FACULTY OF LAW AND CRIMINOLOGY

PROVING A CAUSAL LINK IN CLIMATE CHANGE LITIGATION

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Abstract

Climate change is one of the great challenges of this age. The impacts become more and more tangible, impacting ever larger groups of people. In line with this, the number of climate litigation cases is growing rapidly. The outcomes of many of those hinge on proving a causal link. In this thesis, I research ways to translate scientific evidence of the causal link between anthropogenic climate change drivers, climate change and climate change impacts to prove legal causation in climate change litigation for plaintiffs seeking damages for climate impacts or mitigation/adaptation orders. This requires firstly, scientific proof of causation along the causal chain. Secondly, it requires insight in what evidence judges require to find the existence of a causal link, and if and how scientific and expert evidence can meet that requirement in complex causal settings. A last element brings the previous two together, in looking concretely at how the scientific evidence of causation that's available, fares in practice: do plaintiffs have access to it, can they use it well, and could they manage to convince courts?

I found that science is capable of showing causal links across the causal chain with remarkable reliability. Climate science provides proof with likelihood high enough to meet the standard of proof applicable in civil lawsuits. It meets admissibility and reliability standards for use in court. However, I also found that the constellations of facts in climate litigation cases often strain the generally applied causation test, and proving but-for causal links between individual impacts and emitters remains challenging for plaintiffs. This hurdle may be surmounted by novel legal reasoning, which can be helped by the interchange of legal reasoning and models between jurisdictions and from other toxic tort cases. Leveraging litigation to influence the way climate change is viewed in society at large can also help. My research has shown that a lot of the required work has been done and is being done, both at the nexus of legal and climate scholarship and by legal practitioners. This can be expected to improve the odds of success for plaintiffs in climate-aligned cases.

Samenvatting

Klimaatverandering is een van de grote uitdagingen van deze tijd. De gevolgen worden steeds tastbaarder en treffen steeds grotere groepen mensen. In lijn daarmee neemt het aantal klimaatgerelateerde rechtszaken snel toe. De uitkomst van veel van die rechtszaken is afhankelijk van het aantonen van een causaal verband. In deze thesis onderzoek ik manieren om wetenschappelijk bewijs van het causale verband tussen antropogene oorzaken van klimaatverandering, de klimaatverandering zelf en de gevolgen van klimaatverandering te vertalen naar juridisch bewijs van causaliteit. Ik bekijk deze vraag in het kader van klimaatzaken waarin eisers een schadevergoeding voor klimaatschade en/of mitigatie- en adaptatiemaatregelen eisen. Ten eerste is wetenschappelijk bewijs van causaliteit langs de gehele causale keten vereist. Ten tweede is inzicht nodig in welk bewijs nodig is om rechters het bestaan van een causaal verband vast te laten stellen, en in welke mate en op welke manier wetenschappelijk en deskundig bewijs aan die eisen kan voldoen in complexe causale settings. Een laatste element brengt de vorige twee samen, door concreet na te gaan hoe het wetenschappelijk bewijs van causaliteit dat beschikbaar is, het in de praktijk doen: hebben eisers er toegang toe, kunnen ze het goed gebruiken, en kunnen ze erin slagen rechters te overtuigen?

Ik heb vastgesteld dat de wetenschap in staat is om met opmerkelijk hoge betrouwbaarheid causale verbanden aan te tonen. Klimaatwetenschap levert bewijs met een waarschijnlijkheid die hoog genoeg is om te voldoen aan de bewijsstandaard die geldt in burgerlijke rechtszaken en dat voldoet aan de ontvankelijkheids- en betrouwbaarheidsnormen voor gebruik in de rechtbank. Ik heb echter ook vastgesteld dat de feitenconstellaties in klimaatrechtszaken de algemeen toegepaste causaliteitstests vaak onder druk zetten, en dat het bewijzen van een oorzakelijk verband tussen lokale klimaatimpacts en individuele uitstoters van broeikasgassen een uitdaging blijft voor eisers. Deze hindernis kan worden overwonnen door nieuwe juridische argumentaties. Inspiratie daarvoor kan gevonden worden in de uitwisseling tussen jurisdicties en in andere zaken over aansprakelijkheid voor vervuiling. Klimaatzaken strategisch inzetten om de manier te beïnvloeden waarop klimaatverandering in de samenleving bekeken wordt, kan ook helpen. Uit mijn onderzoek is gebleken dat veel van het daarvoor vereiste werk gedaan is en wordt, zowel op het raakvlak van juridische en klimaatwetenschap als door juristen in de praktijk. Dit zal de kansen op succes voor eisers in klimaatzaken vergroten.

Acknowledgements

> “Se vogliamo che tutto rimanga come è, bisogna che tutto cambi. Mi sono spiegato?”
> –Tancredi in *Il Gattopardo* by Giorgio Tomasi di Lampedusa[1]

This master’s thesis is the culmination of what was perhaps a crazy idea: starting a law degree at age 34. It’s a rather fitting culmination, however, since climate litigation, and environmental and human rights law more generally, were what motivated me to embark on this journey. Arriving here wouldn’t have been possible without the continuing support of my family, so, thanks infinitely Nelle and Maia Josephine—if this thesis is to benefit anyone, let it be you. Neither would it have been possible without the support of what have been a lot more than just wonderful colleagues at de Koer in Gent. The same goes, without saying, for my extended family and my friends.

My work on this thesis started when I spotted the proposed topic on 20 September 2021, and immediately sent an email to my promotor, professor Dembour. After a meeting with professor Dembour and Nele Schuldt, a PhD-student affiliated to professor Dembour’s DISSECT research project, the work started in earnest. Finally—without yet knowing what for exactly, I’d been collecting notes and source material on climate litigation for years before. I’d like to sincerely thank professor Dembour and Nele for giving me a direction, a framework and, more importantly, for their valuable input, feedback, inspiration–and for putting up with my nasty habit of cutting close to deadlines.

Climate change is terrifying, but confronting it is possible; it’s all we can do and what we must do. I’m hopeful, as we all have to be. Onwards.

Jef Seghers
Genoa, 15 May 2023

[1] “If we want things to stay as they are, things will have to change. Did I make myself clear?” GT di Lampedusa, *Il Gattopardo* (11th edn, Feltrinelli) 41.

Luca Cambiaso, ‘Odysseus Slays the Suitors in His Palace’ (1565-66).[2] Odysseus wields the Aegis, Athena’s shield with Medusa’s head attached to it.

[2] Fresco in the Salone del Cambiaso at the Palazzo della Meridiana, Genoa, Italy. <https://www.palazzodellameridiana.it/> accessed 1 May 2023. Picture from <https://genovacittasegreta.com/2017/04/07/lesaltazione-della-vendetta-in-un-affresco-cinquecentesco/> accessed 5 May 2023.

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1. Introduction

> "Felix, qui potuit rerum cognoscere causas."
> – Virgil[3]

1.1. Background

As one of the great (the greatest?) issues of our time, climate change cannot be ignored. It is such an all-encompassing challenge that it has been described as a hyper-object, something "massively distributed in time and space relative to humans" so "pervasive, large, [...] multidimensional and [extended] across such enormous timeframes," that it can overwhelm human individual and collective cognition, threatening, like a Medusa, to turn us into stone.[4] Others have described it as a *wicked problem*, featuring the risk of irreversible and catastrophic effects, the lack of a coordinated global governance system capable of addressing it and irrationally excessive discounting of the future such that the benefits of intervention are undervalued,[5] leading the public and decision makers to make short-term decisions even in the face of overwhelming evidence.[6]

The first theories about the phenomenon date back many decades,[7] and by now it has long been agreed that anthropogenic climate change is a fact. This entails a warming of the global climate, caused by the emission of greenhouse gases (GHG) from human activities, which has accelerated greatly since the beginning of the industrial revolution.[8] The consequences and impacts have been predicted with ever greater accuracy in the past decades, and for some years now they have been unmistakably measurable and tangible. The greenhouse effect is causing global warming of the oceans and atmosphere, which

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[3] "Fortunate is he, who was able to know the causes of things", a citation from the works of Virgil (Virgil, <https://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.02.0059%3Abook%3D2%3Acard%3D475> accessed 25 May 2022, Georgica, II, verse 490). Dryden translated it as: "Happy the Man, who, studying Nature's Laws, / Thro' known Effects can trace the secret Cause" (Dryden, *The works of Virgil*, (1697)). The same line can be read in J Rozie and T Vansweevelt, 'Causaliteit in het Belgisch strafrecht' (2014) 8 Preadviezen Vereniging voor de vergelijkende studie van het recht 105. It seemed appropriate to me as a coda to my research plan, and, correspondingly, as the opening and inspiration for the implementation.

[4] E Boulton, 'Climate Change as a 'hyperobject': A Critical Review of Timothy Morton's Reframing Narrative' (2016) 7 WIREs Climate Change 772, 777;

[5] FEL Otto and others, 'Causality and the fate of climate litigation: The role of the social superstructure narrative' (2022) 13 Global Policy 736, 740.

[6] S Marjanac and L Patton, 'Extreme weather event attribution science and climate change litigation: an essential step in the causal chain?' (2018) 36 Journal of Energy & Natural Resources Law 265, 275; V Thomas, *Risk and Resilience in the Era of Climate Change* (Palgrave Macmillan Singapore 2023) 104. Other examples of such problems, such as smoking, ozone depletion and COVID-19, "have seen coherent, effective global solutions." There is hope.

[7] Fossil fuel companies made a significant contribution to early climate science. See, for instance, G Supran, S Rahmstorf and N Oreskes, 'Assessing ExxonMobil's global warming projections' (2023) 379 Science eabk0063. The way fossil fuel companies tried creating confusion around climate change and its drivers is a central issue in one of the cases I study; see 5.2.

[8] IPCC, 'Summary for Policymakers' in V Masson-Delmotte and others (eds), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2021).

results in frequent episodes of extreme weather such as heat waves,[9] hurricanes, prolonged droughts, changing patterns of rainfall, etc.[10] These phenomena frequently result in damage, from widespread and common occurrences such as destroyed property, crop failures, the costs of adapting to e.g. drought, heat or rising sea levels, to more extreme cases such as the disappearance of villages or—in time—entire states due to rising sea levels.[11]

In what follows, I will continue setting the scene with a problem definition, before describing the aims of my thesis and the main research question I have tried to answer. I will then describe my research methods, before giving a brief outline of what I found. This chapter will be closed with an outline of what will follow after it.

1.2. Problem definition

In line with the ongoing climate change and the increasing incidence of climate damage, the number of legal cases involving climate issues is also increasing rapidly.[12] Such cases can be brought in the vertical relationship against states, between states (although there seems to be much international resistance to an interstate loss and damage mechanism in the climate change field)[13] and in the horizontal relationship between citizens.[14]

Climate change, as a phenomenon which "disproportionately strikes those who have contributed least to it and who are also, for a variety of reasons, least well-placed to respond,"[15] raises fundamental questions of justice and fairness, across temporal and spatial scales. Many climate cases can be understood as so-called strategic litigation,[16] which refers to lawsuits whose intended impact goes beyond the specific claim, with the aim of bringing about change in law, policy, practice or discourse.[17] The legal route is one of a range of

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[9] V Thompson and others, 'The Most At-risk Regions in the World for High-impact Heatwaves' (2023) 14 Nature Communications, article number 2152 1.
[10] IPCC WG I (n 8).
[11] IPCC, 'Summary for Policymakers' in HO Pörtner and others (eds), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2022).
[12] J Setzer and C Higham, 'Global Trends in Climate Change Litigation: 2022 Snapshot' (Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science 2022) 2; H Schoukens and CM Billiet (eds), *Klimaatrechtspraak. Waarom rechters het klimaat (niet) zullen redden*, (die Keure 2021) 23.
[13] R Mechler and others (eds), *Loss and Damage from Climate Change - Concepts, Methods and Policy Options* (Springer Open 2019) 196.
[14] The reference database for climate change litigation is the Climate Case Chart of the Sabin Center for Climate Change Law at Columbia Law School and Arnold & Porter. The website contains a U.S. Climate Change Litigation database and a Global Climate Change Litigation database, which contains all cases except those from the U.S (see http://climatecasechart.com/). Another important resource, especially for cases outside of the US, is the Climate Change Laws of the World Database, which joins the aforementioned with data collected by the Grantham Research Institute at the London School of Economics (see https://climate-laws.org/). Finally, the yearly case law overviews published by Setzer and Higham at the Grantham Research Institute are also useful references (see e.g. Setzer and Higham (n 12)).
[15] Marjanac and Patton (n 6) 276.
[16] Setzer and Higham (n 12) 1.
[17] M Hinteregger, 'Civil Liability and the Challenges of Climate Change: A Functional Analysis' (2017) 8 Journal of European Tort Law 238, 245.

tactics that activists use to achieve their goals, in addition to political influence, influencing public opinion and so on.[18] As Stuart-Smith puts it:

> "The objectives of these lawsuits include compelling governments and corporations to reduce greenhouse gas emissions [...] A subset of these cases makes claims relating to climate change impacts. In most of these cases, plaintiffs (1) seek compensatory damages for losses incurred as a result of defendants' greenhouse gas emissions ('damage liability cases'), or (2) ask courts to compel defendants, primarily governments or corporations, to reduce emissions."[19]

Conversely, climate litigation can also be strategic for the defendants, especially those against companies, because judgements in favour of plaintiffs can put business models under pressure.[20] The WEF stated, in 2013:

> "[...] five decades ago, the US tobacco industry would not have suspected that in 1997 it would agree to pay US$ 368 billion in health-related damages. For some businesses, investing in climate change mitigation now could be as much about enterprise risk management as about mitigating a global risk."[21]

These cases hinge on proving that a causal relationship exists between the defendants' emissions and climate impacts.[22] For a claim for damages or an order or injunction to be granted, the plaintiff must, according to generally accepted legal theory, prove three things: the existence of a fault,[23] of damage and of a causal connection between the two.[24] If an injunction for emissions reductions is sought, it must usually also be shown that this remedy can reduce or stop the harm (redressability). When judging if a plaintiff has standing, (at

