in each case. These models will advance different methods and assumptions about attributable damages, informing the types of impacts that should be included in a SCC valuation, and potentially expanding the types of impacts considered.

2. Additional Legal Claims

Information produced through tort litigation not only bears on related policymaking but also on claims founded in alternative legal theories. For example, information produced through discovery concerning fossil fuel executives' knowledge about the consequences of their activities[329] can inform corporate and securities law claims. In one example, ExxonMobil shareholders brought claims against negligent managers for misleading investors about climate risks.[330] In

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[326] The social cost of carbon (SCC) was introduced by the Obama administration in 2013 as a value of harm caused by one metric ton of GHG emissions using a 3% discount rate. *See* Stephen Lee & Courtney Rozen, *Biden Reverts to Obama-Era Method of Valuing Climate Change*, BLOOMBERG L., https://news.bloomberglaw.com/environment-and-energy/biden-turns-back-to-obama-era-method-of-valuing-climate-change [https://perma.cc/7D6Z-UCBE] (Feb. 26, 2021).

[327] *Id.* The Biden administration's interim estimate relies on the same models and discount rate that the Obama administration adopted. Attribution science methods advanced in the decade since the SCC was developed as a metric now enable researchers to link many more extreme weather events directly to climate change, while updated econometric methods can better compute the financial impacts. *See* Gernot Wagner et al., *Eight Priorities for Calculating the Social Cost of Carbon*, 590 NATURE 548, 548 (2021) ("Advances in attribution science mean that researchers can now link many more extreme weather events directly to climate change, and new econometric techniques help to quantify the dollar impacts. The monetary losses exceed the predictions of early models. The same goes for sea-level rise and many other types of damage.").

[328] Kevin Rennert et al., *Comprehensive Evidence Implies a Higher Social Cost of CO_2*, 610 NATURE 687, 687, 689 (2022).

[329] *See, e.g.*, Chris McGreal, *Big Oil and Gas Kept a Dirty Secret for Decades. Now They May Pay the Price*, THE GUARDIAN (June 30, 2021), https://www.theguardian.com/environment/2021/jun/30/climate-crimes-oil-and-gas-environment [https://perma.cc/3QEU-8PZW] (discussing the role of information generated through discovery in advancing tobacco litigation, and identifying parallels to climate litigation).

[330] *See* Oliver Milman & Emily Holden, *Lawsuit Alleges ExxonMobil Deceived Shareholders on Climate Change Rules*, THE GUARDIAN (Oct. 24, 2018), https://www.theguardian.com/business/2018/oct/24/lawsuit-alleges-exxonmobil-deceived-shareholders-on-climate-change-rules [https://perma.cc/CVP6-57WX] ("New York is suing the oil giant ExxonMobil in a lawsuit that claims the company engaged in a 'longstanding fraudulent scheme' to downplay the risks posed to its business by climate change regulations."); Benjamin Franta, *Early Oil Industry Knowledge of CO_2 and Global Warming*, 8 NATURE CLIMATE CHANGE 1024, 1024 (2018) ("[A]rchival documents show that . . . oil industry leaders were aware that their products were causing CO_2 pollution to accumulate in the planet's atmosphere in a potentially dangerous fashion."); Benjamin Franta, *Shell and Exxon's Secret 1980s Climate Change Warnings*, THE GUARDIAN (Sept. 19, 2018), https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/sep/19/shell-and-exxons-secret-1980s-climate-change-warnings [https://perma.cc/

another example from the United Kingdom, Shell shareholders brought claims against company executives for failing to plan for climate change and a net zero transition.[331] Information about in-house knowledge and communications can also inform criminal or conspiracy claims against fossil fuel executives, as proposed by Senators Bernie Sanders and Elizabeth Warren on the campaign trail,[332] and as alleged by the State of Minnesota in its lawsuit against the American Petroleum Institute.[333]

Climate attribution methods also have considerable relevance for a foreseeable wave of related insurance lawsuits. As comprehensive general liability insurers are faced with massive payouts for fossil fuel clients, they might dispute coverage under the "pollution exclusion" or contest whether harms due to climate change may be designated as an "accidental occurrence." Until now, only the Virginia Supreme Court has litigated these questions, holding that the alleged climate impacts were a "natural or probable consequence" of the intentional act of emissions, thus not an accident under Virginia law and not covered under the associated insurance policy.[334] Similar questions arise in the property insurance context, with climate tort claims provoking novel questions

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VY7P-QVDS] ("Privately, these companies did not dispute the links between their products, global warming, and ecological calamity. On the contrary, their research confirmed the connections."); *In re Exxon Mobil Corp. Derivative Litigation*, CLIMATE CASE CHART, http://climatecasechart.com/case/von-colditz-v-exxon-mobil-corp/ [https://perma.cc/9E9J-3PQT] (documenting the progress of the litigation).

[331] Another variation of shareholder derivative suits against fossil fuel executives concerns their failure to prepare for the effects of climate change. This strategy is being pursued by Shell shareholders in the UK. *We're Taking Shell's Board of Directors to Court*, CLIENTEARTH (Feb. 9, 2023), https://www.clientearth.org/latest/latest-updates/news/we-re-taking-legal-action-against-shell-s-board-for-mismanaging-climate-risk/ [https://perma.cc/YLW5-D6ZF].

[332] On the campaign trail, Vermont Senator Bernie Sanders suggested criminal charges for fossil fuel executives who knew about the harms of climate change resulting from their products. *See* MSNBC, *Bernie Sanders: I'd Look into Criminal Charges Against Fossil Fuel Executives*, YOUTUBE (Sept. 19, 2019), https://www.youtube.com/watch?v=yXIycmnWBZo [https://perma.cc/6H2T-TAHR]. Massachusetts Senator Elizabeth Warren also proposed prosecution for "corporate perjury." Elizabeth Warren, *Fighting Corporate Perjury*, MEDIUM: TEAM WARREN (Nov. 12, 2019), https://medium.com/@teamwarren/fighting-corporate-perjury-2346950a08b8 [https://perma.cc/YF5Z-RRJQ] ("[I]f bad actors like Exxon break the rules and deliberately lie to government agencies, my plan will treat them the same way the law treats someone who lies in court—by subjecting them to potential prosecution for perjury.").

[333] Complaint at 31, Minnesota v. Am. Petrol. Inst., No. CV 20-1636 (Minn. Dist. Ct. July 27, 2020) ("[Defendants] engaged in a conspiracy to misrepresent the scientific understanding of climate change, the role of Defendants' products in causing climate change, the potential harmful consequences of climate change, and the urgency of action required to mitigate climate change.").

[334] AES Corp. v. Steadfast Ins. Co., 725 S.E.2d 532, 537 (Va. 2012) (holding that the climate impacts alleged were a "natural or probable consequence" of the intentional emissions and thus not an accident under Virginia law).

about an insurer's duty to subrogate claims for repayment of climate-related damages that were paid out to policyholders.[335]

B. Limitations and Concerns

Critics and even some supporters of tort litigation for climate injuries anticipate a parade of horribles if plaintiffs do succeed in their claims against major emitters. To be sure, judicial intervention to redress harms from GHG-emitting activities will have consequences for the economy and for equity. The most salient objections concern policy displacement, leakage, bankruptcy, and distributive inequality. This Section articulates and engages with each of these major concerns.

1. Displacement

Policy displacement is a primary critique of private law interventions or private ordering solutions to major public challenges like climate change.[336] Critics of private law interventions are concerned that ceding attention and resources to climate tort litigation will displace more comprehensive and systematic public law interventions. By this account, NGOs and activists supporting legal action are diverting their energy and resources from policy change. This trade-off, however, is not evidenced by the plurality of campaigns pursued by climate activists who support both legislative and legal action.[337] Legal action might instead provide opportunities for experimentation, as elaborated in the preceding section, serving as a precursor to more stable and permanent policy rather than as a substitute for it.[338] Lawsuits also create new dynamics in the private domain. For example, increased litigation risk might shift incentives for parties who have traditionally lobbied against a carbon tax to instead support more predictable and comprehensive public law interventions with a bargain to preempt tort claims.[339]

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[335] *See* Jason Reeves & José Umbert, ZELLE LLP, *Climate Change and Insurance: Insurers' Subrogation Claims*, JD SUPRA (July 15, 2019), https://www.jdsupra.com/legalnews/climate-change-and-insurance-insurers-69017/ [https://perma.cc/P5V6-QALW].

[336] Aneil Kovvali considered this "stark choice hypothesis" in the corporate governance context, but the rationale of framing private intervention as an obstruction to public intervention applies in the private tort litigation context, as well. *See generally* Aneil Kovvali, *Stark Choices for Corporate Reform*, COLUM. L. REV. (forthcoming 2023), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4067505 [https://perma.cc/U65Y-ZTD9].

[337] For example, the Natural Resources Defense Council, a leading organization for environmental advocacy, engages in litigation and legislative advocacy. *See About NRDC*, NAT'L RES. DEF. COUNCIL, https://www.nrdc.org/about [https://perma.cc/Q6GN-M8GW].

[338] Sharkey, *supra* note 322, at 2–3.

[339] *See, e.g.*, Steven Mufson, *Top Oil and Gas Lobbying Group Close to Backing a Carbon Tax*, WASH. POST (Mar. 2, 2021), https://www.washingtonpost.com/climate-environment/2021/03/02/api-climate-carbon-tax/ [https://perma.cc/NJ7B-KG7P]; Press Release, Am. Petrol. Inst., API Outlines Path

Another version of the displacement critique is that arguments like those advanced in this Article—reconciling climate change within existing doctrine—stymie more radical doctrinal or policy innovations that are better matched to the scale and complexity of climate change. Ad hoc rulings in discrete lawsuits might build the "staircase" to more paradigm shifting interpretations,[340] but they might also ossify existing doctrine and pacify demand for more radical doctrinal shifts.

2. Leakage

Leakage in the context of GHG emissions concerns the shifting of high-emitting industries to jurisdictions with lower regulatory barriers instead of mitigating or eliminating the polluting activity.[341] Given the global and fungible nature of GHGs, industry liability might merely shift production abroad rather than deter polluting industries. At least one example already appears to validate this concern. In 2021, the Hague District Court ordered Royal Dutch Shell to reduce its worldwide CO_2 emissions by forty-five percent by 2030.[342] The decision was the first of its kind, imposing a duty on a major producer of greenhouse gases to reduce emissions in order to prevent climate change.[343] A few weeks after the decision, Shell's chief executive conveyed skepticism about the consequences of the court's ruling, arguing that "it would not help the world one bit" because "[p]eople would fill up their cars and delivery trucks at other service stations."[344]

Indeed, just months after the Hague court's ruling, Shell sold off almost $10 billion in oil holdings to ConocoPhillips, prompting speculation of a strat-

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for Low-Carbon Future in New Climate Action Framework (Mar. 25, 2021), https://www.api.org/news-policy-and-issues/news/2021/03/24/climate-action-framework [https://perma.cc/W8H3-NCCM].

[340] Calabresi & Smith, *supra* note 317, at 191 ("At some point, a judge will on occasion find herself at the top of a staircase 'constructed' by her and her siblings, leaving her at the macrolevel—and with an opportunity to reshape the law." (footnote omitted)).

[341] *See generally* Daniel A. Farber, *Carbon Leakage Versus Policy Diffusion: The Perils and Promise of Subglobal Climate Action*, 13 CHI. J. INT'L L. 359 (2013) (providing a comprehensive discussion of carbon leakage).

[342] Ron Bousso, *Shell to Step Up Energy Transition After Landmark Court Ruling*, REUTERS (June 9, 2021), https://www.reuters.com/article/us-shell-netherlands-court-idCAKCN2DL0TH [https://perma.cc/62ZR-CJJK].

[343] RBDHA 26 mei 2021 (ECLI:NL:RBDHA:2021:5339) (Milieudefensie et al./ Royal Dutch Shell P.L.C.) (Neth.), http://climatecasechart.com/wp-content/uploads/sites/16/non-us-case-documents/2021/20210526_8918_judgment-1.pdf [https://perma.cc/M4TR-9MAB]. The decision was based on an unwritten duty of care in Dutch tort law. The Hague District Court recognized that Shell has an "obligation of result" to reduce Scope 1 emissions resulting from its direct activities and a "best-efforts obligation" to reduce Scope 3 emissions generated by its suppliers and end users. *Id.* ¶ 4.4.37.

[344] Ben van Beurden, *The Spirit of Shell Will Rise to the Challenge*, LINKEDIN (June 9, 2021), https://www.linkedin.com/pulse/spirit-shell-rise-challenge-ben-van-beurden/ [https://perma.cc/C7AV-TLQK].

egy to comply with its mandated emissions reductions.[345] In this example of legal intervention to reduce GHG emissions from the fossil fuel sector, the problem of leakage was real and probably perverse. Although significant, the problem of leakage is not unique to tort law interventions. It also applies to regulatory efforts to limit GHG emissions. Of the hundreds of simulations of the effects of a carbon price on leakage, a majority estimate that "carbon prices in the developed world that produce global emissions reductions in the range of 10% have leakage rates between 5% and 25%."[346] The problem of leakage may be unavoidable for any domestic intervention in a world of limited jurisdictions and global emissions.[347]

3. Bankruptcy

A public law conception of torts might envision the desirable outcome of climate lawsuits in terms of a Pigouvian tax, or a "judicial carbon tax"[348] on high emitting industries that internalizes the costs of their activities.[349] Other accounts are less optimistic, suggesting that if climate tort claims succeed on the merits, the fossil fuel industry will face bankruptcy.[350] They envision a cas-

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[345] *Shell Completes Sale of Its Permian Business to ConocoPhillips*, SHELL (Dec. 1, 2021), https://www.shell.com/media/news-and-media-releases/2021/shell-completes-sale-of-its-permian-business-to-conocophillips.html [https://perma.cc/T5CB-NTLH]; Clifford Krauss, *Royal Dutch Shell Sells Permian Basin Oil Holdings for $9.5 Billion*, N.Y. TIMES, https://www.nytimes.com/2021/09/20/business/energy-environment/shell-conoco-permian-sale.html [https://perma.cc/3SPJ-XWA4] (Oct. 28, 2021).