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[18] T Ezer and P Patel, 'Strategic Litigation to Advance Public Health' (2018) 20 Health and Human Rights Journal 149, 151.
[19] R Stuart-Smith and others 'Attribution science and litigation: facilitating effective legal arguments and strategies to manage climate change damages' (Summary report for FILE Foundation 2021) 1.
[20] J Setzer and C Higham, 'Global Trends in Climate Change Litigation: 2021 Snapshot' (Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science 2021), 30; Setzer and Higham (n 12) 19; G Ganguly, J Setzer and V Heyvaert, 'If at First You Don't Succeed: Suing Corporations for Climate Change' (2018) 38 Oxford Journal of Legal Studies 841, 858 and 862.
[21] Cited from Z Akhtar, 'Greenhouse Gas Emissions, "Event Attribution" and Locus Standi in Foreign Courts', (2020) 50 Environmental Policy and Law 50 309, 213. Law firms, too, are increasingly publishing reports on the issue and related risks to business. ee, for example, A Chaize, I Thain and J Medlong, 'Tortious claims and climate change: Where are we now?' (2023 DLA Piper International LLP) <https://www.dlapiper.com/en/insights/publications/2022/1/tortious-claims-and-climate-change-where-are-we-now> accessed 29 March 2023 ; M Clarke and T Hussain, 'Climate change litigation: A new class of action' (2018 White & Case LLP) <https://www.whitecase.com/insight-our-thinking/climate-change-litigation-new-class-action> accessed 2 May 2023; Dentons, 'Climate litigation risk – five trends to watch in 2023' (2023 Dentons) <https://www.dentons.com/en/insights/articles/2023/january/9/climate-litigation-risk-five-trends-to-watch-in-2023> accessed 2 May 2023 and Freshfields, 'Legal risk and climate change. What rising global temperatures mean for business' (2019 Freshfields Bruckhaus Deringer LLP) <https://www.freshfields.com/4aeb7b/globalassets/our-thinking/campaigns/climate-change/07803_fi_climate_change.pdf> accessed 2 May 2023.
[22] Stuart-Smith and others (n 19) 1.
[23] Or duty and breach of duty, or activity from which strict liability can arise.
[24] H Bocken, I Boone and M Kruithof, *Inleiding tot het Schadevergoedingsrecht* (2014 Die Keure) 27; RW Wright, 'Causation in Tort Law' (1985) California Law Review 1735, 1758.

least) *prima facie* evidence of causality is often also required.[25] Note that this challenge of establishing legal causality based on scientific evidence is not limited to climate change litigation, but is also present in other toxic tort cases such as tobacco, asbestos or DES.[26]

Whether or not a causal link between damage, emissions and/or climate change can be successfully proven largely determines the chances of success of a claim for compensation.[27] Proving legal causality is often—but not always[28]—the hurdle that plaintiffs fail to take, leading to dismissal of their claim.[29] This topic will form the central question of my thesis.

1.3. Aims & research question

The general aim of my research is to study ways to translate scientific proof of causation to help establish legal causation in climate change litigation. This is needed because the legitimacy of the factual determination a judge makes when deciding a case depends on external epistemic support.[30] Another way of stating the issue is thus: to what extent can scientific evidence of causality help supply the needed epistemic support to legitimise a judicial decision of legal causality?

The research is normative, not positive, in that I did not limit myself to trying to establish what the positive, existing legal rule on causations in climate change litigation are,[31] but also try to establish what can improve the odds that claimants succeed in proving legal causation, which will necessarily involve thinking *de lege ferenda*. Specifically, I will analyse the (legal) hurdles a plaintiff may encounter in proving a causal link when seeking damages or injunctions in climate change litigation, and suggest ways to overcome them.

My main research question can be stated as follows: What are ways to translate scientific evidence of the causal link between anthropogenic climate change drivers, climate change and climate change impacts to prove legal causation in climate change litigation for plaintiffs seeking damages for climate impacts or mitigation/adaptation orders?

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[25] Akhtar (n 21) 309. See also M Drenovak-Ivanovic, 'Standing in Environmental Law after Urgenda, Juliana and COVID-19 Crises: Who Should Force Governments to Act in Environmental Issues Related to Climate Change?' (2020) 4 ECLIC 3.
[26] See S Lawson, 'The Conundrum of Climate Change Causation: Using Market Share Liability to Satisfy the Identification Requirement in Native Village of Kivalina v. Exxonmobil Co.' (2011) 22 Fordham Envtl L Rev 433.
[27] M Van Quickenborne, *Oorzakelijk verband tussen onrechtmatige daad en schade* (Recht en Praktijk 47, Kluwer 2006) 11 citing AM Honoré, 'Causation and remoteness of damage' in *International Encyclopedia of comparative law* (vol. XI, *Torts*, chapter 7, Tübingen-Den Haag-New York 1972) [107]-[110].
[28] See f.i. *Commune de Grande-Synthe* Conseil d'État (FR) 1 July 2021 427301 ECLI:FR:CECHR:2021:427301.20210701 <https://www.conseil-etat.fr/fr/arianeweb/CE/decision/2021-07-01/427301> and Schoukens and Billiet (n 12) 225.
[29] RF Stuart-Smith and others, 'Filling the Evidentiary Gap in Climate Litigation' (2021) 11 Nature Climate Change 651.
[30] K Sulyok, *Science and Judicial Reasoning: the legitimacy of international environmental adjudication* (Cambridge University Press 2021) 28.
[31] Cf. "The prophecies of what the courts will do in fact, and nothing more pretentious, are what I mean by the law." OW Holmes, 'The Path of the Law' (1897) Harvard Law Review 461.

The answers to the following sub-questions will provide the necessary elements to answer the main question. The first two are more descriptive/explanatory, whereas the last one is more normative/exploratory in that I will evaluate what I find in the first two questions with a view to answering the third sub-question.[32]

A. What degree of certainty (i.e. what statistical probabilities) can climate (detection and attribution) science provide? (SQ1)
    - In linking emitters to climate change?
    - In linking climate change to impacts?
    - In linking damage to impacts?
B. What degree of certainty is required to establish legal causation under uncertainty in climate change cases? (SQ2)
    - How does this vary across jurisdictions?
    - Is the required degree of certainty the same across the climatic causal chain?
    - Is there an established 'translation' from the required certainty to a statistical probability? How are probabilities expressed in words? Is this done consistently?[33]
C. What types of and ways to present scientific evidence in court help, or don't help, in proving legal causality in climate change cases? (SQ3)
    - What evidence is presented? How is it judged? Is it in line with the scientific state of the art? What is the role and impact of expert testimony?
    - Do climate science and legal practice interact?
    - What difficulties do plaintiffs encounter when trying to prove causality? What could alleviate these?

1.4. Methods

In this section, I will describe the research methods used in this thesis; the toolkit I used to shed light on the research questions. I will set out by outlining the research strategy I applied, followed by an overview of how I collected and analysed data.

1.4.1. Research strategy

The legal theoretical framework[34] within which I situate my research is the issue of causality in damage compensation/tort law. This framework is well established, with troves of doctrinal and broader legal scholarship published over many decades.[35] Within this field, my research questions, however, are relatively less researched. Climate science is likewise well established,[36] but the field of detection/attribution within climate science is developing quickly.

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[32] S Taekema, 'Theoretical and Normative Frameworks for Legal Research: Putting Theory into Practice' [2018] Law and Method 2.
[33] See S Willems, C Albers and I Smeets, 'Variability in the Interpretation of Probability Phrases Used in Dutch News Articles — a Risk for Miscommunication' (2020) 19 Journal of Science Communication A03.
[34] Taekema (n 32); J Gerring and L Cojocaru, 'Selecting cases for intensive analysis: A diversity of goals and methods' (2016) 45(3) Sociological Methods & Research 392, 394.
[35] See the different books cited in the bibliography.
[36] With years of widely accepted IPCC-reports; see also Schoukens and Billiet (n 12) 278-279.

My main research strategy will be the case study, a qualitative, doctrinal strategy.[37] The research is comparative in nature, especially as it concerns SQ2 and SQ3. I have looked across legal systems and jurisdictions from a functional point of view[38] in order to answer the research questions. By analysing cases from the point of view of my research questions, I have studied the way in which scientific evidence of causation can result (or not) in the acceptance of legal causation in a judicial decision.

I departed from a literature review in order to flesh out SQ1. In answering SQ2, I likewise researched the literature to elaborate the theoretical framework on causality that frames the research. Thus, for SQ1 and SQ2 the focus will be explanatory. Finally, when moving to SQ3, the research was more normative, and the method of necessity more exploratory.

1.4.2. Scope, data collection & analysis

In the first phase, I reviewed the extensive extant literature on legal causation, climate science and the overlap between both. I also reviewed climate change cases in which the question of establishing (legal) causality is discussed.[39] I used databases such as the Climate Case Chart, the Climate Change Laws of the World Database as well as case law overviews such as those published by Setzer and Higham.[40]

Both the causes of climate change and its consequences are global phenomena. Similarly, climate science, activism and policy only make sense if they are viewed across borders. For these reasons, I also look at the problem globally, in a comparative law perspective. This means I will be discussing legal concepts, more than specific instruments, laws or statutes. Since climate change litigation is a relatively recent phenomenon, I do not explicitly limit the temporal scope.

I limited my research to civil cases[41] before domestic courts, since this is where most can be found (especially litigation in which damages or injunctions are sought).[42] As to law systems, I set out with a very broad scope: including civil and common law systems. This does, however, exclude a number of legal traditions (chthonic or indigenous, talmudic, Islamic, Hindu and Confucian law, when borrowing Glenn's taxonomy of legal traditions).[43]

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[37] W Hardyns, *Onderzoeksmethoden* (coursebook for bachelor of Laws, Universiteit Gent 2017); Taekema (n 32) 45.
[38] R Michaels, 'The Functional Method of Comparative Law' in R Mathias and R Zimmermann (eds), *The Oxford Handbook of Comparative Law* (Oxford Academic 2006) 339-382.
[39] In my research plan, I wrote that I planned to produce a taxonomy of cases. However, given the limited time available to perform the research, and the extensive number of taxonomies, overview publications etc.that are already available, I decided not to do this. The added value to this thesis would have been limited.
[40] See n 14.
[41] The criminal angle is interesting as well. See for example this forthcoming paper: D Arkush and D Braman, 'Climate Homicide: Prosecuting Big Oil For Climate Deaths' (2024) 48 1 Harvard Environmental Law Review, <http://dx.doi.org/10.2139/ssrn.4335779> accessed 29 March 2023.
[42] Setzer and Higham (n 12) 2.
[43] H Patrick Glenn, *Legal Traditions of the World: Sustainable diversity in law* (5th edn, Oxford University Press 2014)

With a view to the case studies, I looked for cases that concern plaintiffs seeking damages for climate impacts and/or mitigation injunctions and/or compensation for adaptation measures, and in which scientific evidence is used in trying to establish or prove legal causality. By selecting cases, I severely but naturally limited the scope. This raises the question of the *case selection* method.

My thesis can be typified as descriptive (as opposed to causal).[44] I selected relatively diverse cases, in order to capture the diversity of possible answers to the main research question.[45] The four cases comprise two sets of two comparable cases, an older one and a (very) recent one. The cases span two major legal traditions, common law and civil law, as well as 15 years and two 'waves' of climate litigation.[46] During this timeframe, climate science also evolved a lot, as we will see in chapter 3. The climate itself, as well, changed, and climate change's impacts became more and more visible, as shown by the progression reports released by the Intergovernmental Panel on Climate Change (IPCC)[47] over the period.[48]

I made an in-depth analysis of the cases, in an approach inspired by the dissecting method developed by Dembour.[49] I analysed the use of evidence in the documents that are available for the different cases. These include submissions by the plaintiffs and the defendants, export testimony, as well as court decisions. I also reviewed the literature (jurisprudence and climate science) related to the cases. For the recent cases, as less documents are available, I interviewed a key person involved in each case.[50] My analysis focuses specifically on the issue of causation. Other issues that impact the outcome of the cases discussed, such as the political questions doctrine[51] or the permit defence[52], are out of scope.

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[44] Gerring and Cojocaru (n 34) 394.
[45] Ibid.
[46] See section 5.1.
[47] See www.ipcc.ch.
[48] D Corrington, 'From climate change 'certainty' to rapid decline: a timeline of IPCC reports' *The Guardian* (London 20 March 2023) <https://www.theguardian.com/environment/2023/mar/20/from-climate-change-certainty-to-rapid-decline-a-timeline-of-ipcc-reports> accessed 8 May 2023.
[49] MB Dembour, 'A Dissecting Method of Analysis' in *When Humans Become Migrants. Study of the European Court of Human Rights with an Inter-American Counterpoint* (Oxford University Press 2015) ch 1 section VIII 22.
[50] Interview with Cybèle Schneider, Juristische Fachperson Klimagerechtigkeit, HEKS-EPER (online from Bern, Switzerland and Genoa, Italy, 26 April 2023); Interview with Melissa Sims, Senior Counsel, Milberg Coleman Bryson Phillips Grossman LLC (online from Illinois, United States and Genoa, Italy, 27 April 2023).
[51] In the case of *Native Village of Kivalina v ExxonMobil Corp,* "The District Court held that Kivalina's claims were "barred by the political question doctrine and for lack of standing under Article III." Under the political question doctrine, the determinations it would have to make in order to resolve the nuisance claim were issues that should be determined by either the legislative or executive branch." N Johnson, 'Say Goodbye to Federal Public Nuisance Claims for Greenhouse Gas Emissions' (2013) 40 Ecology Law Quarterly 557, 558.
[52] For an example of this argument applied to *Lliuya v RWE*, see A Chatzinerantis and M Appel, 'Climate Change Litigation – The Liability of CO2-Emitters under German Law' (2019) 13 Carbon & Climate Law Review 280, 284.

Throughout this thesis, I used the Oscola 4th edition citation style.[53] More information on the archiving and future accessibility of the data collected can be found in the research data management plan, attached as an annex.

1.5. Findings

I found that science is capable of showing causal links across the causal chain with remarkable reliability. Climate science meets admissibility and reliability standards for use in court, and can make statements with a high enough likelihood to meet the standard of proof applicable in civil lawsuits. The constellations of facts in climate litigation cases often strain the generally applied legal causation frameworks, and proving but-for causal links between individual impacts and emitters remains a challenge for plaintiffs. Novel legal reasoning may be required to overcome this hurdle, which can be helped by the interchange of legal reasoning and models between jurisdictions and from other toxic tort cases, and by leveraging strategic litigation to influence the way climate change is viewed in society at large. My research has shown that a lot of the required work has been done and is being done, both at the nexus of legal and climate scholarship and by legal practitioners. This can be expected to improve the odds of success for plaintiffs in climate-aligned cases.