[346] David A. Weisbach & Sam Kortum, *Climate Change Policy in the International Context: Solving the Carbon Leakage Problem* 16–17 (Univ. of Chi. Pub. L. Working Paper, Paper No. 813, 2022) (footnote omitted), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4328814# [https://perma.cc/D9C6-DBPU].

[347] That some degree of leakage is unavoidable is not a reason to abandon enforcement in a particular jurisdiction. For example, tax law is enforced even though this causes tax evaders to move out of jurisdiction.

[348] Jonathan Zasloff, *The Judicial Carbon Tax: Reconstructing Public Nuisance and Climate Change*, 55 UCLA L. REV. 1827, 1827–29 (2008).

[349] This outcome might be criticized as "deep pocket jurisprudence" financing a mitigation fund for cities and states burdened by the costs of climate change. *See, e.g.*, Huck v. Wyeth, Inc., 850 N.W.2d 353, 380 (Iowa 2014) ("We are unwilling to make brand manufacturers the de facto insurers for competing generic manufacturers . . . ." (citing Victor E. Schwartz, Phil Goldberg & Cary Silverman, *Warning: Shifting Liability to Manufacturers of Brand-Name Medicines When the Harm Was Allegedly Caused by Generic Drugs Has Severe Side Effects*, 81 FORDHAM L. REV. 1835, 1872 (2013))); Kingman v. Dillard's, Inc., 835 F. Supp. 2d 732, 734 (W.D. Mo. 2011) (dismissing reliance on "deep pocket jurisprudence"), *aff'd*, 721 F.3d 613 (8th Cir. 2013). For a more extensive discussion of deep pocket jurisprudence, see generally Victor E. Schwartz, Phil Goldberg & Christopher E. Appel, *Deep Pocket Jurisprudence: Where Tort Law Should Draw the Line*, 70 OKLA. L. REV. 359 (2018).

[350] *See, e.g.*, Alex Brown, *Some Cities, States Say Big Oil Should Pay for Climate Damage*, PEW: STATELINE (Apr. 13, 2022), https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2022/04/13/some-cities-states-say-big-oil-should-pay-for-climate-damage [https://perma.cc/8C4M-HE7W] ("'If these cases all go to their logical extreme, [the oil companies] all go bankrupt' said Parenteau, [a]

cade of harms for a society that remains dependent on fossil fuel products and still far removed from a transition to renewable energy sources.

It is conceivable that several interventions may forestall the bankrupting of the fossil fuel industry due to climate litigation: a federal bailout,[351] mass settlement agreement,[352] or a legislative bargain with preclusion for climate tort claims.[353] However, even if we were to imagine a deluge of climate tort lawsuits resulting in damages at a scale that bankrupts high emitting industries like the fossil fuel sector, the outcome of bankruptcy is not elimination, but restructuring.[354] The case of Purdue Pharma's bankruptcy settlement offers one such example where assets are restructured while the underlying industry continues to operate with a public beneficiary and operational limits.[355] A similar scenario could be imagined for companies like Exxon or ConocoPhillips that become restructured as public benefit corporations owned by a climate trust, for example.[356]

4. Distributional Inequity

Relying on fragmented interventions to deal with the multi-jurisdictional challenge of climate change presents considerable implications for distributive equity. From a global perspective, domestic litigants will have a greater likelihood of success availing themselves of U.S. courts to recoup costs from major

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Vermont Law School professor. 'They should.' Others argue that outcome is why the cases should be dropped." (first alteration in original)).

[351] *Cf.* Austan Goolsbee & Alan B. Krueger, *A Retrospective Look at Rescuing and Restructuring General Motors and Chrysler* (IZA Discussion Paper No. 8888, 2015), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2578240 [https://perma.cc/V62T-R8ZM] (analyzing the U.S. government's restructuring of General Motors and Chrysler in the late 2000s).

[352] *Cf. The Master Settlement Agreement*, *supra* note 223 (describing the Master Settlement Agreement between four major tobacco companies and 52 U.S. states and territories).

[353] Such a bargain could include civil liability preemption, such as in the example of the PLCCA. 15 U.S.C. §§ 7901–7903.

[354] *But see* Alexander Gouzoules, *Going Concerns and Environmental Concerns: Mitigating Climate Change Through Bankruptcy Reform*, 63 B.C. L. REV. 2169, 2175 (2022) (proposing "novel legislative reforms that would require bankrupt fossil fuel firms to liquidate rather than reorganize, while also mandating consideration of the public interest").

[355] A 2022 settlement restructured Purdue Pharma's assets for a public purpose. Press Release, Purdue Pharma, Plan of Reorganization of Purdue Pharma L.P. Receives Bankruptcy Court Approval, (Sept. 1, 2021), https://www.purduepharma.com/news/2021/09/01/plan-of-reorganization-of-purdue-pharma-l-p-receives-bankruptcy-court-approval/ [https://perma.cc/KDQ7-9E62].

[356] Opioid litigation offers an instructive example for climate tort lawsuits. Both opioid and fossil fuel industries present both benefits and harms for society, and are not exclusively harmful like in the case of the tobacco litigation, for example, complicating the cost-benefit calculus. In opioid litigation, cities, states, and municipalities faced a massive burden of costs related to the opioid crisis. The Purdue settlement provides resources to shoulder those costs as well as reorganized operations and purpose that account for the harms while allowing for the benefits of opioid production. For more on the settlement and parallels between opioid litigation and fossil fuel litigation, see generally Joselow, *supra* note 199.

emitters. Meanwhile, prospective claimants from the Global South who have also suffered climate damages due to emissions from the same set of defendants will confront a higher procedural hurdle to access U.S. courts and secure damages. As a matter of procedural possibility, foreign plaintiffs could bring claims against fossil fuel producers with a nexus to the United States in U.S. courts under the Alien Tort Claims Act.[357] This strategy remains viable even in a post-*Jesner* context,[358] but such claims are unlikely to progress under the current Supreme Court.[359] The result is that foreign claimants will be disadvantaged by a judicial approach to recouping compensation for climate harms.

CONCLUSION

Statutory regulation of greenhouse gas emissions has remained an elusive goal for the legislative branch, and executive action has been blunted by political partisanship. Administrative agency interpretation to meet the challenge of climate change has been further hindered by the Supreme Court's recent opinion in 2022, in *West Virginia v. EPA*, which limited executive action on climate change.[360] Those seeking compensation for the impacts of climate change are turning to private law, and specifically tort law, as a tool of last resort. Advances in climate attribution science linking specific emitters to increased frequency and intensity of climate impacts address challenges previously identified as obstacles to a successful tort claim, including standing, duty and foreseeability, causation, and damages.

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[357] *See* 28 U.S.C. § 1350 ("The district courts shall have original jurisdiction of any civil action by an alien for a tort only, committed in violation of the law of nations or a treaty of the United States.").

[358] In 2018, in *Jesner v. Arab Bank, PLC*, the Supreme Court held that foreign corporations could not be defendants under the Alien Tort Claims Act (ATCA). 138 S. Ct. 1386, 1403 (2018). Claims against U.S. corporations by foreign claimants, however, remain possible. For discussion of the narrowing of the ATCA, see generally STEPHEN P. MULLIGAN, CONG. RSCH. SERV., LSB10147, THE RISE AND DECLINE OF THE ALIEN TORT STATUTE (2018). Such strategies might be compared to those advanced in a recent case from Germany. *See Luciano Lliuya v. RWE AG*, CLIMATE CASE CHART, http://climatecasechart.com/non-us-case/lliuya-v-rwe-ag/ [https://perma.cc/F5LH-DAHX]. In *Lliuya v. RWE AG*, a Peruvian farmer filed claims against a German energy company in German courts seeking damages for the flooding of his village due to the company's contributions to global GHG emissions. In addition, *Nestlé USA, Inc. v. Doe* may have implications for the scope of a nexus required to establish conduct as occurring in the U.S. *See* 141 S. Ct. 1931, 1937 (2021) (holding that "[t]o plead facts sufficient to support a domestic application of the ATS, plaintiffs must allege more domestic conduct than general corporate activity"). If, however, the conduct in question in the corporate climate deception cases is top-level corporate policy, then ATCA claims might remain viable for foreign plaintiffs.

[359] Myanna Dellinger, *Post*-Jesner *Climate Change Lawsuits Under the Alien Tort Statute*, 44 COLUM. J. ENV'T L. 241, 243 (2019).

[360] West Virginia v. EPA, 142 S. Ct. 2587, 2603 (2022) (holding that Congress did not grant the EPA authority to devise emissions caps based on a "generation shifting" approach taken in the agency's Clean Power Plan).

The developments in attribution science discussed in this Article have considerable implications for overcoming procedural and substantive obstacles to furthering climate tort litigation, but these scientific advances do not resolve or even neutralize embedded normative questions. Attribution methods might allow us to conceptualize and quantify the contributions of specific industries or companies to climate change, but they do not establish a moral duty to pay, the scope of emissions and liability, whether litigation is an efficient method for dealing with the costs of climate change, or the policy implications that a more robust climate tort regime might inspire. However, innovations in climate science do overcome procedural hurdles that would advance climate tort lawsuits. Moreover, they provide tools for conceptualizing and responding to such critical normative questions, thus allowing tort law to articulate new norms for a changing society as it has done in eras past.

APPENDICES

(Also available at https://perma.cc/RRD4-7KZ7)

Appendix A – Climate Tort Cases

Case Name	Filings Reviewed	Filings Relevant to Climate Attribution
City of Annapolis v. BP p.l.c.	5	5
Anne Arundel County v. BP p.l.c.	4	4
Connecticut v. Exxon Mobil Corporation	3	3
State of Delaware v. BP	3	3
City of Charleston v. Brabham Oil Company	3	3
City of Hoboken v. Exxon Mobil Corp. et al	4	4
State of Minnesota v. American Petroleum Institute	4	4
City & County of Honolulu v. Sunoco LP	12	6
Pacific Coast Federation of Fishermen's Associations, Inc. v. Chevron Corp.	4	1
Mayor & City Council of Baltimore v. BP p.l.c.	16	5
Rhode Island v. Chevron Corp.	13	6
Board of County Commissioners of Boulder County v. Suncor Energy (U.S.A.), Inc.	17	4
King County v. BP p.l.c.	7	2
City of Richmond v. Chevron Corp.	1	1
City of New York v. BP p.l.c.	3	3
City of Santa Cruz v. Chevron Corp.	1	1
City of Oakland v. BP p.l.c.	-	-
People of State of California v. BP p.l.c.	-	-
County of Marin v. Chevron Corp.	1	1

City of Imperial Beach v. Chevron Corp.	1	1
County of San Mateo v. Chevron Corp.	20	3
Pietrangelo v. S & E Customize It Auto Corp.	1	1
Comer v. Murphy Oil USA, Inc (2)	3	3
Native Village of Kivalina v. ExxonMobil Corp.	5	3
California v. General Motors Corp.	3	3
Comer v. Murphy Oil USA, Inc (1)	5	4
Connecticut v. American Electric Power Co.	6	4
	145	78

Appendix B – Year and Jurisdiction Filed

Case Name	Year Filed	Juridiction Filed
City of Annapolis v. BP p.l.c.	2021	MD
Anne Arundel County v. BP p.l.c.	2021	MD
Connecticut v. Exxon Mobil Corporation	2020	CT
State of Delaware v. BP	2020	DE
City of Charleston v. Brabham Oil Company	2020	SC
City of Hoboken v. Exxon Mobil Corp. et al	2020	NJ
State of Minnesota v. American Petroleum Institute	2020	MN
City & County of Honolulu v. Sunoco LP	2020	HI
Pacific Coast Federation of Fishermen's Associations, Inc. v. Chevron Corp.	2018	CA
Mayor & City Council of Baltimore v. BP p.l.c.	2018	MD
Rhode Island v. Chevron Corp.	2018	RI
Board of County Commissioners of Boulder County v. Suncor Energy (U.S.A.), Inc.	2018	CO
King County v. BP p.l.c.	2018	WA
City of Richmond v. Chevron Corp.	2018	CA
City of New York v. BP p.l.c.	2018	S.D.N.Y.
City of Santa Cruz v. Chevron Corp.	2017	CA
City of Oakland v. BP p.l.c.	2017	CA
People of State of California v. BP p.l.c. (San Francisco)	2017	CA
County of Marin v. Chevron Corp.	2017	CA
City of Imperial Beach v. Chevron Corp.	2017	CA
County of San Mateo v. Chevron Corp.	2017	CA
Pietrangelo v. S & E Customize It Auto Corp.	2013	NY
Tzakis v. Berger Excavating Contractors, Inc.	2012	IL
Comer v. Murphy Oil USA, Inc (2)	2011	S.D. Miss.
Native Village of Kivalina v. ExxonMobil Corp.	2008	N.D. Cal.
California v. General Motors Corp.	2006	N.D. Cal.
Comer v. Murphy Oil USA, Inc (1)	2005	S.D. Miss.
Connecticut v. American Electric Power Co.	2004	S.D.N.Y.