1.6. Outline

In what follows, I will first sketch the theoretical framework around the different threads of my thesis, examining climate and climate change, the metaphysical background to the question of causation, and how this translates to scientific and legal accounts of causation. In the following three chapters, I will answer the sub research questions in turn. Chapter 3 addresses the state of the art in climate science and how it supports the case for a causal link. In Chapter 4, I move to the legal angle, studying what degree of certainty is required to establish legal causation under uncertainty in climate change cases. In chapter 5, I explore how the theory works in practice, studying how the argument for causation was made in four different climate cases. This will allow me to set out my findings in chapter 6. In chapter 7, I will discuss the findings, before concluding in chapter 8.

2. Theoretical framework

Even though this master's thesis has the concepts of causation in the law and in science as its main playfield, a thorough understanding of the topic requires us to start off taking a wider view. Stepping back from the narrower scope of this thesis, I will look at the broad strokes of climate and climate change, the metaphysical background to the question of causation, and how this translates to scientific and legal accounts of causation. Along the way, I will define a number of concepts as they will be used in the rest of my thesis.

[53] See <https://www.law.ox.ac.uk/sites/default/files/migrated/oscola_4th_edn_hart_2012.pdf> consulted very often.

2.1. Climate, weather, greenhouse gases and climate change

However trivial it may seem, given the amount of publications written about it, and the intuitive ease with which the terms are usually used, we will now discuss climate, weather, emissions and climate change, concepts which are central to the question of the causal link in climate litigation and which are used throughout my thesis.

The World Meteorological Organisation (WMO) defines climate as the average weather and the statistics of its variability over a period of thirty years. Weather, as the WMO defines it, describes "short term natural events–such as fog, rain, snow, blizzards, wind and [thunderstorms], tropical cyclones, etc.--in a specific place and time."[54] When considering that the impact of climate change drivers, such as rising levels of GHGs in the atmosphere of anthropogenic aerosols, can cause significant changes in shorter timescales, this definition is problematic.[55]

A different definition of climate is more useful in the context of climate change. Edward Lorenz put it pithily: "climate is what you expect, weather is what you get".[56] More precisely, the definition is as follows:

> "[...] the 'expected' weather, and its variability, given the boundary conditions (in lay terms, the parameters governing the climate system, including atmospheric composition, levels of solar and volcanic activity and so on) that apply to the atmosphere-ocean system at any given time."[57]

This definition thus is based not on weather statistics over a long time, but calculated for a large range of hypothetical earths ('possible worlds') under different boundary conditions. Given that boundary conditions, in reality, change all the time, the properties of climate under this definition can only be inferred by combining observations with theory, models and (computer) simulations. This definition is better adapted to a rapidly changing real climate, and to the way climate and attribution science work today, as we will see in chapter 4.[58]

Anthropogenic climate change entails a warming of the global climate, caused by the emission of GHG from human activities, which has accelerated greatly since the beginning of the industrial revolution.[59] Many different chemical substances have a greenhouse effect. The IPCC defines greenhouse gases as:

> "[...] those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit [...] specific wavelengths [of the] radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary GHGs [...] there are a number of entirely human-made GHGs [...] such as the halocarbons and other chlorine- and

[54] See WMO, <https://public.wmo.int/en/our-mandate/weather> accessed 8 May 2023.
[55] M Allen, 'The scientific basis for climate change liability' in Lord R, Goldberg S, Rajamani L and Brunnée J *Climate change liability. Transnational Law and Practice* (Cambridge University Press 2012) 9.
[56] M Allen, 'Liability for climate change. Will it ever be possible to sue anyone for damaging the climate?' (2003) 421 Nature 891.
[57] Allen (n 55) 8-22
[58] Ibid 22.
[59] IPCC WG I (n 8).

bromine-containing substances, [...] sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)."[60]

The emissions of the different GHG can be aggregated as CO_2-equivalents.[61]

The greenhouse effect impacts the earth system, causing global warming of the oceans and atmosphere that is leading, among other things, to rising sea levels (due to expansion of the warming water in oceans and seas and melting of ice caps) and changing weather patterns. This results in frequent episodes of extreme weather such as heat waves,[62] hurricanes, prolonged droughts, changing patterns of rainfall, etc.[63]

It's important to note that the climate responds to absolute changes in GHG levels in the atmosphere relative to pre-industrial levels, and not to the *rate of change* of these levels. Since CO_2, the most impactful GHG (both in concentrations and projected impacts), is broken down only very slowly in the atmosphere, emissions made today will continue to affect the climate for centuries.[64] This means that changes in emissions today will not have an immediate discernible effect, and that all GHG emitted since the beginning of fossil fuel use continue to have effect today.[65]

Even though roughly half of current CO_2-emissions are absorbed by the oceans and life on land, a reduction by half of emissions would, according to current scientific understanding, simply slow the rate of increase of CO_2-concentrations in the atmosphere, not stop it. Concentrations may fall, but only when emissions are more or less completely eliminated, and won't return to pre-industrial levels for many centuries. Thus, mitigation today means slowing down the impacts, not eliminating them.[66] This is relevant in the context of redressability and compensation for damage or adaptation measures.

2.2. Human, all too human: causation as a metaphysical problem

It comes naturally to human beings to look for causes, effects and origins. It helps us to function in the world, to understand how certain actions generate their effects, what forces work on physical objects around us etc. We also seek explanations for things that are or were hard to understand, through myths for instance.[67]

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[60] IPCC, 'Greenhouse gases' (IPCC Glossary) <https://www.ipcc.ch/sr15/chapter/glossary/#article-glossary-g-h-i> accessed 8 April 2023.
[61] H Lee and others, 'Synthesis Report of the IPCC Sixth Assessment Report (AR6). Summary for Policymakers' (IPCC 2023) <https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf> accessed 19 April 2023 4.
[62] Thompson V and others (n 9).
[63] IPCC WG I (n 8).
[64] Unless they were to be removed from the atmosphere at some point. Technologies making this possible exist, but are far from being deployable at anywhere near the required scale. See <https://www.iea.org/reports/direct-air-capture> accessed 12 May 2023.
[65] Allen (n 55) 9-10. We will see in chapter 3, however, that the moment when emissions are made, is relevant for calculating its effect on certain impacts.
[66] Allen (n 55) 9-10.
[67] See C Partenie, 'Plato's Myths' in EN Zalta (ed), *The Stanford Encyclopedia of Philosophy* (Summer 2022 Edition) <https://plato.stanford.edu/archives/sum2022/entries/plato-myths/> accessed 29 March 2023.

The concept of causation has been the subject of intense philosophical, theological, legal and scientific discussion for millennia.[68] Even though the notions of a cause, an effect, and the link between them, feel natural, when digging deeper it turns out to be a very complicated issue that raises a host of thorny questions. Unsurprisingly then, it has also given rise to many well-described logical fallacies and biases of human thinking.[69]

The Oxford Dictionary of Philosophy defines causation as:

> "[...] the relation between two events that holds when, given that one occurs, it produces, or brings forth, or determines, or necessitates the second; equally we say that once the first has happened the second must happen or that the second follows on from the first."[70]

The entry also calls causation "one of the central problem areas of metaphysics." One of the issues cited is "the general problem of forming any conception of what [causation] is." A thorough discussion of this is outside the scope of this thesis, but I will introduce some definitions and concepts relevant to this thesis in the following paragraphs.

The concept of the bond or link between an effect and its cause is called the *causal nexus*, or *causal link*.[71] The mere existence of such a bond or link has been called into question by a number of thinkers. Hume, for instance, disputed that a cause makes its effect happen, leaving room only for the observation of systems in which a certain effect regularly follows a specific cause, thus taking the 'glue' out of causation.[72] This discussion has also influenced thinking on legal causation, as we will see below.

In philosophy, a distinction is made between *general* causation, also called type-level causation, and singular, token-level or *actual* causation. This distinction also applies to scientific accounts of causality. A common example to illustrate the difference between both is toxic exposure. A statement of general causation would be to say "asbestos exposure causes lung cancer," whereas a statement of *actual causation* would be to say "Paolo's exposure to asbestos at work caused him to develop lung cancer."[73] In terms of climate

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[68] See, apart from the bibliography, <https://plato.stanford.edu/entries/causation-medieval/, https://plato.stanford.edu/entries/arabic-islamic-causation/> and <http://philsci-archive.pitt.edu/view/subjects/causation.html> for some further reading.

[69] D Kahneman, *Thinking, Fast and Slow* (Farrar, Straus and Giroux 2011) 158; see also N Taleb, *The Black Swan* (Penguin 2007).

[70] S Blackburn, 'Causation' (entry) in *A Dictionary of Philosophy* (3rd edn Oxford University Press 2016) <https://www.oxfordreference.com/display/10.1093/acref/9780198735304.001.0001/acref-9780198735304-e-523?rskey=rpwc13&result=1 > accessed 12 March 2023.

[71] S Blackburn, 'Causal Nexus' (entry) in *A Dictionary of Philosophy* (3rd edn Oxford University Press 2016) <https://www.oxfordreference.com/display/10.1093/acref/9780198735304.001.0001/acref-9780198735304-e-514?rskey=cbQLcw&result=537> accessed 12 March 2023.

[72] Ibid; HLA Hart and T Honoré, *Causation in the Law* (2nd edition, Oxford University Press 1985) 12; M Moore, 'Causation in the Law' in EN Zalta (ed), *The Stanford Encyclopedia of Philosophy (Winter 2019 Edition)* (Metaphysics Research Lab, Stanford University 2019) <https://plato.stanford.edu/archives/win2019/entries/causation-law/> accessed 29 March 2023 section 5.2.

[73] C Hitchcock, 'Probabilistic Causation' in EN Zalta (ed), *The Stanford Encyclopedia of Philosophy (Spring 2021 Edition)* (Metaphysics Research Lab, Stanford University 2021) <https://plato.stanford.edu/archives/spr2021/entries/causation-probabilistic/> accessed 29 March 2023 paragraph 1.4; Hart and Honoré (n 72) 8.

change, an example of a general causation statement could be “greenhouse gas emissions cause climate change, which increases the incidence of heatwaves,” as opposed to an actual causation statement such as "Holcim's historical emissions helped cause the heatwave that killed Jill’s grandmother.” To distinguish between those two concepts in the rest of this thesis, I will use the terms *general* and *actual causation*.

Both concepts are linked in the causal mechanism theory of causation, which comprises the meaning of ordinary causal ascriptions. The theory says that assertions of the form “A caused B” imply (the belief of the person making the statement in) the existence and practical operation of a law in the sense of “a general rule that states what always happens when the same conditions exist,” a causal process connecting A and B.[74] Thus, when saying “Holcim's historical emissions helped cause the heatwave that killed Jill’s grandmother”, one says that there is potentially a repeating, law-governed process that links GHG emissions to climate change and its impacts (general causation), and that the death of Jill’s grandmother is linked to Holcim’s emissions through this process *(*actual causation).

Psychology researchers typically distinguish the causal mechanism theory from the *covariation* or *regularity* theory, which says that people make causal ascriptions when a cause and an effect are systematically observed in temporal succession, without considering the connection causal process.[75] This type of thinking can lead to the *post hoc ergo propter hoc* logical fallacy, where the mere fact that one event follows the other in time is mistaken for causation (but: “consecutiveness is a necessary but not a sufficient condition for causality”).[76] A focus on regularity can also contribute to the confusion of correlation and causation (see section 2.3).

2.3. Scientific accounts of causation

In science, different accounts of causality are used. An exhaustive overview of them is out of the scope of this thesis. Suffice it to say that they share the goal of explaining why, or rather, how something occurs.[77] One specific type of theories is of particular interest as much of climate and attribution science is based on them: the theories of probabilistic causation, which have as their central idea that causes change the probability of their effects.[78]

I will first give a brief and very high-level introduction of (Bayesian) probability. Probability is a *function* assigning a value from 0 to 1 to an event, representing how *likely* it is to happen. A probability of 1 (or, equivalently, 100%) means that an event is certain to happen, whereas a probability of 0 means that the event is certain not to happen. Any value in between is possible; in a coin toss for instance, the probability of tossing ‘heads’ is 0,5 or 50%.

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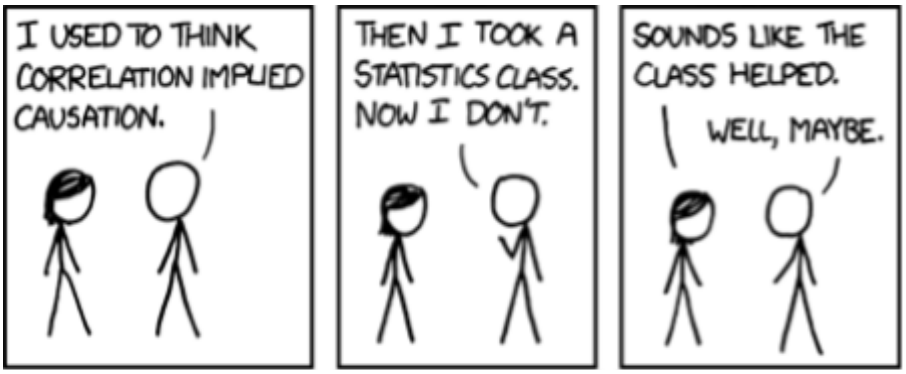
[74] P Bach-Y-Rita, ‘The Causal Mechanism Theory of Legal Causation’ (2021) 34 Ratio Juris 57.
[75] Ibid.
[76] J Henning Schulze, ‘ISSA Proceedings 2014 ~ Think Twice: Fallacies And Dual-Process Accounts Of Reasoning’ (Rozenberg Quarterly 2014) <https://rozenbergquarterly.com/issa-proceedings-2014-think-twice-fallacies-and-dual-process-accounts-of-reasoning/> accessed 8 May 2023.
[77] L Ross and J Woodward, ‘Causal Approaches to Scientific Explanation’ in EN Zalta and U Nodelman (eds), *The Stanford Encyclopedia of Philosophy* (Spring 2023 Edition) <https://plato.stanford.edu/archives/spr2023/entries/causal-explanation-science/> accessed 29 March 2023.
[78] Hitchcock (n 73) paragraph 1.4.