Appendix C – Type and Strength of Attribution Evidence

	Type of attribution evidence	**Strength of attribution evidence**		
	1	**2(i) – confidence**	**2(ii) – uncertainty**	**2(iii) – human influence**
A	Peer-reviewed attribution study	Confidence in attribution given (state value)	Uncertainty given (state value)	Magnitude of human influence = 100%
B	Extrapolation from regional/global attribution statement (e.g. IPCC)	No relevent confidence assessment	No relevant uncertainty assessment	> x2 likelihood (RR) / >50% FAR
C	Attribution presumed based on consistency with projections			< x2 likelihood (RR) / < 50% FAR
D	Attribution presumed / implied with no supporting evidence			Δ magnitude
E	Expert testimony			Other
F	IPCC evidence used			Not quantified
G	No causal link alleged			
H	Government report			

Case name	Type of scientific evidence		Strength of attribution evidence					
	1	Detail	2(i) – confidence	Detail	2(ii) – uncertainty	Detail	2(iii) – human influence	Detail
American Electric Power Co. v. Connecticut	C	Attribution presumed for observed changes	A	IPCC confidence for global warming	B	-	F (A)	Impacts / projections / observations presumed to be entirely attributable
Board of County Commissioners of Boulder County v. Suncor Energy (U.S.A.), Inc.	C / D / F	Uses IPCC statements and presumes emissions are responsible for changes which have been observed and projected	B	-	B	-	E	Change in magnitude given for various mean meteorological conditions but no attribution for any individual events
California v. General Motors Corp.	B / D	Use of IPCC evidence for attribution of global temperature change; presumes other impacts are attributable	A	IPCC confidence for global warming	B	-	F (A)	Impacts / observations presumed to be entirely attributable
City & County of Honolulu v. Sunoco LP	D	Observed changes and harmful events presumed attributable	B	-	B	-	F (A)	Impacts presumed to be entirely attributable
City of Imperial Beach v. Chevron Corp.	C / D	Peer-reviewed study, but not an attribution study; attribution to defendants alleged with no supporting evidence (incorrect claim that supporting reference demonstrates this)	B	-	B	-	F(A)	SLR presumed entirely attributable to human influence
City of New York v. BP p.l.c.	D	No attribution evidence provided, climate impacts presumed attributable (to defendants)	A	Quotes IPCC: "there is very high confidence that the net effect of human activities since 1750 has been one of warming"	B	-	F (A)	Impacts presumed to be entirely attributable
City of Oakland v. BP p.l.c.	A / C	Peer-reviewed studies and local government reports; primarily projections.	B	-	B	-	F(A) / B	Some impacts: >> return time, others, presumed 100% attributable (most are projections; case concerns adaptation costs)
City of Richmond v. Chevron Corp.	A	Refers to peer-reviewed attribution studies to substantiate claims of the impacts of human emissions on the plaintiffs	A	IPCC confidence levels given for global warming	B	No discussion of uncertainty (other than in the context of fossil-fuel companies' emphasising uncertainty in climate science)	B	Human emissions primary cause of glob temp rise; >70% for SLR
City of Santa Cruz v. Chevron Corp.	Identical to City of Richmond v Chevron Corp.							
Comer v. Murphy Oil USA, Inc (I)	D	Presumes Hurricane Katrina intensity is the direct result of climate change	B	-	B	-	D	"The environmental conditions present in the Gulf of Mexico which fostered the strengthening of Hurricane Katrina are the direct result of ... Global Warming"

Comer v. Murphy Oil USA, Inc (2)	D	Presumes attribution of SLR and hurricane strength	B	-	B	-	F (A)	Does not quantify extent of anthropogenic influence on different impacts; presumed 100%
County of Marin v. Chevron Corp.	Identical to City of Imperial Beach v. Chevron Corp.							
County of San Mateo v. Chevron Corp.	Identical to City of Imperial Beach v. Chevron Corp.							
County of Santa Cruz v. Chevron Corp.	Identical to City of Richmond v Chevron Corp.							
King County v. BP p.l.c.	C / D	Describes alleged climate change impacts in King County, some supported by comparison with projections	A	Provides 5-95% confidence intervals for regional warming	B	No discussion of uncertainty	F (A)	Impacts (primarily in future) are framed as likely consequences of climate change
Mayor & City Council of Baltimore v. BP p.l.c.	A	Refers to peer-reviewed attribution studies to substantiate claims of the impacts of human emissions on the plaintiffs	A	IPCC confidence assessment for human influence causing warming	B	-	C	"The same study also found climate change-related sea level rise has already increased the likelihood of extreme floods in and around Baltimore by at least 20 percent".
Native Village of Kivalina v. ExxonMobil Corp.	D	No specific attribution evidence, generalises from regional statements; paraphrases testimony to the US Senate Committee on Appropriation that flooding and erosion in coastal Alaska were due in part to rising temperatures.	A	Only discusses confidence in the context of IPCC AR4 assessment of that there is very high confidence in the net effect of human emissions causing warming	B	No discussion of uncertainty	F	Not quantified and unclear. "Due in part..." but also claims impacts are "due to" without substantiating references
Pacific Coast Federation of Fishermen's Associations, Inc. v. Chevron Corp.	A	Attribution science (BAMS) evidence from published literature on NE Pacific heatwaves	A	Only discusses confidence in the context of IPCC AR4 assessment of that there is very high confidence in the net effect of human emissions causing warming	B	-	B	Increased risk of warm 'blob' by at least a factor of 5
People of State of California v. BP p.l.c. (San Francisco)	See City of Oakland v. BP p.l.c							
Petrangelo v. S & E Customize It Auto Corp.								
Rhode Island v. Chevron Corp.	A	>70% SLR due to human influence 1970-2000, natural RF makes essentially zero contribution over the 20th Century. Further attribution evidence provided from reputable sources (e.g. Climate Central). Detailed attribution information given for various impacts	B	-	B	No discussion of uncertainty	A / B / F	Some impacts attributed directly, others partially (>70% for SLR) and others not quantified.

Tyahla v. Berger Excavating Contractors, Inc.	D	Changes in return time presumed attributable	B	-	B	-	F(A)	this Defendant knew or should have known that the older return frequency standards were substandard based upon the effect of global warming and climate change...'
State of Delaware v BP	D	Impacts presumed attributable	A	IPCC confidence assessment for human influence causing warming	B	Uncertainty only in context of fossil fuel company advocacy	F(A)	Impacts presumed directly attributable without formal substantiation
City of Charleston v Brabham Oil Company	D	Impacts presumed attributable	A	IPCC confidence assessment for human influence causing warming	B	Uncertainty only in context of fossil fuel company advocacy	F(A)	Impacts presumed directly attributable without formal substantiation
City of Hoboken v Exxon Mobil Corp. et al	A / B / D	Attribution evidence for fossil fuel combustion contribution to SLR, Superstorm Sandy etc, local attribution presumed based on general IPCC statements	A	IPCC confidence assessment for human influence causing warming	B	-	D / F(A)	Most impacts attributed according to change in intensity e.g. change in intensity of Hurricane Sandy; increase in high-tide flooding; 'Both storms were as intense as they were because of anthropogenic climate change' - but attributable change in storm intensity not quantified
City of Annapolis v. BP	D	Impacts presumed attributable	A	IPCC confidence assessment for human influence causing warming	B	No discussion of uncertainty	F(A)	Impacts presumed directly attributable without formal substantiation
Anne Arundel County v. BP	Identical to City of Annapolist v. BP							
Connecticut v. Exxon Mobil	D	Impacts presumed attributable	B	-	B	No discussion of uncertainty	F(A)	Impacts presumed directly attributable without formal substantiation
Minnesota v. API	D	Impacts presumed attributable	B	-	B	No discussion of uncertainty	F(A)	Impacts presumed directly attributable without formal substantiation

Appendix D – Emissions and Attributed Damages

	Emissions		Attributed Damages			
	3(i) - emission scopes	3(ii) - forcings	4(i) - how damages are attributed to physical impacts	4(ii) - economic damages	4(iii) - non-economic damages	4(iv) - physical impact
A	Scope 1 only	CO2 only	Entire cost presumed attributable	Economic losses quantified	Inclusion of non-economic losses	Sea-level rise
B	Scope 1 and 2	CO2 and CH4	Damages attributed according to change in intensity	Not quantified	Not included	Glacial retreat
C	Scope 1, 2 and 3	All GHGs	Damages attributed according to change in probability			Meteorological
D	Not specified	GHGs + aerosols	Unclear			Multiple
E	N/A	Attribution to individual emitter's emissions	Not specified			Other
F		Not specified	Other			
G		Other				
H		N/A				

	Emissions				Attributed Damages							
Case name	3(i) - emission scopes	Detail	3(ii) - foreign s	Detail	4(i) - attributing damages to physical impacts	Detail	4(ii) - economic damages	Detail	4(iii) - non-economic damages	Detail	4(v) - physical impact	Detail
American Electric Power Co. v. Connecticut	D	Not specified	C	All GHGs	A	Entire damages presumed attributable	B	Losses not quantified	A	Details of non-economic losses are provided	A / C / D	SLR / wildfires / agricultural impacts / heat and health etc
Board of County Commissioners of Boulder County v. Suncor Energy (U.S.A.), Inc.	D	Not specified	F	Not specified	A	Entire costs presumed attributable	B	Losses not quantified in the complaint, include future damages	B	Non-economic past and future damages within scope of alleged liability	C / D	Various meteorological impacts
California v. General Motors Corp.	C	Includes emissions from cars sold	A	CO2 only	A	Entire costs presumed attributable	B	Losses not quantified in the complaint, gives ballpark numbers ("millions of dollars" on adaptation etc)	A	Details of non-economic losses are provided	A / B / C / D	SLR / coastal erosion / glacial melt / meteorological: illustrative (rather than exhaustive) examples
City & County of Honolulu v. Sunoco LP	D	Not specified	F	Not specified	E	"But for Defendants' conduct, the City would have suffered no or far fewer serious injuries and harms than it has endured and foreseeably will endure, due to the climate crisis and its physical, environmental, social, and economic consequences"	B	Attributable losses not quantified	A	Details of non-economic losses are provided	A / C / D / E	SLR / storm impacts / ocean warming and acidification impacts on coral reefs, habitat loss, change of range and distribution of disease-carrying pest species, reduced availability of freshwater resources
City of Imperial Beach v. Chevron Corp.	C	-	B	-	A	Entire costs presumed attributable	A	Quantified projected financial losses are provided	A	Details of non-economic losses projected are provided	A	Sea level rise impacts
City of New York v. BP p.l.c.	C	Not specified	G	CO2, CH4, NOx	A	Entire costs presumed attributable to physical impacts	B	Adaptation costs. Most losses are not quantified; indication of potential losses due to sea-level rise to 2100 given	A	Details of non-economic losses projected are provided	A / C / D	SLR, extreme precipitation events
City of Oakland v. BP p.l.c.	C	-	A	Only refers to defendants' fossil fuel production	A	Physical impacts necessitate adaptation costs	A	Quantifies costs of building seawalls / upgrading sewers ($5bn and $350 million respectively)	A	Provides details of non-economic losses projected	A	Sea level rise impacts
City of Richmond v. Chevron Corp. [illegible]	C	-	B	Heede data	A	Entire costs presumed attributable to physical impacts	B	Not quantified	B	Don't specify non-economic losses but may be within the scope of liability	A / C / D	Sea level rise impacts, wildfires, extreme precipitation, landslides, salt water etc

City of Santa Cruz v.												
Comer v. Murphy Oil USA, Inc (1)	C	-	C	-	A	Entire costs presumed attributable to physical impacts	B	Not quantified	A	Details various non-economic losses	C	Hurricane impacts
Comer v. Murphy Oil USA, Inc (2)	C	-	C	"Carbon dioxide and other greenhouse gas"	A	Entire costs presumed attributable to physical impacts	B	Not quantified	A	Details various non-economic losses	A / C / D	SLR impacts, hurricane impacts
County of Marin v. Chevron Corp.												
County of San Mateo v. Chevron Corp.												
County of Santa Cruz v. Chevron Corp.												
King County v. BP p.l.c.	C	Implied	F	Not specified	A	Entire costs of future impacts presumed attributable to physical impacts	B	Economic costs not quantified	A	Details examples of impacts of a range of types	A / B / C / D / E	Wide range of impacts including SLR, physical retreat, meteorological impacts (e.g. heatwaves), trends (e.g. changing mean conditions.
Mayor & City Council of Baltimore v. BP p.l.c.	C	-	B	Heede data	A / B / C	"The City has already incurred, and will foreseeably continue to incure, injuries, and damages due to ... sea level rise and associated impacts, increased frequency and severity of extreme precipitation events' etc	B	Some damages quantified but not for all damages for which relief is sought	A	Details a range of present and future impacts (e.g. projected deaths due to extreme heat days)	A / C / D	SLR, coastal erosion, storm surges, hydrological cycle impacts, intensity / frequency of extreme precipitation events
Native Village of Kivalina v. ExxonMobil Corp.	D	Not specified. Values for cumulative company emissions not given	A	Also refers to other GHGs but doesn't quantify companies' proportional contribution to damages	A	Entire cost of relocation due to (attributable) physical impacts	A	Economic costs of relocation quantified	B	No quantification of non-economic losses (relief is limited to monetary damages)	A	Sea-level rise - coastal erosion, relocation cost
Pacific Coast Federation of Fishermen's Associations, Inc. v. Chevron Corp.	C	-	G	CO2, CH4, NOx	A	"But for the Hob, caused by Defendants' actions, the California and Oregon commercial Dungeness crab fisheries would not have been closed",	B	Impacts not quantified	B	Closure of crab fisheries	E	Marine heatwave
People of State of California v. BP p.l.c. (San Francisco)												
Pietrangelo v. S & E Customize It Auto Corp.												
Rhode Island v. Chevron Corp.	C	Heede data	B	"By quantifying CO2 and methane pollution attributable to Defendants by and through their fossil fuel products ... can be attributed to Defendants on an individual and aggregate basis"	D	Unclear how damages will be calculated "according to proof"	B	Economic costs not quantified	B	Not specified	A / C / D	Sea level rise, drought, precipitation events, heat waves