Conditional probability means the probability of some event happening, given another event. We can for example discuss the probability of a certain weather event happening given a certain amount of climate change. If the likelihood of this event is influenced by the amount of climate change, then the event and the condition are said to be *probabilistically dependent* or *correlated*. If not (in our example, if the incidence of a certain weather event is not influenced at all by the amount the climate has changed), the variables are said to be *probabilistically independent*.[79]



xkcd, 'Correlation' <https://xkcd.com/552/> © CC BY-NC 2.5

When then, can one, in scientific terms, speak of causality? When making a case for causation, we reason in two stages (in practice, using statistical methods). First, we make the case for a statistical correlation between the purported cause C and effect E, showing that they are *probabilistically dependent*. This correlation can be caused by a range of different mechanisms however, so it doesn't prove a causal link. In the second stage, all other probable explanations for the observed change in E, other than the change in the C, need to be eliminated. This is because causation is only proven when an unconfounded change to C (i.e. no variables that might influence E, other than C, are changed) leads to a change in the probability of E.[80] The standard for saying there is a causal link between C and E is then set at 95%, meaning that one needs to be at least 95% certain that the observed effect of C on E[81] is not due to random variation.[82]

There are many ways of fleshing out the effect of changes in C on E, such as trying to *control* for changes in other variables in a statistical analysis, or through an *intervention* in the value of C. This is done, for example, in medical trials, by giving some participants a drug and the others a placebo. The intervention can also be approximated through statistical methods, as is done in toxicology studies for instance.[83] We will see in section 3.3 that for

[79] Ibid paragraph 1.2.
[80] Ross and Woodward (n 77) section 3.
[81] The *value* of a parameter in studies of this type also has a *confidence interval*, which refers to the range of possible real values that corresponds to the observed value of a parameter when taking the sampling error (of an opinion poll, for example) into account. A 95% confidence interval then refers to minimum and maximum value between which the 'real' value of the observed parameter would lie with 95% certainty. See R Scheines, 'Causation, Statistics, and the Law' (2007) 16 Journal of Law & Policy 102, 116-117.
[82] Ibid 116.
[83] Ibid 110.

the attribution of extreme weather events to climate change, this is done by running simulation in climate and weather models *with* or *without* anthropogenic GHG emissions.

To end this section on causality in science, I will explain the distinction between *objective* or *physical* probabilities, which can be said to describe 'human-independent' features of the physical world, and *epistemic* or *logical* probabilities, which can be said to describe or measure the degree of rational belief in a hypothesis that is justified by the body of evidence.[84] The probability of a certain weather pattern occurring under a given amount of climate change, or the amount of global warming caused by a certain amount of atmospheric greenhouse gas concentration, would be examples of the former category. The confidence with which such a statement is made by scientists, how certain they are of a specific finding, is an example of the latter. This distinction is relevant to keep in mind when we discuss the concepts of likelihood and confidence level in 4.4.2.

2.4. Causation in the law

Even though the concept of causation in law overlaps with the ones described above, there is a tendency–especially among legal scholars and professionals–to view the law's conception of causation as autonomous.[85] It is a thorny issue that has been the subject of discussion for many decades (or even centuries[86]), all the while defying efforts to grasp it, even in theory, in a simple formula.[87]

Before diving into this discussion, it is useful to distinguish between the *de lege lata* and the *de lege ferenda* perspective. The former refers to the law as it is, thus in our discussion to the presently valid requirements for legal causation. This is the perspective that ought to most interest a lawyer. The latter perspective refers to the law as it ought to be, the perspective of the legal reformer.[88] This is a perspective I will take from time to time in my thesis. I think this is unavoidable in the context of a complex issue such as causality in climate change, which current causation law has trouble grappling with.

The different conceptions of causation in law are influenced by interplay between three main factors. First, the explicit, theoretical definitions of legal causation (*law in the books*). Second, the implicit, practical application of the causation requirement by courts (*law in action*), which, especially in complex cases, rarely entirely matches the theory.[89] Finally, and crucially, the concept is moulded by the values served by causal requirements.[90]

The first and second factors will be discussed extensively in chapter 4. Here, we will briefly discuss what views exist of the third, normative factor. Sceptics, including the well-known

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[84] HL Ho, *A philosophy of Evidence Law. Justice in Search for truth*, (Oxford University Press 2008), 110. See also the paragraphs on legal probabilism in section 3.4.2.
[85] Moore (n 72) section 4; See M Kruithof, 'Oorzaak of aanleiding? Geen causaal verband zonder causale bijdrage' in T Vansweevelt and B Weyts (eds), *Actuele ontwikkelingen in het aansprakelijkheidsrecht en verzekeringsrecht* (Intersentia 2015) 171.
[86] BW Frier, 'Prototypical Causation in Roman Law' (1988) 34 Loy L Rev 485.
[87] Wright (n 24) 1737.
[88] Moore (n 72) section 4.
[89] For a discussion of the concepts *law in action* and *law in the books*, see R Pound, 'Law in Books and Law in Action ' (1910) 44 Am L Rev 12.
[90] Ibid section 1.

American legal realist Wex Malone, state that it is mere pragmatism that leads us to pick “the cause” of a certain event, and that by this we are doing no more than deciding who is responsible for a harm. Metaphysical questions of causation are thus largely swept aside. Building on this criticism, the Critical Legal Theorists in the US argued that the causal requirements in the law are a “liberal myth.” Echoing Hume’s criticism, they conclude that causation can’t have a factual basis. Though no obvious practical prescriptions follow from it, this criticism has the merit of putting the question of the policy or normative aspect of legal causation centre-stage.[91]

What interests, then, are served by the causation requirement? The legal economist school of thought sees it in essence as a way of efficiently allocating costs,[92] efficiently and/or fairly. Scholars like Ronald Coase and Guido Calabresi, basing their reasoning on this premise, come to the conclusion that assigning a ‘cause’ without any policy considerations should be avoided, since it doesn’t lead to efficient outcomes. A solution is found in a more probabilistic interpretation, in which an act raising the probability of a harm by enough is said to have caused the harm.

The legal economists are concerned with incentives and assigning costs where they ‘should be borne’. Even when put in terms of efficiency, it seems clear that true neutrality is unachievable and that, even in the reasoning of legal economists, considerations of fairness enter the frame.[93] This brings us to the view that criminal law serves retributive justice, and tort law serves corrective justice. The cause identified by legal causation theory should, in such a view, be found with the party who can correct unjustly caused harm by compensating the victim.[94]

We can conclude that there are differing views on the *why* of a certain conception of the legal causation requirement. We will see that this can lead to modifications of a purely mechanistic view of causation, especially when the outcomes of such mechanistic tests clearly don’t square with the normative end the test serves, be it utilitarian or otherwise. The differing ways in which these corrections are applied, are, on the one hand, what makes proving the causal link in climate litigation so challenging, and, on the other hand, offer a range of possibilities for both lawyers (*de lege lata*) and legal reformers (*de lege ferenda*) to reconceptualise the causation requirement. This will be discussed at length in chapter 4.

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This chapter gave a broad overview of the main domains in which the rest of my thesis plays out, and defined a number of relevant concepts within those. We looked at climate and climate change, the metaphysical background to the question of causation, and how this

[91] Moore (n 72) section 4.
[92] Which would also apply when making companies liable for the harm they cause through their GHG emissions, see Hinteregger (n 17) 247; Akhtar (n 21) 312.
[93] Moore (n 72) section 5.2.3; S Gilles, 'Causation and Responsibility after Coase, Calabresi and Coleman' (1996) 16 QLR 255, 256; Kruithof (n 85) 139.
[94] Moore (n 72) section 4. Kruithof remarks that, in practice, tort law often leads to a *distribution* of (the costs of a) harm between a victim and a party causing harm, which suggests that the view that tort law’s (corrective) function is to shift the costs from victim to tortfeasor is too simplistic. See Kruithof (n 85) 139.

translates to scientific and legal accounts of causation. In the following chapters, we'll get into the nitty-gritty of things, starting with climate science.

3. Degrees of certainty: the state of the art of climate science

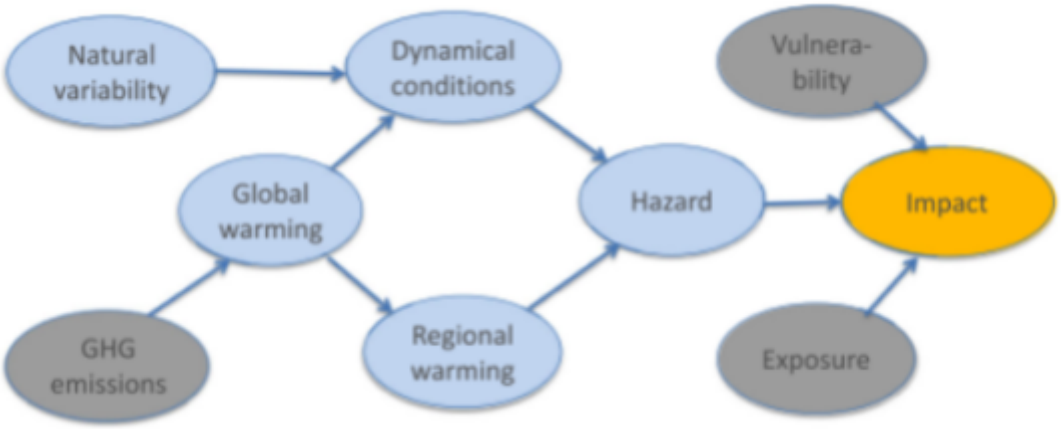
Here we dive into the state of the art climate science can offer. We try to find out with what degree of certainty science is capable of providing evidence of causation across the climatic causal chain. I begin by explaining the causal chain in climate science in more detail. This is followed by an appraisal of the evidence climate science can provide, addressing every step along the chain in turn. I discuss sources and methods behind these data and this knowledge, seeing the degree to which they are considered as 'authoritative' and what residual degree of uncertainty there is. Before concluding, I address the issue of the unequal 'coverage' offered by climate science in different areas of the world.

3.1. The causal chain in climate science

With the background set out in section 2.1 in mind, let us now look into causation in the domain of climate science in more detail. The causal chain is very complex. A simplified summary looks like this: (anthropogenic) drivers of climate change → climate change → effects of climate change → impact (damage) and risks. More specifically, in the context of the issue of climate liability, the relative contribution of certain emission sources and land-use changes to total anthropogenic climate change is important.[95]

In addition to the above, in reality there are a large number of other variables that make it more difficult to demonstrate a full causal chain, especially in the case of local damage. For example, we can think of natural variability of the weather, regional differences in the effects of global climate change, population and land-use changes, water usage, surface roughness etc. Vulnerability and exposure to hazards thus compound the role played by climate change in creating a certain impact.[96] The figure below illustrates this.

[95] M Burger, J Wentz and R Horton, 'The Law and Science of Climate Change Attribution' (2021) 51 Envtl L Rep 10646.
[96] F Otto and others, 'How to Provide Useful Attribution Statements: Lessons Learned from Operationalizing Event Attribution in Europe' in *Explaining Extremes of 2020 from a Climate Perspective* (a supplement to Bull. Amer. Meteor. Soc., 103 (3) <https://doi.org/10.1175/BAMS-D-21-0236.1>) S21, S22.



Causal graph depicting the different plausible explanations of a generic climate impact. Blue symbols denote elements in the physical climate system, gray symbols those in the human-affected domain, and the orange symbol a combination of the two. Arrows denote direction of causal influence. From EA Lloyd and TG Shepherd, 'Climate Change Attribution and Legal Contexts: Evidence and the Role of Storylines' (2021) 167 Climatic Change 1, 5.

All these factors can be scientifically modelled and quantified. Establishing causality between an observed phenomenon and global climate change belongs to the domain of so-called *detection & attribution*.[97] Detection involves the identification of a statistically significant change in a particular variable, without necessarily proceeding to search for or identify a cause. Attribution is the next step, looking for possible causes with the aim of determining to what extent each of them played a role in bringing about the observed change.[98]

In order to be able to use a possible physical causal chain to base a legal claim on it, it is necessary to be able to link the defendant's action to the damage or harms caused, i.e. to what happens in practice and can be observed. This can be regarded as a scientific hypothesis that can be tested. Given the complexity of the climate system and the multitude of variables that can influence the occurrence of a particular event, this hypothesis must be considered alongside a number of other possible hypotheses.[99] The challenge, therefore, is to quantify the probability of a given hypothesis occurring and to compare the probabilities with each other.

This domain is particularly important for linking the findings of IPCC Working Group I (physical climate) with those of Working Group II (impacts).[100] The step that is made here is from climate as 'possible weather' to actual weather.[101] More generally, this involves interlinked questions and research domains, which link the anthropogenic driving forces to climate change (climate change attribution), which in turn needs to be linked to a certain impact (event and impact attribution), and which furthermore study the links between the

[97] PA Stott and others, 'Detection and Attribution of Climate Change: A Regional Perspective' (2010) 1 WIREs Climate Change 192, 193.
[98] Burger, Wentz and Horton (n 95) 10646.
[99] Ibid 1650.
[100] EA Lloyd and TG Shepherd, 'Climate Change Attribution and Legal Contexts: Evidence and the Role of Storylines' (2021) 167 Climatic Change 1, 5.
[101] See section 2.1.

contribution of a certain emission source or other anthropogenic driver to the whole of climate change (source attribution).[102]

Attribution science quantifies and compares the likelihoods of a specific instance of *actual weather* under different climate scenarios, with or without the influence of anthropogenic climate change. Even though there is no difference in principle between attributing climate change as a global phenomenon, or a single weather event, to anthropogenic GHG emissions (both are 'events' of which the probability can be compared to their probability in a pre-industrial climate), evidence of concrete causal chains is required to translate general statements about the consequences of climate change to measurable losses and damage from climate change (as opposed to mere weather-related losses).[103]

The figure below provides an overview of the entire causal chain, each step of which needs to be proven. As the figure illustrates, the picture is further complicated by the fact that impacts arise on different time scales (with different lags compared to emissions). In the next sections, we will discuss the available scientific evidence for the different steps along the chain. Studies typically research one of the steps, although in some, multiple steps are synthesised.[104]

[102] M Burger, J Wentz and R Horton, 'The Law and Science of Climate Change Attribution' (2021) 51 Envtl L Rep 10646.
[103] Otto and others (n 5), 741.
[104] Stuart-Smith R, Otto FEL and Wetzer T, 'Liability for Climate Change Impacts: the Role of Climate Attribution Science ' in Elbert R De Jong and others (eds), *Corporate Responsibility and Liability in Relation to Climate Change* (Intersentia 2022) *forthcoming book* <http://dx.doi.org/10.2139/ssrn.4226257> accessed 30 March 2023 8.

Chain of causality from greenhouse gas emissions to loss and damage. The boxes with yellow colour indicate the main driver of regional impacts. The red and blue colours indicate impacts that scale with global mean temperature changes (red) and those that have a lagged response time (blue). Losses and damages result from both types of impacts, indicated in purple. From Otto FEL and others, 'Causality and the fate of climate litigation: The role of the social superstructure narrative' (2022) 13 Global Policy 736, 738.

3.2. Climate change attribution

Climate change attribution evaluates the effects of drivers of climate change on the earth system and its components. This includes studies that assess the correlation between greenhouse gas and aerosol emissions and their impact on physical phenomena such as global temperature variations, rising sea levels, severe weather patterns, and the shrinking of glaciers. The attribution of extreme weather events is sometimes treated as part of climate change attribution in general.[105] However, in the frame of this master's thesis, I will treat them as a separate category, extreme event attribution (discussed in section 3.3.), because

[105] Stuart-Smith, Otto and Wetzer (n 104) 8.

in this field big strides have been made, with a large potential impact for proving the causal link in climate change litigation.

Even at the dawn of the field of detection and attribution in the late 1990s, methodologies were developed to attribute observed climate change (through trends in global mean temperatures) to natural and anthropogenic drivers. Climate models, in essence, simulate possible climates under a range of conditions, with or without human emissions of GHG. In this way, it can be shown that the currently observed warming can't be simulated without human emissions, thus proving that the observed climate change is caused by human activity.[106]

There is wide acceptance of the science behind climate change, and many impartial, (inter-)governmental organisations provide reliable, and largely undisputed reports on this. The science surrounding both the driving mechanisms of climate change and the modelling and scenarios of the (current and future) consequences of climate change is centralised on a global scale in the reports of the IPCC. These enjoy global authority, based on a reputation for objectivity, and are highly valuable sources of evidence, widely considered to be near unimpeachable. IPCC reports provide a robust basis for general causation claims and have often been accepted as valid in judicial decisions. Due to their general nature, they are less useful to demonstrate actual causation.[107]

3.3. Probabilistic event attribution

Since the beginnings of the field, detection and attribution science has evolved rapidly. While they may have been true in the 1990s, often-heard statements to the effect that "individual weather events can't be attributed to climate change" have now become false.[108] Advances were made in the models themselves, through increasing data availability and due to the shrinking costs and growing availability of computing power. This has led to the emergence and maturing of a new subfield: probabilistic (extreme) event attribution.[109] Through a range of methods, scientists active in this field can calculate weather and to what extent anthropogenic climate change has made individual extreme weather events more likely

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[106] P Minnerop and F Otto, 'Climate Change and Causation: Joining Law and Climate Science on the Basis of Formal Logic' (2019-2020) 27 Buff Envtl LJ 49, 67.

[107] Schoukens and Billiet (n 12) 279; Stuart-Smith, Otto and Wetzer (n 104) 10-12; P Minnerop, 'Integrating the 'Duty of Care' under the European Convention on Human Rights and the Science and Law of Climate Change: the Decision of The Hague Court of Appeal in the Urgenda Case' (2019) 37 Journal of Energy & Natural Resources Law 149, 153. For an example, see *Commune de Grande-Synthe* Conseil d'État (FR) 19 November 2020 427301 ECLI:FR:CECHR:2020:427301.20201119 <https://www.conseil-etat.fr/fr/arianeweb/CE/decision/2020-11-19/427301> para 3.

[108] SJ Hassol, S Torak and P Luganda, '(Un)Natural disasters: Communicating linkages between extreme events and climate change' (2016) 65(2) WMO Bulletin 3 <https://public.wmo.int/en/resources/bulletin/unnatural-disasters-communicating-linkages-between-extreme-events-and-climate> accessed 24 April 2023; Allen (n 55) 8-22, para 2.07-2.09. Courts have made similar claims, which are likewise becoming rebuttable, Stuart-Smith, Otto and Wetzer (n 104) 27.

[109] A good source of information and case-studies is the World Weather Attribution (WWA) initiative, "a collaboration between climate scientists at Imperial College London in the UK, KNMI in the Netherlands, IPSL/LSCE in France, Princeton University and NCAR in the US, ETH Zurich in Switzerland, IIT Delhi in India and climate impact specialists at the Red Cross / Red Crescent Climate Centre (RCCC) around the world." See <https://www.worldweatherattribution.org/about/>.

and/or more intense. This is done by comparing what actually occurred with what would have occurred in a counterfactual world (i.e., model with different initial conditions). This allows to causally link[110] extreme weather events as they occurred to external drivers of the climate system, thus bridging the gap between climate and weather (see section 2.1).[111]

Intensity and *likelihood* of extreme weather events are two sides of the same coin, but depending on the kind of causation test applied, one or the other formulation may be more suitable. For instance, likelihoods may be more useful to describe the impact of climate change on threshold-related events, such as a river bursting its banks (where climate change increased the odds of so much rain falling that the river floods neighbouring lands). Conversely, for continuous hazard-impact relationships, it may be more useful to describe attribution study results in terms of intensities. Here we can for example think of increasing mortality as temperatures rise (such as claimed in the *Verein Kimaseniorinnen*-case).[112] So far, most research and claims, however, have been based on the attribution of changing likelihoods.[113]

The results of attribution studies are expressed in 'risk ratios' (RR), which are calculated by dividing the probability of an event in the actual current climate by the probability of it occurring in a (counterfactual) climate unaffected by human activity.[114] What follows from this is a causal statement identifying a cause and quantifying the risk attributable to it (cf. the concept of causal contribution, section 4.1). In other words, it "is a quantification of the change in the probability of an extreme that can be attributed to a particular cause."[115] A related parameter that's often found in attribution studies is the *Fraction of Attributable Risk* (FAR), which refers to the fraction of the total likelihood of an event that can be traced back to climate change or one or more specific drivers (again, by comparing its probability in the current climate to the probability in a pristine climate or a climate lacking the driver in question).[116] FAR results can also be used to attribute specific damages to climate change (and further on, to emitters, see section 3.4).[117]

An example of such a result is a simulation by the UK Met Office showing that human action has increased the probability of extreme temperatures such as those currently experienced in India and Pakistan by a factor of 100.[118] Attribution studies can be ready very quickly after

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[110] As opposed to merely observing a correlation, see section 2.3.
[111] Minnerop and Otto (n 106) 67-68; Stuart-Smith, Otto and Wetzer (n 104) 9.
[112] *Verein KlimaSeniorinnen Schweiz et al v Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation UVEK*, Bundesverwaltungsgericht (CH) 27 November 2018, Gesuch um Erlass einer Verfügung. Both changing likelihood and intensity are argued here.
[113] Stuart-Smith, Otto and Wetzer (n 104) 18.
[114] Minnerop and Otto (n 106) 69; Allen (n 55) para 2.09.
[115] SC Lewis and others, 'Assessing Contributions of Major Emitters' Paris-era Decisions to Future Temperature Extremes' (2019) 46 Geophysical Research Letters 3936, 3939.
[116] A Hannart and others, 'Causal Counterfactual Theory for the Attribution of Weather and Climate-related Events' (2016) 97 Bulletin of the American Meteorological Society 99, 100; T Pfrommer and others, 'Establishing Causation in Climate Litigation: Admissibility and Reliability' (2019) 152 Climatic Change 67, 70.
[117]For an example of such a study, see DJ Frame and others, 'Climate change attribution and the economic costs of extreme weather events: a study on damages from extreme rainfall and drought' (2020) 162 Climatic Change 781.
[118] N Christidis, 'The heatwave in North India and Pakistan in April-May 2022. Technical summary' (MetOffice 2022) <https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/climate-science/att

the event studied has occurred. A study on the role of climate change in the Cyclone Gabrielle, which hit New Zealand in February 2023, was published by 14 March 2023, for instance.[119]

A related approach is the so-called storyline approach, in which, assuming that a certain weather phenomenon would have occurred anyway, it is studied how the conditions which led to an event unfolding as it did, were altered by anthropogenic changes to the climate, and thus how much 'worse' man-made climate change has made the event. This leads to more explanatory than statistical answers, which may align well with legal discourse on causation.[120] On the basis of my research, I find that the approach has not been applied often in practice, though.

It is important to note that a number of factors in the setup of the study influence how its results can be interpreted and used. The first one is the design and framing of the study, involving questions such as the temporal and geographical scope of the event study. In general, longer timeframes and larger geographical areas taken into consideration will lead to stronger observed increases in the risk ratio driven by climate change. A second factor is that not all types of events are influenced by climate change to the same extent. For example, the Arctic heatwave of 2016 was made 10 times (1000%) more likely due to anthropogenic GHG emissions, whereas the rainfall event in the UK in January 2014 was made only 40% more likely by total GHG emissions.[121] Thirdly, while the relation between climate change and certain types of events is more or less linear, for others the relation is near-exponential, or sigmoidal for others still. Fourthly, results can be confounded by natural variability, local variations in exposure and vulnerability to risks, which are influenced by drivers other than climate change, such as land use change, population changes, water use etc.[122]

In sum, the definition of the causal relationship, and resulting strength of the causal link that can be calculated, depends very strongly on temporal and geographical scales, region of the world and type of event studied.[123] It is thus important to be transparent about the decisions taken when presenting the results of an attribution study,[124] clearly stating the limitations of an individual study, how far vulnerability and exposure have been taken into account, while

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ribution/indian_heatwave_2022.pdf> accessed 28 may 2022, 3. See also, for instance, S Li and F Otto, 'The Role of Human-induced Climate Change in Heavy Rainfall Events Such as the One Associated with Typhoon Hagibis' (2022) 172 Climatic Change.

[119] LJ Harrington and others, 'The role of climate change in extreme rainfall associated with Cyclone Gabrielle over Aotearoa New Zealand's East Coast. World Weather Attribution Initiative Scientific Report' (Grantham Institute 2023) <https://doi.org/10.25561/102624> accessed 29 March 2023.

[120] A Myles, 'Attribution of Climate Change-Related Harm to Individual States or Private Companies' in Holzhausen A and Luporini R (eds), *The Role of Science in Climate Change Litigation: International Workshop Report* (2021) <https://www.biicl.org/publications/the-role-of-science-in-climate-change-litigation-international-workshop> accessed 12 August 2022; Lloyd and Shepherd (n 100) 1; Stuart-Smith, Otto and Wetzer (n 104) 9-10.

[121] Minnerop and Otto (n 106) 70.

[122] Otto (n 96) S22.

[123] Ibid.

[124] FEL Otto and others, 'Assigning historic responsibility for extreme weather events' (2017) 7 Nature Climate Change 757, 759; RB Skeie and others, 'Perspective has a strong effect on the calculation of historical contributions to global warming' 2017 Environ Res Lett 12 024022 1; Marjanac and Patton (n 6) 275.

also not underemphasizing the robustness of an attribution study and thus underestimating the role of anthropogenic climate change.[125]

The degrees of uncertainty contained in the properties of *likelihood* and *confidence* explained in section 4.4.2 also apply to the results of probabilistic event attribution. Likelihood here expresses the probability of the causal link itself as calculated by the models used (e.g. "Climate change made record breaking early season heat in Argentina and Paraguay about 60 times more likely"),[126] whereas the degree of confidence is a function of "the climatic variables (temperature, precipitation, pressure, etcetera) analysed, availability and quality of observed data, strength of theory describing and understanding processes in the climate system, reliability of climate models and the availability of evidence (number of scientific studies as well as number of independent data sources)."[127]

There has been wide agreement for several years that attribution methods are ready and reliable. So-called re-attribution studies have also shown this. A next step could be the standardisation of attribution studies,[128] or the construction of so-called "operational event attribution systems," which would work under predefined modelling choices, in a way similar to weather forecasts.[129] So, while taking remaining uncertainties into account, it can be stated that the methods to study this are scientifically robust, and the studies reliable.[130]

3.4. Source attribution

As we have seen, there is global scientific agreement on the existence of climate change and the fact that it's driven by anthropogenic factors, first and foremost GHG emissions. We have also seen that impacts, be they general and slow-onset or individual extreme weather events, can be reliably attributed to anthropogenic climate change. When proving causality across the whole chain, another piece of the puzzle is assessing the historical and ongoing individual contributions to GHG emissions by companies, sectors or countries. This is what I call *source attribution*.[131]

To date, and compared to the flood of event attribution studies that has materialised, the question of who emitted which greenhouse gases at what point in time, has been less studied.[132] A number of studies does exist however, and they're often used in litigation. The well-regarded and widely cited[133] Carbon Majors study by Heede made a solid historical analysis available, spanning the GHG emissions to the 90 largest emitters (the so-called

[125] Ibid S24-25.
[126] See <https://www.worldweatherattribution.org/climate-change-made-record-breaking-early-season-heat-in-argentina-and-paraguay-about-60-times-more-likely/> accessed 28 April 2023.
[127] Minnerop and Otto (n 106) 71-72.
[128] B Clarke and others, 'Extreme weather impacts of climate change: an attribution perspective' 2022 Environmental Res: Climate 1 012001, 1-2.
[129] Pfrommer (n 116) 81-82.
[130] Marjanac and Patton (n 6) 283; Stuart-Smith, Otto and Wetzer (n 104) 20-21.
[131] Stuart-Smith, Otto and Wetzer (n 104) 8.
[132] Marjanac and Patton (n 6) 278.
[133] P Paiement, 'Reimagining the Energy Corporation: Milieudefensie and Others v Royal Dutch Shell Plc' in D Dam-de Jong and F Amtenbrink (eds), *Netherlands Yearbook of International Law 2021: A Greener International Law—International Legal Responses to the Global Environmental Crisis* (T.M.C. Asser Press 2023) 283-284; Ganguly, Setzer and Heyvaert (n 20) 852-854.