Tioga v. Berger Excavating Contractors, Inc.	F	N/A	H	N/A	A	Damages presumed directly attributable to impacts	B	Economic costs not quantified (but >$75,000)	A	Various non-economic damages detailed	C	Flooding from rainfall events
State of Delaware v. BP	C	Downstream emissions included	C	All GHGs	A	Damages presumed directly attributable to impacts, particular vulnerabilities of certain groups noted	B	Economic costs not quantified	A	Various non-economic damages detailed	A / C	SLR, hydrological impacts, extreme weather, droughts, heatwaves,
City of Charleston v. Brabham Oil Company	C	Downstream emissions included	C	All GHGs	A	Damages presumed directly attributable to impacts, particular vulnerabilities of certain groups noted	B	Economic costs not quantified	A	Various non-economic damages detailed	A / C	SLR, hydrological impacts, extreme weather, droughts, heatwaves,
City of Hoboken v. Exxon Mobil Corp. et al	C	Downstream emissions included	C	All GHGs	B	Sandy damages according to damage in net county (additional $2bn flooding damage to NYC alone)	A	>$500 million adaptation costs	A	Various non-economic damages detailed	A / C	SLR (to-date, future) high tide flood days, storms, extreme weather
City of Annapolis v. BP	C	Not specified	F	Not specified	A	Damages presumed directly attributable to impacts	B	Economic costs not quantified	A	Various non-economic damages detailed	A/C	SLR, hydrological impacts, extreme weather, droughts, heatwaves
Anne Arundel County v. BP												
Connecticut v. Exxon Mobil	C	Not specified	F	Not specified	A	Damages presumed directly attributable to impacts	B	Economic costs not quantified	A	Various non-economic damages detailed	A/C	SLR, flooding, droughts, extreme weather
Minnesota v. API	C	Not specified	G	CO2, CH4, NOx	A	Damages presumed directly attributable to impacts	A	>$500 million adaptation costs	A	Various non-economic damages detailed	A/C	SLR, snow and ice cover diminishing, droughts, extreme weather

Appendix E – Expert Evidence and Defendants' Responses

	Expert Testimony		**Defendants' Response**	
	5(i) - plaintiffs	**5(ii) - defendants**	**6(i) - Attribution**	**6(ii) - Responsibility**
A	Experts have expertise in and have published on climate change attribution science	Experts have expertise in and have published on climate change attribution science	Acknowledge role of climate change in creating specific impact	Acknowledges responsibility for impacts
B	Experts do not have expertise in attribution science	Experts do not have expertise in attribution science	Acknowldge role of GHG emissions in causing climate change but not in causing the specific impacts on plaintiffs	Challenges defendants' responsibility for impacts
C	No expert testimonies provided	Defendants do not seek to admit expert evidence to oppose causation argument	Reject alleged attribution	Do not discuss causation / attribution
D			Do not discuss causation / attribution	

Case name	Expert Evidence				Defendants' Approach			
	6(i) – plaintiffs	Detail	6(ii) – defendants	Detail	6(i) – Attribution	Detail	6(ii) – Responsibility	Detail
American Electric Power Co. v. Connecticut	C	No attempt to admit expert testimony	C	No response from defendants	N/A	-	N/A	-
Board of County Commissioners of Boulder County v. Suncor Energy (U.S.A.), Inc.	C	No attempt to admit expert testimony	C	No attempt to admit expert testimony	D	No discussion of attribution by defendants	C	No discussion of responsibility
California v. General Motors Corp.	C	No attempt to admit expert testimony	C	No attempt to admit expert testimony	D	No discussion of attribution by defendants	C	No discussion of responsibility
City & County of Honolulu v. Sunoco LP	C	Still in early stage	C	No response from defendants yet	N/A	-	N/A	-
City of Imperial Beach v. Chevron Corp.	A	Amicus brief submitted by Mario Molina, Michael Oppenheimer, Susanne Moser, Donald Wuebbles, Gary Griggs, Peter Frumhoff, and Kristina Dahl	?	?	D	No discussion of attribution by defendants	B	Plaintiffs' claims are preempted by the Clean Air Act
City of New York v. BP p.l.c.	C	Still in early stage	C	No response from defendants yet	N/A	-	N/A	-
City of Oakland v. BP p.l.c.	A	Tutorial by: Myles Allen, Gary Griggs, Donald Wuebbles	B	"Experts" = (1) Viscount Monckton of Brenchley, (2) Willie Soon, (3) David Legates, (4) William Briggs, (5) Michael Limburg, (6) Dietrich Jeschke, (7) Alex Henney, (8) John Whitfield, (9) James Morrison, William Happer, Steven Koonin, Richard Lindzen	C	"Because of the nature of the phenomena alleged, there is 'no realistic possibility of tracing any particular alleged effect of global warming to any particular [action] by any specific person, entity, or group at any particular level'" (Quoting Kivalina opinion) Also: "plaintiffs cannot prove that Defendants' conduct caused their alleged injuries" - argue that plaintiffs do not / cannot make claims about attribution of (marginal) impacts to defendants.	B	"Plaintiffs do not (and cannot) allege that Defendants' actions, by themselves, were sufficient to cause the climate-related harms Plaintiffs assert here" Also: argue that defendants' did not have control over use of their products.
City of Richmond v. Chevron Corp. ([illegible])	C	No attempt to admit expert testimony	C	No attempt to admit expert testimony	D	No discussion of attribution by defendants	C	No discussion of responsibility
City of Santa Cruz v. Chevron Corp.								
Comer v. Murphy Oil USA, Inc (1)	C	No attempt to admit expert testimony	C	No attempt to admit expert testimony	C	"global warming and its harms ... cannot be traced to discrete and identifiable sources"	B	Does not dispute that GHGs cause warming, but dispute that CO2 is 'inherently harmful and the responsibility of individual emitters
Comer v. Murphy Oil USA, Inc (2)	C	No attempt to admit expert testimony	C	No attempt to admit expert testimony	N/A	-	N/A	-