Carbon Majors) from 1854 to 2010.[134] It has been updated since it was first published.[135] This study was the first of its kind and has been regarded as a turning point, enabling a new class of climate change litigation cases (of which the case of *Lliuya v RWE* studied in chapter 6 is an early example). Although the study and methods have been criticised, it has been peer reviewed and published since it first appeared.[136]

Data on historical emissions and emissions by country and sector are available and kept up to date by the World Resources Institute.[137] In other studies, the contribution of countries[138] and oil supermajors[139] to climate change has been accounted for in detail and the impacts of climate change have been traced to major carbon emitters.[140] Based on this knowledge on historical emissions, it's also possible to quantify the responsibility of specific countries or regions for specific extreme events,[141] or even assigning fractions of attributable risk for such events on a per person basis.[142]

Regarding companies, a distinction must be made between the emissions generated by the company itself and during the production of the energy it uses, during production and in the course of other operations, and those generated by the use of the products sold by the company. These are the so-called *scope 1, 2 and 3 emissions*.[143] Emitters with a high fraction of scope 3 emissions could argue that their clients, rather than they, are responsible for those emissions. However, in the context of tobacco litigation, second hand smokers rightly put the lion's share of responsibility with the manufacturers, not the smokers, who weren't well informed, or even misinformed. The discussion can thus be resolved by proving that harms were *foreseeable* for these companies.[144]

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[134] R Heede, 'Carbon Majors: Accounting for Carbon and Methane Emissions 1854-2010. Methods & Results Report' (Climate Accountability Institute 2013) <https://climateaccountability.org/pdf/MRR%209.1%20Apr14R.pdf> accessed 3 May 2023.
[135] R Heede, 'Press Release – 9 December 2020. Update of Carbon Majors 1965-2018' (Climate Accountability Institute 2020) <https://climateaccountability.org/pdf/CAI%20PressRelease%20Dec20.pdf> accessed 25 April 2023
[136] Ganguly, Setzer and Heyvaert (n 20) 853.
[137] M Ge and J Friedrich, '4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors' (World Resources Institute 2020) <www.wri.org/blog/2020/02/greenhouse-gas-emissions-by-country-sector> accessed 28 April 2023; World Resources Institute 'Climate Watch Historical GHG Emissions' (World Resources Institute 2022) <www.climatewatchdata.org/ghg-emissions> accessed 28 April 2023.
[138] MGJ Den Elzen and others, 'Countries' Contributions to Climate Change: Effect of Accounting for All Greenhouse Gases, Recent Trends, Basic Needs and Technological Progress' (2013) 121 Climatic Change 397.
[139] J Chen, P Toledano and MD Brauch, 'How Much Have the Oil Supermajors Contributed to Climate Change?' (Columbia Center on Sustainable Investment Staff Publications 2022) <https://scholarship.law.columbia.edu/sustainable_investment_staffpubs/220> accessed 27 April 2023.
[140] B Ekwurzel and others, 'The Rise in Global Atmospheric CO2, Surface Temperature, and Sea Level from Emissions Traced to Major Carbon Producers' (2017) 144 Climatic Change 579.
[141] As illustrated with an example calculating that EU28 emissions made the Argentinian heatwave of 2013–14 19-60% more likely, in Otto and others (n 124) 759.
[142] See FC Lott and others, 'Quantifying the Contribution of an Individual to Making Extreme Weather Events More Likely' (2021) 16 Environmental Research Letters 104040.
[143] World Resources Institute and World Business Council for Sustainable Development, *The Greenhouse Gas Protocol, a corporate accounting and reporting standard* (2004) <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf> accessed 25 April 2023.
[144] DA Kysar, 'What Climate Change Can Do About Tort Law' (2011) 41 Environmental Law 1, 40.

It also shows, as we have seen, that the contributions of some defendants can be very small, making it unlikely that *only* a small contribution satisfies but-for causation (except in scenarios near a specific threshold, such as a river very close to bursting its banks). These cases may require the application of less stringent standards of causation (which, as we will see in chapter 4, are sometimes granted where causal uncertainty exists). Concepts like market share liability might also be applied where individual contributions are very small.[145] Then, but-for causation can be proven for anthropogenic climate change as a whole, in which an individual emitter incontrovertibly has a part.

3.5. Impact or damage attribution

Impact attribution describes the link between the physical processes of climate change and their environmental, societal, economic and humanitarian consequences.[146] In this way, a price tag can be placed on the diverse impacts of climate change, which helps support claims for damages.[147]

One example is the extension of the causal chain to the attribution to health impacts is a 2020 study by Ebi, in which, notably, health impacts from heat waves in 2018 and 2019 in Europe and Japan, were attributed to climate change.[148] Health impact studies[149] are also cited in the *Municipalities of Puerto Rico*-case discussed below (section 5.3.). Studies like these can help prove causal links between climate change and health impacts in a way comparable to the epidemiological causation studies that helped prove that smoking causes cancer.[150] Ecosystem damage can likewise be an effect of climate change. Studies on this are notably provided by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which was modelled on the IPCC.[151]

It is important to note that, when calculating an individual emitter's contribution to an extreme weather event, the time profile of emissions can be relevant to the attribution of damages. When the time profile of emissions is non-linear, and/or when the impact is influenced by a warming climate in a non-linear way, the fraction of damage that can be attributed to a certain company can vary very much when compared to purely linear scenarios.[152] Thus, apportioning damage proportionally to total historical emissions[153] can be a good

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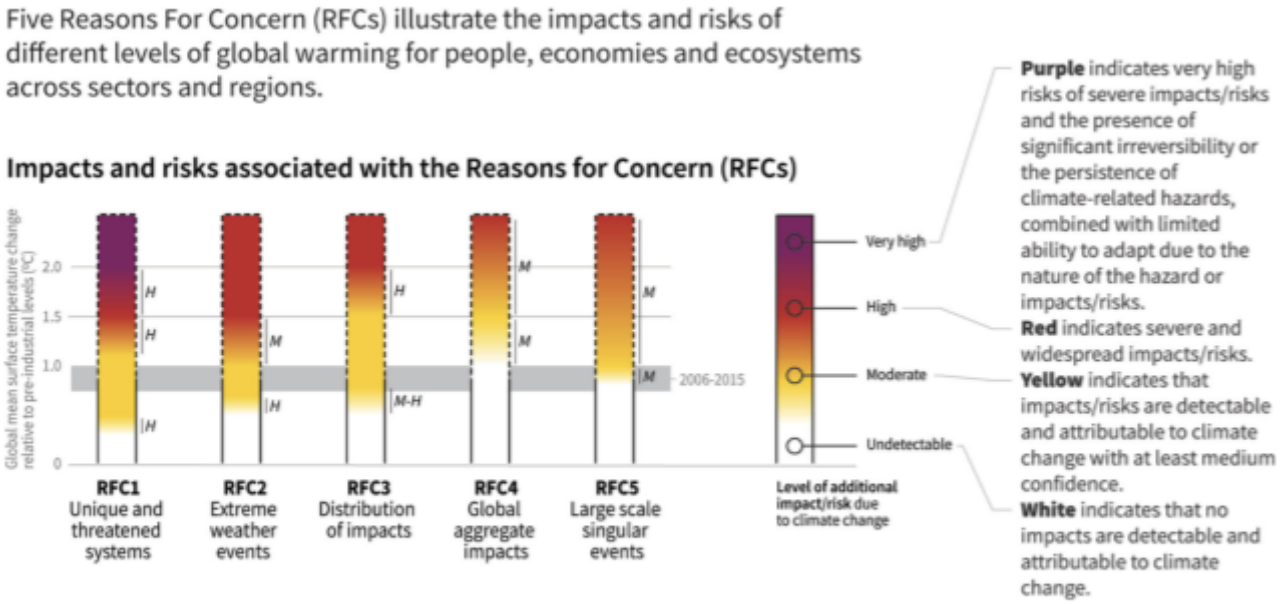
[145] Stuart-Smith, Otto and Wetzer (n 104) 15-16.
[146] Ibid 8.
[147] Clarke (n 128) 2.
[148] KL Ebi and others, 'Using Detection And Attribution To Quantify How Climate Change Is Affecting Health' (2020) 39 Health Affairs 2168.
[149] See N Kishore and others, 'Mortality in Puerto Rico After Hurricane Maria' (2018) 379 New England Journal of Medicine 162.
[150] Ebi (n 148) 2169
[151] See https://ipbes.net/. For an example, see HO Pörtner and others, 'IPBES-IPCC co-sponsored workshop report on biodiversity and climate change' (IPBES and IPCC 2021) <https://www.ipbes.net/sites/default/files/2021-06/20210609_workshop_report_embargo_3pm_CEST_10_june_0.pdf> accessed 30 April 2023.
[152] LJ Harrington and FEL Otto, 'Attributable damage liability in a non-linear climate' (2019) 153 Climatic Change 15, 18.
[153] This reasoning is applied, for instance, in the cases studied in chapter 5.

approximation in linear scenarios, but in the less linear or slow onset changes, this approach may need to be adapted.[154]

3.6. Risk attribution

Climate science in general and the development of probabilistic event attribution in particular makes it possible to calculate the (increase) in risks of certain adverse effects.[155] Given sufficient information about vulnerabilities and thresholds, the way the risk of a certain event or impact changes under climate change, can be calculated before the risk materialises. The 6th assessment report of the IPCC illustrates this,[156] as do many other publications.[157]

The IPCC organised climate-related risks around five "Reasons for Concern" (RFCs), which allow an aggregated representation of how climate impacts change with rising future temperatures. They are summarised in the figure below.[158]



The assessment of impacts and risks of climate change in IPCC Reasons for Concern framework. From Harrington LJ, Schleussner C-F and Otto FEL, 'Quantifying uncertainty in aggregated climate change risk assessments' (2021) 12 Nature Communications 7140 2.

Risk can be seen as an impact, but I have decided to treat it separately here, because exposure to risk[159] (as opposed to damage that has already occurred) is one of the possible

[154] Stuart-Smith, Otto and Wetzer (n 104) 14-15; Harrington and Otto (n 152) 18.
[155] The Economist, 'How to predict record-shattering weather events' (London, 8 February 2023) <https://www.economist.com/science-and-technology/2023/02/08/extreme-weather-events-are-getting-more-frequent> accessed 8 February 2023.
[156] Lee (n 61) 12; other examples across this thesis.
[157] Minnerop and Otto (n 106) 70.
[158] LJ Harrington, CF Schleussner and FEL Otto, 'Quantifying uncertainty in aggregated climate change risk assessments' (2021) 12 Nature Communications 7140 1.
[159] Or 'losses of a chance', see section 4.2.3

forms of climate damage for which compensation or injunctions can be sought in court.[160] A focus on risks also allows the calculation of actual losses due to increased risks[161] and conception of appropriate mitigation measures,[162] which in turn helps to better specify compensation sought in court. Especially interesting when seeking injunctions is the *contribution to excess risk ratio*, where it is calculated how much certain policy choices (for nations, in the example cited) contribute to projected future extreme events, for example by comparing risks in a 1,5°C world to risks in a 2°C world. Next, an emitter's contribution to the increased risk can then be calculated.[163]

3.7. Unequal science coverage

In the private sector, many actors have access to (non-public) scientific data and modelling on climate change risks and impacts. Think for instance, of the climate science many US fossil fuel companies produced in house. The same goes for insurers, finance companies, rating agencies and even NGOs. Given the growing importance of climate studies, Condon argues for larger public investment in robust climate data, science and information, since it is a public good the private sector can't be relied on to provide equitably or reliably.[164]

The problem may be all the more pressing on a global scale, where the lack of science for/about/in the Global South[165] reinforces existing climate injustices.[166] In the US, a doctrine was developed which entails that in cases of product or pollutant exposure where damages take a long time to appear, producers may be held liable for monitoring costs, as well as for damage that may later appear, if it can be shown that it is linked to the exposure.[167] It seems reasonable for plaintiffs, especially those from regions where attribution studies are less readily available, to argue along similar lines and claim compensation for the costs of studies required to make their case.[168] Likewise, the fields of climate and attribution science could strengthen efforts for global coverage.[169]

3.8. Conclusion

In this section, we have discussed the scientific state of the art regarding causality along the entire chain from (individual) GHG emissions to current and future harms. We saw that even

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[160] Allen (n 56) 892; A Porat and A Stein, *Tort liability under uncertainty* (1st edn, Oxford University Press 2002) 129; Wright (n 24) 1814.
[161] For example, one study estimates that unpriced climate risk means that houses in flood-prone areas in the US are overvalued by 121-237 billion USD. See JD Gourevitch and others, 'Unpriced Climate Risk and the Potential Consequences of Overvaluation in US Housing Markets' (2023) 13 Nature Climate Change 250.
[162] For a stark example of this, see The Economist, 'India's deadly heatwaves are getting even hotter' (London, 8 April 2023) <https://www.economist.com/asia/2023/04/02/global-warming-is-killing-indians-and-pakistanis> accessed 8 April 2023.
[163] Lewis (n 115).
[164] M Condon, 'Climate Services: The Business of Physical Risk' *forthcoming* Ariz St L J <http://dx.doi.org/10.2139/ssrn.4396826> accessed 29 March 2023, 1-2.
[165] Clarke (n 128) 1.
[166] See Mechler (n 13).
[167] Marjanac and Patton (n 6) 287.
[168] In the *Municipalities of Puerto Rico* case, a claim along these lines is made. See section 5.2.2.
[169] Otto (n 96) S22; Clarke (n 128).

though a lot of data has been assembled and made available, some of the work, especially as regards event and impact attribution, remains *ad hoc*. Uncertainties remain, especially for attribution studies, which are sensitive to parameter choices; and the geographical scope of the available studies is not equally distributed across the globe. We have also seen that the field is still evolving very rapidly, and that efforts are being undertaken to consolidate and address the remaining challenges.

Coming back to the first subquestion, asking what degree of certainty (i.e. what statistical probabilities) climate (detection and attribution) science can provide along the causal chain, we can conclude that state of the art science is capable of showing causal links across the causal chain, along the various pathways between GHG emissions and impacts, in fine detail and with remarkable reliability.[170] The most uncertainty remains at the fuzzy outer ends of the causal chain, when linking (individual) emitters to impact events. Theories and frameworks which make this possible have been developed however, and are rapidly evolving and improving. The next question we address is how and whether this evidence can be used to build a case proving causality in law.

4. Reconceptualising the causation requirement for the age of climate change

In this chapter, we look at the main research question through a legal lens, asking what degree of certainty is required to establish legal causation under uncertainty in climate change cases. After explaining the general, two step test of establishing factual causes by applying the but for test, before selecting legal causes among them, I will discuss a number of situations in which this leads to unacceptable results, and the policy correctives which judges have applied in such situations. Next, I will explain the burden of proof and the standard of proof that applies in civil cases. After that; I will dig into the challenging cases that require complex scientific evidence present in court, including admissibility, reliability and the specific challenge of matching a verbal standard of proof with numerically expressed scientific probabilities. Before concluding, I will describe a proposed framework to bring the different strands together.

4.1. The basics: factual cause and legal cause

To answer the question of proving causality in (civil) court, I will first give a comparative overview of a number of legal systems. Even though the law, as a social, intersubjective concept, is by nature parochial, varying from place to place,[171] I argue that this analysis is widely applicable, because there are strong similarities in the way legal causation is conceived of and applied across existing legal systems.[172] That having been said, within the scope of this master's thesis, I will of necessity have to limit myself to a relatively brief overview, which does not aspire or pretend to be complete.

[170] Stuart-Smith and others (n 19) 12; Minnerop and Otto (n 106) 52; Paiement (n 133) 284.
[171] F Pirie, *The Rule of Laws* (1st paperback edn, Profile Books 2022) 5, 14.
[172] Moore (n 72) section 1.