County of Marin v. Chevron Corp.								
County of San Mateo v. Chevron Corp.								
County of Santa Cruz v. Chevron Corp.								
King County v. BP p.l.c.	C	Unable to find any details of expert testimony provided	C	Did not contest causation / provide expert testimony	C	"With respect to cause in fact, Plaintiff does not allege that its alleged injuries from sea rise would not have occurred if any Defendant had altered its behaviors and stopped producing fossil fuel products … nor could it, as the "undifferentiated nature of greenhouse gas emissions from all global sources and their worldwide accumulation over long periods of time … make[] clear that there is no realistic possibility of tracing any particular alleged effect of global warming to any particular [action] by any specific person, entity, [or] group at any particular point in time." (Quoting Kivalina) … "Even if Defendants' productions were considered cumulatively, the	B	Challenges responsibility on various grounds including other firms are responsible and failure to demonstrate causal relationship between Defendants' emissions and impacts
Mayor & City Council of Baltimore v. BP p.l.c.	A	Amicus brief submitted by Mario Molina, Michael Oppenheimer, Bob Kopp, Fredi Otto, Suzanne Mester, Donald Wuebbles, Gary Griggs, Peter Frumhoff, Kristina Dahl	C	Defendants do not seek to admit expert evidence to oppose causation argument	C	"Indeed, Defendants as a group allegedly account for only a small percentage of worldwide, historical production and promotion of fossil fuels, yet Plaintiff asserts that "[b]ut for Defendants' conduct," Plaintiff would not have been injured"".	B	Challenges responsibility on grounds that Plaintiffs' claim that impacts would not have been experienced but for Defendants' actions is incorrect due to their limited contribution to GHG emissions
Native Village of Kivalina v. ExxonMobil Corp.	C	Unable to find any details of expert testimony provided	C	Did not contest causation / provide expert testimony	B	Do not challenge the argument that climate change is caused by GHG emissions and is responsible for the harm in Kivalina.	B	Argues that the defendants are arbitrarily selected and many others contribute to climate change
Pacific Coast Federation of Fishermen's Associations, Inc. v. Chevron Corp.	C	Unable to find any details of expert testimony provided yet	C	No expert testimony provided on the topic of causation	C	Do not directly challenge that climate change may be responsible for impacts, at least in part	B	Challenge attribution to plaintiffs' emissions given climate change is a global phenomenon
People of State of California v. BP p.l.c. (San Francisco)								
Pistrangelo v. S & E Contractor II Auto Corp.								
Rhode Island v. Chevron Corp.	C	Unable to find any details of expert testimony provided	C	No expert testimony provided on the topic of causation	D	No discussion of attribution by defendants	C	No discussion of responsibility
Tinkis v. Berger Excavating Contractors, Inc.	C	No expert testimony on attribution	-	Unable to find defendant's response	-	-	-	-
State of Delaware v BP	C	No expert testimony yet	-	No response from defendants yet	-	No response from defendants yet	-	No response from defendants yet
City of Charleston v Brabham Oil Company	C	No expert testimony yet	-	No response from defendants yet	-	No response from defendants yet	-	No response from defendants yet

City of Hoboken v. Exxon Mobil Corp. et al	C	No expert testimony yet	-	No response from defendants yet	-	No response from defendants yet	-	No response from defendants yet
City of Annapolis v. BP	C	No expert testimony yet	-	No response from defendants yet	-	No response from defendants yet	-	No response from defendants yet
Anne Arundel County v. BP								
Connecticut v. Exxon Mobil	C	No expert testimony yet	-	No response from defendants yet	-	No response from defendants yet	-	No response from defendants yet
Minnesota v. API	C	No expert testimony yet	-	No response from defendants yet	-	No response from defendants yet	-	No response from defendants yet

Appendix F – Top Five Repeat Defendants

Case	BP	Exxon Mobil	Chevron	Shell	Conoco Phillips
Annapolis v. BP	X	X	X	X	X
Anne Arundel County v. BP	X	X	X	X	X
Connecticut v. Exxon Mobil		X			
Delaware v. BP	X	X	X	X	X
Charleston v. Brabham Oil	X	X	X	X	X
Hoboken v. Exxon Mobil	X	X	X	X	X
Minnesota v. API		X			
Honolulu v. Sunoco	X	X	X	X	X
Pacific Coast Federation of Fishermen's Associations v. Chevron	X	X	X	X	X
Baltimore v. BP	X	X	X	X	X
Rhode Island v. Chevron	X	X	X	X	X
Boulder v. Suncor		X			
King County v. BP	X	X	X	X	X
Richmond v. Chevron	X	X	X	X	X
City of New York v. BP	X	X	X	X	X
Santa Cruz v. Chevron	X	X	X	X	X
Oakland v. BP	X	X	X	X	X
California v. BP	X	X	X	X	X
Marin v. Chevron	X	X	X	X	X
Imperial Beach v. Chevron	X	X	X	X	X
San Mateo v. Chevron	X	X	X	X	X
Pietrangelo v. S&E Customize It Auto Corp.					
Tzakis v. Berger Excavating Contractors					
Comer v. Murphy Oil (2)		X	X	X	
Kivalina v. ExxonMobil	X	X	X	X	X
California v. GM					
Comer v. Murphy Oil (1)	X	X	X		X
Connecticut v. AEP					

Appendix G – Repeat Defendants' Contribution to Global Emissions

Defendant	Number of Cases (of 28)	Percent of global emissions (1751-2010)[361]	Percent of emissions (1988-2015 Scope 1 & 3)[362]	2021 Revenue (USD)
BP	19	2.470%	1.50%	157,700,000,000
Exxon Mobil	23	3.210%	2.00%	285,600,000,000
Chevron	20	3.520%	1.30%	162,400,000,000
Shell	19	2.120%	1.70%	272,600,000,000
ConocoPhillips	19	1.160%	0.90%	45,800,000,000
Phillips 66	13	n/a	n/a	114,800,000,000
Hess	11	0.160%	n/a	7,500,000,000
TotalEnergies	7	0.820%	0.90%	205,800,000,000
Occidental Petroleum	7	0.350%	n/a	26,300,000,000
Marathon	14	0.210%	n/a	119,900,000,000
Consol	9	0.630%	0.50%	n/a
Peabody	5	0.860%	1.20%	n/a
Murphy USA	4	n/a	n/a	n/a
Devon	6	0.120%	n/a	12,200,000,000
Apache	7	0.070%	n/a	8,000,000,000
Arch resources	5	0.410%	0.60%	n/a
Eni	5	0.410%	0.60%	90,500,000,000
Rio Tinto	4	0.410%	0.70%	n/a
Repsol	5	0.230%	0.30%	61,600,000,000
OMV	5	0.020%	n/a	42,000,000,000
		17.180%	**12.20%**	

[361] *See* RICHARD HEEDE, CLIMATE MITIGATION SERVS., CARBON MAJORS: ACCOUNTING FOR CARBON AND METHANE EMISSIONS 1854–2010, at 27 tbl.12 (2014), https://climateaccountability.org/pdf/MRR%209.1%20Apr14R.pdf [https://perma.cc/S98M-H42P].

[362] *See* PAUL GRIFFIN, CLIMATE ACCOUNTABILITY INST., THE CARBON MAJORS DATABASE: CDP CARBON MAJORS REPORT 2017, at 14 app.I (2017), https://cdn.cdp.net/cdp-production/cms/reports/documents/000/002/327/original/Carbon-Majors-Report-2017.pdf?1501833772 [https://perma.cc/P4CK-KPY5].