The question of proving the causal link arises regardless of the specific legal basis for a claim, be it fault, a common law tort, strict liability or faultless liability.[173] The intensity of the required causal link varies across legal systems and in function of the legal basis for a claim, however (see below, and section 4.3). Many legal systems use a two-step test to establish the causal link between a ground for liability and the damage. The first step is to determine the *factual causes*, and the second step is to determine the *legal causes*.[174]

In order to find the factual causes, it is examined whether a harm would also have occurred without a certain (f)act, omission or behaviour. In this way, it is ascertained whether this behaviour is a *necessary* condition.[175] This is the well known *sine qua non* test, or but-for test.[176] The question here is whether a defendant's act *made a difference* in creating a plaintiff's harm? Was it *necessary* to create a certain effect?

This first step can feel relatively straightforward in simple cases. It can be seen as close to causal mechanism theory;[177] close to *common sense* understanding of causal ascriptions.[178] But since it operates by imagining a non-existent counterfactual world, in which the fact of which we want to test if it's a but-for cause is omitted, it is by nature inexact and riddled with uncertainties.[179] This, as we will see below in the discussion of *corner cases*, creates problems in more complex constellations of facts. In general, we see that the *sine qua non*-test can lead to a multitude of possible factual causes for a given damage: any cause without which the damage would not have occurred, even the smallest or most marginal, can come into play.[180]

This gives rise to the criticism that the but-for test is *overinclusive*.[181] Regardless of the precise normative perspective one takes, assigning liability to a marginal *sine qua non* cause is an undesirable–unfair and/or inefficient–outcome. Doing this would also run contrary to what common sense would suggest. For any effect, a near-infinite number of but-for causes can be found. In order to square with what most people would understand as a cause worthy of blame (i.e. liability), it should have both a sufficiently high *probability of necessity*, and a sufficiently high *probability of sufficiency*.[182] Second, when ascribing responsibility or blame

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[173] For a discussion of possible civil liability claims against GHG emitters, see Hinteregger (n 17).
[174] Bocken, Boone and Kruithof (n 24) 64; Wright (n 24) 1735; Rozie and Vansweevelt (n 3) 109; Minnerop and Otto (n 106) 55-56.
[175] Hannart (n 116) 103.
[176] Ibid 110; Bocken, Boone and Kruithof (n 24) 64.
[177] See above, section 3.1.
[178] So called "if only"-thinking, see MD Alicke and others, 'Causal Conceptions in Social Explanation and Moral Evaluation: A Historical Tour' (2015) 10 Perspectives on Psychological Science 790, 800.
[179] Minnerop and Otto (n 106) 66.
[180] Rozie and Vansweevelt (n 3) 110.
[181] Moore (n 72) section 5.1.1; M Kruithof, 'Een kritische analyse van het concept causaliteit in het ontwerp van de Commissie tot hervorming van het aansprakelijkheidsrecht' (2021) Tijdschrift voor Privaatrecht 269, 288-89; Harvard Law Review, 'Rethinking actual causation in tort law' (2017) 130 Harvard L Rev 8 2163, 2169.
[182] Kruithof cites Pearl and Mackenzie, who illustrate the difference through an example of arson: the presence of oxygen and lighting a match are both required to start a fire, but the presence of oxygen will not be seen as having *increased the risk* of fire in a concrete situation of arson, whereas lighting the match will; Kruithof (n 181) para 16. A related concept is *intrinsicness*, the notion that "the causal structure of a process is … determined … by the intrinsic natures of the events that make up the

in scenarios where multiple causes concur, the abnormal (such as the presence of a lighted match where a fire started, rather than the presence of oxygen in the air), and voluntary or deliberate (human) actions are typically cited as primary causes.[183]

Judges, too, apply this type of common sense to justify their reasoning. As an English judge put it:

> "it has often been said that the legal concept of causation is not based on logic or philosophy. It is based on the practical way in which the ordinary man's mind works in the everyday affairs of life."[184]

In most legal systems, a second step is thus to select among the possible causes, the aim of which is usually to ensure that only those causes of damage that are reasonably acceptable are put in the spotlight for the award of damages at the expense of a particular defendant.[185] What is seen as reasonable is evidently influenced by the values and goals served by the causal requirement.

Thus, in Germany, Greece, Austria and Switzerland, liability is limited to consequences or damage that are a reasonably foreseeable consequence of a particular liability-generating event, thus eliminating *unlikely* causes. This is called the *adequate cause theory*.[186] In Belgium, in practice, a liability-generating event is seen as a cause when it has contributed (the so called *causal contribution*) to the realisation of the harm as it occurred in fact.[187] In the Netherlands use is made of the so-called *Kelderluik*-criteria, which are open to review in cassation, to test the reasonableness of the attribution.[188]

In common law systems, the doctrine of proximate cause is invoked. A cause-in-fact can become a legal cause if it is 'a substantial factor' in bringing about a certain harm. Substantial is taken to mean:

> "[having] such an effect in producing the harm as to lead responsible men to regard it as a cause, using that word in the popular sense, in which there always lurks the idea of responsibility."[189]

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process, together with the ways in which they are juxtaposed with one another, together with the laws that govern that process." Harvard Law Review (n 181) 2175.

[183] Alicke (n 178) 795.

[184] Marjanac and Patton (n 6) 280, citing Lord Reid in *McGhee v National Coal Board* [1973] 1 W.L.R. 1, [1956] 1 All ER 615 HL(Sc) para 4F. See also *Massachusetts v EPA*, 549 U.S. 497 (2007), dissent Roberts CJ: "Schoolchildren know that a kingdom might be lost all for the want of a horseshoe nail, but likely redressability is a different matter." He refers to the proverb "For want of a nail, the kingdom was lost", which refers to far-reaching and unforeseen consequences that apparently unimportant acts or omissions can have, especially when applying but-for reasoning. See also *British Columbia Saw-Mill Co v Nettleship*, [1868] LR 3 CP 499: "[...] a case [...] where a man going to be married to an heiress, his horse having cast a shoe on the journey, employed a blacksmith to replace it, who did the work so unskillfully that the horse was lamed, and, the rider not arriving in time, the lady married another; and the blacksmith was held liable for the loss of the marriage. [...] we should inevitably fall into [...] absurdity unless we applied the rules of common sense to restrict the extent of liability for the breach of contract of this sort." (underlining my own).

[185] Rozie and Vansweevelt (n 3) 110; Minnerop and Otto (n 106) 55-56.

[186] Hart and Honoré (n 72) 385; Rozie and Vansweevelt (n 3) 116.

[187] Kruithof (n 181) 281.

[188] Bocken, Boone and Kruithof (n 24) 65; Schoukens and Billiet (n 12) 225.

[189] DA Grossman, 'Warming up to a Not-So-Radical Idea: Tort-Based Climate Change Litigation' (2003) 28 Colum J Envtl L 1, 25.

It is thus assessed, taking into account the remoteness of the cause, the foreseeability of the damage, among other things, whether there are reasonable grounds to attribute the damage to a certain cause.[190] In other words, whether it is reasonable to find a defendant *liable*, if he is responsible for a cause-in-fact of the damage. This requires that the defendant can't escape liability through one of the defences that legal systems define.[191]

Thus, there is considerable variation in the concrete interpretation and assessment of the legal causation requirement to establish liability for damages. As we will discuss in the following section, the tests of legal causation discussed above are not infallible. This creates both hurdles and opportunities when reconciling legal and scientific causation.

4.2. Straining the system: corner cases and how they're dealt with

As we have seen in the previous section, when the question of proximate or legal causation is approached in the courtroom, *reasonableness* in some form becomes a criterion. This supports the contention that judges, often and across jurisdictions, engage in policy judgements when analysing causality, as a step in judging whether a defendant should be held liable or found guilty of an injury or crime to which her conduct has contributed.[192] This issue becomes especially salient in so-called *corner cases*,[193] where the apparent simplicity of the but-for test breaks down, and, when strictly applied, leads to 'unacceptable' results, because they are (or feel, to an observer) illogical, unfair or contrary to the perceived aims of (tort) law.[194]

In this section, we will discuss a number of situations that challenge the traditionally applied tests of causality we described in the previous section. Climate litigation often involves variations of these corner cases: when reconciling the scientific approach to causality with legal causality, many obstacles can arise that lead to causal uncertainty, and thus a rejection of a claim.[195] According to Marjanac and Patton, these issues are linked to the aim of the law to "[...] promote certainty in the face of changing facts, while science is characterised by an openness to change and adaptability to alternative hypotheses."[196] However, the way the law deals with these examples shows it can be flexible too, by applying policy or normative correctives to the causation testing framework.[197]

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[190] Ibid 116.
[191] G Calabresi, 'Concerning Cause and the Law of Torts: An Essay for Harry Kalven, Jr.', (1975) 43 U Chi L Rev 69, 72. One typical way to escape liability, in the US, is claiming *unforeseeability* of the damage, see Marjanac and Patton (n 6), 282. Another requirement for liability is that the harm was avoidable, see C Muffet and others, 'Smoke and Fumes: The Legal and Evidentiary Basis for Holding Big Oil Accountable for the Climate Crisis' (The Center for International Environmental Law 2017) <https://www.ciel.org/wp-content/uploads/2019/01/Smoke-Fumes.pdf> accessed 18 April 2023 5. Note that, given how far climate science has advanced, claims of unforeseeability are becoming difficult to support.
[192] Wright (n 24) 1737-1738 and 1827; Kruithof (n 181) 320; Moore (n 72) section 5.2; C Van den Wyngaert and S Vandromme, *Strafrecht en strafprocesrecht in hoofdlijnen* (11th edition, Gompel&Svacina 2019) 317.
[193] Harvard Law Review (n 181) 2164.
[194] Minnerop and Otto (n 106) 49.
[195] Bocken, Boone and Kruithof (n 24) 68.
[196] Marjanac and Patton (n 6) 279
[197] Minnerop and Otto (n 106) 66. See also section 4.5.

4.2.1. Identification, alternative causation and fair traceability

A first group of challenges relates to the identification requirement: one must be able to identify the defendant responsible for the damage.[198] In climate litigation, this is very challenging. After all, anthropogenic climate change is a global phenomenon, which, taken as a whole, is caused by an enormous variety of driving forces, and greenhouse gases currently in the atmosphere emitted by humans have been emitted over a time scale of several centuries and by countless parties.[199] This makes the identification of a *single* responsible party an impossible task. Even if the link between climate change and damage can be established, there may be many different emitters responsible for the damage, and it may be impossible to determine which defendant exactly caused the damage. This is called the problem of *indeterminate* or *alternative causation*.[200]

In many legal systems this leads to in solidum or joint and several liability of the different parties, often with internal recourse.[201] In the environmental liability context, this was applied in the CERCLA[202] cases in the US,[203] and has proponents in the context of climate litigation as well.[204] Given the huge number of (f)actors contributing to climate change, and coupled with the enormous damage, this is, in my view, difficult to justify from a reasonableness and policy perspective, as could result in an entirely disproportionate burden being placed on one party. This may make judges reluctant to apply it, making it a claim that may not favour plaintiffs.

Researchers have noted however, that lay people tend to feel that, when an outcome is overdetermined in a group context, “each individual in the group has some degree of responsibility for the outcome.”[205] Other solutions are therefore needed. One possibility is to apply the concept of *causal contribution*, the degree to which a cause has increased the risk of the damage that occurred, to determine the share of the damage each of the contributors is liable for. It is conceptually similar to the fraction of attributable risk calculated in climate science (see sections 3.3 and 3.4). The concept is applied in cases where there is joint and several liability, in the relationship to the co-defendants of jointly liable parties.[206]

A related challenge is proving *fair traceability.* This is due to the fact that greenhouse gases are ‘stock pollutants’, which means they cause their effects as they accumulate over time, rather than at the moment they are emitted. They are also fungible and well-mixed, so that they quickly become evenly distributed throughout the atmosphere. Thus, all emissions contribute in the same manner to climate change over the whole time they remain in the

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[198] Lawson (n 26) 449.
[199] See section 2.3.
[200] Hinteregger (n 17) 255; A Porat and A Stein, 'Indeterminate Causation and Apportionment of Damages: An Essay on Holtby, Allen, and Fairchild' (2003) 23 Oxford Journal of Legal Studies 667.
[201] Ibid; Bocken, Boone and Kruithof (n 24) 71.
[202] The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §§ 9601-9675 (2012), informally called *Superfund*, this act enabled the EPA to clean up highly polluted sites in the US while imposing liability on the polluters. See <https://www.epa.gov/superfund/what-superfund>.
[203] MC Wood and D Galpern, 'Atmospheric Recovery Litigation: Making the Fossil Fuel Industry Pay to Restore a Viable Climate System' (2015) 45 Environmental Law 259, 311.
[204] Ibid.
[205] Alicke (n 178) 803.
[206] Kruithof (n 181) para 14-16. See also section 3.3.1.

atmosphere, no matter who was the emitter or where the emissions happened.[207] This is sometimes used as an argument to deny 'fair traceability' of an emission to a harm.[208] The damage may also be considered too *remote.* However, as Lord Atkin puts it:

> "You must [...] avoid acts or omissions which [...] would be likely to injure your neighbour. Who, then, in law is my neighbour? The answer seems to be — persons who are so closely and directly affected by my act that I ought reasonably to have them in contemplation as being so affected [...]" [209]

It is true that each emitter is responsible for only a relatively limited part of the total emissions (which, moreover, may have come about over long time scales, giving rise to problems linked to statutes of limitation).[210] Since even a large emitter may be responsible for less than half a percent of total emissions,[211] it is difficult to argue that such an actor's emissions were a *substantial factor* that has caused climate change to an appreciable extent.[212] This is sometimes called the *drop in the ocean* argument.[213]

Courts, including the highest, in several jurisdictions have refuted this argument however, recognising that a causal link to impacts exists even for small contributions to climate change. Examples include the German Constitutional Court in *Neubauer et al v Germany*[214] and the Supreme Court of the Netherlands in *Klimaatzaak Urgenda.*[215] Likewise, the regional court of Hamm didn't accept the argument (made by RWE) in *Lliuya v RWE,*[216] nor did the Court of Den Haag (NL) in the *Milieudefensie et al v Royal Dutch Shell*-case.[217] The arguments all run along the lines that, while it is clear that the emissions of a single state or company can't by themselves cause or stop climate change entirely, this can't be used as an argument to escape responsibility: "partial causation [also justifies] partial responsibility," as the Supreme Court of the Netherlands puts it.[218] A similar argument has been made regarding state responsibility in relation to the climate litigation pending before the European Court of Human Rights: responsibility under international law in general, and the European

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[207] EA Page, 'Climatic Justice and The Fair Distribution of Atmospheric Burdens: A Conjunctive Account' (2011) 94 The Monist 412, 416.
[208] See for instance *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009) 20.
[209] *Donoghue v Stevens* [1931] UKHL 3, 1932 SC (HL) 31, [1932] UKHL 100, [1932] AC 562, 580. When it comes to applying the concept of 'neighbourliness' to climate change (litigation), see N Walker-Crawford, 'Climate change in the courtroom: An anthropology of neighborly relations' (2023) 23 Anthropological Theory 76. See also section 5.3.
[210] Chatzinerantis and Appel (n 52) 282.
[211] See, for examples, section 5.2.
[212] Ibid; D Hunter and J Salzman, 'Negligence in the Air: The Duty of Care in Climate Change Litigation' (2007) 155 U Pa L Rev 1741, 1770; Kysar (n 144) 37-40.
[213] And, by Kysar, the "consequentialist alibi", or "it makes no difference whether or not I do it", Kysar (n 144) 35.
[214] *Neubauer et al v Germany*, BVerfG Beschluss des Ersten Senats 24 March 2021, 1 BvR 2656/18 paras 1-270 <www.bundesverfassungsgericht.de/SharedDocs/Entscheidungen/DE/2021/03/rs20210324_1bvr265618.html> accessed 4 January 2023 para 119 and 202.
[215] *Klimaatzaak Urgenda*, Hoge Raad (NL) 20 december 2019 nr. 19/00135, ECLI:NL:HR:2019:2006 para 5.6.5-5.6.7
[216] See 5.2.
[217] *Milieudefensie et al v Royal Dutch Shell ,* Rb Den Haag (NL) 26 May 2021 nr C/09/571932/HA ZA 19-379 ECLI:NL:RBDHA:2021:5337 para 4.4.378 and 4.4.49.
[218] *Klimaatzaak Urgenda*, Hoge Raad (NL) 20 december 2019 nr. 19/00135, ECLI:NL:HR:2019:2006 para 5.6.7

Convention for Human Rights[219] in particular, isn't precluded solely by the fact that harm is (also, partly) attributable to other states. Direct and exclusive causality is not an appropriate standard in these cases.[220] The scientific similarity between projection and attribution studies, raises hope that the causal link between impacts and even small shares of emissions can be proven through attribution science.[221]

4.2.2. Overdetermination and cumulative causation

A second category of obstacles are *overdetermination* or *cumulative* causation, the concurrence of several insufficient but necessary causes. In this case, damage is the result of two or (many) more facts, each of which is insufficient in itself to cause the damage. Following the logic of the but-for test and its counterfactual implementation, each of those causes is by itself insufficient and thus not a cause-in-fact.[222] In the case of climate liability, this is a major problem, given the fungibility of greenhouse gases.[223] Even so, we have seen that climate science is able to quantify and provide evidence for the *increase in risk* even a small share of emissions entails.[224]

Of the solutions proposed to the overdetermination problem, the most commonly cited and applied are the INUS (insufficient but necessary element of an unnecessary but sufficient set)[225] and NESS (necessary element of a sufficient set)[226] tests. As an example, we can think of lighting a match, which in itself is insufficient as a cause for a fire, since the presence of oxygen and fuel are also needed. Lighting the match, however, is non-redundant, since the fire wouldn't have started without it.[227] These theories also incorporate a counterfactual element, the difference being that it is asked whether a result would have occurred absent a *set* of conditions, not just absent one element.[228]

Applied to climate change, attribution studies showing that anthropogenic GHG emissions were *necessary* for causing, for example, a hurricane, can't show it was sufficient by itself. They can, however, show that emissions are a non-redundant part of a set of conditions which taken together is sufficient. INUS or NESS thus provide an alternative minimum threshold for causation, for factors which, by themselves, are neither necessary nor sufficient and would thus not pass the but-for-test.[229] This way of looking at causation also takes into account the intuition discussed above, that the abnormal or human-made elements of a causal set should be assigned most of the blame.[230] In this regard, the argument made by

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[219] Convention for the Protection of Human Rights and Fundamental Freedoms (European Convention on Human Rights, as amended) (ECHR).
[220] H Keller and C Heri, 'The Future is Now: Climate Cases Before the ECtHR' (2022) 40 Nordic Journal of Human Rights 153, 167.
[221] Stuart-Smith, Otto and Wetzer (n 104) 24-25.
[222] Kruithof (n 181) 315; Moore (n 72) section 5.1.1; Minnerop and Otto (n 106) 58 and 67.
[223] See previous section.
[224] Minnerop and Otto (n 106) 79.
[225] Explained concisely in the following video: https://www.youtube.com/watch?v=n6_hyQeQQts.
[226] First proposed by Wright, as a formalisation of ideas formulated by Hart and Honoré; Wright (n 24) 1788-1803. See also Harvard Law Review (n 181) 2172-2175.
[227] Kruithof (n 181) 319; Moore (n 72) section 5.1.2; Minnerop and Otto (n 106) 79.
[228] Harvard Law Review (n 181) 2173.
[229] Minnerop and Otto (n 106) 89.
[230] See section 4.1.

Raju and others that the human-made components of vulnerability and hazard in disasters caused by climate change should be emphasised more, is especially salient.[231]

A concrete example in which the challenges of the identification requirement and cumulative causation come together, is the case of *Sindell v Abbott Laboratories*,[232] where liability was assigned on the basis of market share, since individual claimants could not prove which manufacturer of a certain drug caused the harm they suffered. However, US courts have been reticent to extend market share liability beyond medical negligence cases,[233] based on the argument that other products and activities don't have the fungibility that DES has. Greenhouse gases, however, do have this feature, with the difference that all greenhouse gases contribute to the *same, single* global process of climate change. Kysar argues that several (i.e. proportionate) liability is the appropriate theory of recovery here.[234]

In a similar vein, in Canada, regarding the compensation of healthcare costs resulting from smoking, legislation has been enacted that allows to establish causation on an aggregate basis and assigns liability proportionally to tobacco companies' market share.[235] When the proportion to which a certain concurrent cause has contributed to the harm can be determined (for instance through intensity and duration of exposure to a toxic substance), (notably) in Belgium,[236] England and Germany, liability is shared proportionally.[237]

4.2.3. Risk-based approaches

In some cases where it is impossible to prove 'but for'-causation, the counterfactual test is modified to take a risk-based approach. It is asked not whether an act was necessary to a harm as it actually occurred, but rather to the harm having the *chance* (i.e. probability, likelihood) of occurring (as it did).[238] Taken one step further, this approach of *loss of a chance* (of a better outcome), which is to say, increasing, and sufficiently well-characterised, the risk (of harm), leads scholars to see an increased risk of a harm as a compensable harm in itself.[239] It is important to note the legal principle known as the eggshell skull or thin-skull rule[240] here. This means that vulnerability of the *victim* is not legally taken into account in the analysis.[241]

One concrete example relevant for my thesis is the *Fairchild*[242] line of cases. It revolved around the liability of employers who exposed employees to asbestos who later contracted mesothelioma. The identification requirement couldn't be fulfilled in the case of exposure by multiple employers. It could only be shown that the exposure increased the risk of

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[231] E Raju, E Boyd and F Otto, 'Stop blaming the climate for disasters' (2022) 3 Communications Earth & Environment 1.
[232] *Sindell v Abbott Laboratories,* 26 Cal. 3d 588 (1980).
[233] Marjanac and Patton (n 6) 286.
[234] Kysar (n 144) 37-40. For an extensive discussion of proportionate recovery in an English context, see Porat and Stein (n 200).
[235] Minnerop and Otto (n 106) 60.
[236] Kruithof (n 181) 281-282.
[237] Minnerop and Otto (n 106) 60.
[238] Moore (n 72) section 5.1; Wright (n 24) 1814-1824.
[239] Kysar (n 144) 63.
[240] Calabresi (n 191) 92.
[241] Otto and others (n 5) 744.
[242] *Fairchild v Glenhaven Funeral Services Ltd* [2003] 1 AC 32.

developing mesothelioma. Rather, the *material contribution to the risk*-standard was used as a workaround for the identification requirement. The decisions in this line of cases were controversial though, with some authors referring to "judicial remorse" around this relaxation, which has also been partially reversed through primary legislation.[243] However, this case is far from the only example of a risk-based approach to causality in English law, so it certainly is a useful example to keep in mind.[244]

Porat and Stein conceptualise this type of cases as assigning liability for *evidential damage* rather than risk, in which a tortfeasor's actions "[impair] the claimant's ability or reduces the claimant's chances of establishing the facts underlying his or her cause of action for a direct damage."[245] I think that, in climate change cases, this is a crucially important way for plaintiffs to argue their cases, based on the scientific evidence available.[246]

Given the extent of knowledge about the (increased risk of) potential future harms, a clear argument for the precautionary principle[247] can be made.[248] In what can be considered an application of this principle, in the *Neubauer* case[249], the Constitutional Court in Germany recognises that remaining scientific uncertainty regarding causality places *more* constraints on the German legislator, including a duty of care vis-à-vis future generations.[250]

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In this section, we have shown through a number of examples that the strict application of the but-for-test can be and is adjusted in practice when it yields unfair or unjust results. Courts, thus, are prepared to adapt overly formalistic application of principles to the

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[243] Marjanac and Patton (n 6) 281
[244] Otto and others (n 5) 738. For a more extensive discussion and a comparison to the approach taken by the European Court of Human Rights, see G Turton, 'Causation And Risk In Negligence And Human Rights Law' (2020) 79 The Cambridge Law Journal 148. See also Porat and Stein (n 200).
[245] Ibid 697
[246] See below, chapter 5.
[247] N Kobylarz, 'The European Court of Human Rights: An Underrated Forum for Environmental Litigation' in Helle Tegner Anker and Birgitte Egelund Olsen (eds), *Sustainable Management of Natural Resources: Legal Instruments and Approaches*, vol 5 (Intersentia 2018) 111; Keller and Heri (n 223) 164.
[248] K Garnett, 'Nieuwigheid, onwetendheid en het onbekende: onzekere wetenschap en de "grenzen van de wetenschap"-doctrine', 4 TOO 2021 293, 310-311. For an extensive discussion of the precautionary principle in the frame of climate change, see F Fleurke, 'Catastrophic Climate Change, Precaution, and the Risk/Risk Dilemma' in Ambrus M, Rayfuse R and Werner W (eds), *Risk and the Regulation of Uncertainty in International Law* (Oxford University Press 2017); for an extensive discussion of this principle and how it relates to scientific evidence, see C Foster, *Science and the Precautionary Principle in International Courts and Tribunals. Expert Evidence, Burden of Proof and Finality* (Cambridge University Press 2011).
[249] *Neubauer et al v Germany*, BVerfG Beschluss des Ersten Senats 24 March 2021, 1 BvR 2656/18—paras 1–270 <www.bundesverfassungsgericht.de/SharedDocs/Entscheidungen/DE/2021/03/rs20210324_1bvr265618.html> accessed 4 January 2023.
[250] P Minnerop, 'The 'Advance Interference-Like Effect' of Climate Targets: Fundamental Rights, Intergenerational Equity and the German Federal Constitutional Court' (2021) 34 Journal of Environmental Law 135, 149.

demands of justice and fairness.[251] It is worth quoting Lord Hoffmann J in *Fairchild v. Glenhaven Funeral Services Ltd*[252] to illustrate this point:

> "Clearly the rule must be based upon principle. [...] That does not mean, however, that it must be a principle so broad that it takes no account of significant differences which affect whether it is fair and just to impose liability."[253]

In the next section, we will discuss what evidence is required to support a fair and just judgement.

4.3. What likelihood and confidence level are required to establish legal causation?

The legitimacy of the factual determination a judge makes when deciding a case depends on external epistemic support.[254] It depends, in other words, on the evidence which is adduced at the trial.[255] In this section, we will discuss the standards applied to the evidence. More specifically, we will discuss what (scientific) evidence must be supplied for a judge to find there is a causal link, and whose responsibility it is to supply it.

4.3.1. Burden of proof

The burden of proof refers to which party must prove which facts in court. Usually, the party making a claim has to provide evidence for it: *actori incumbit probatio*.[256] This rule (alongside related rules of procedure and proof) is meant to roughly ensure fairness and balance between the parties in a legal dispute, while also taking into account that ideally, any legal judgement should be based on a correct application of the law to the facts.[257] Because in some situations, the factual situation entails a *de facto* imbalance in the availability or difficulty in producing evidence between the parties, doctrines and practices have been developed that allow a shifting, or reversal, of the burden of proof to ensure the balance between the parties.[258]

A device that legal systems often use to shift or reverse the burden of proof are (rebuttable) presumptions. They can be seen as legally defined inferences, in which a certain conclusion *must* be accepted as proven from a proven premise or prior fact, as long as the conclusion remains unrebutted.[259] Another such doctrine is *res ipsa loquitur*,[260] a common law-doctrine that shifts the initial burden of proof to a defendant, because evidence is "practically

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[251] Minnerop and Otto (n 106) 50-51; Otto and others (n 5) 738.
[252] *Fairchild v Glenhaven Funeral Services Ltd* [2003] 1 AC 32.
[253] Ibid [60] (Lord Hoffmann).
[254] Sulyok (n 30) 28.
[255] Ho (n 84) 94.
[256] "The proof rests with the plaintiff," generalised to the principle that a party asserting a fact bears the burden of proving it.
[257] Foster (n 248) 189. In international tribunals, the rules on the burden of proof are more extensive, including inter alia the 'presumption of compliance'. This thesis focuses on national courts, however, so further discussion of this subject is outside of its scope.
[258] Porat and Stein (n 161) 166.
[259] Ho (n 84) 97.
[260] "The thing speaks for itself."

accessible to him but inaccessible to the injured person."[261] It has been argued that for climate change too, the doctrine should be applied in the case of natural disasters uncommon to an area.[262]

Yet another example can be found in the aforementioned case *Sindell v Abbott Laboratories*, where the burden of persuasion was altered because information was *necessarily* lacking to the claimants.[263] This led to shifting the burden of proof from individual citizen plaintiffs to the defendant large pharma companies.[264] In the *Glenhaven*-cases, the burden of proof was reversed: the defendants were held (jointly and severally) liable unless they could prove *not* having caused the plaintiff's cancer.[265]

These analyses show that new doctrines can be developed in the interests of fairness and balance. The ones we discussed here overlap to some extent with the risk-based notions in proving causality, especially with Porat and Stein's conceptualisation of the loss of a chance doctrine as compensation for *evidential damage*.[266] These doctrines could be applied, *mutatis mutandis*, to climate litigation, especially in those cases involving fossil fuel companies involved in efforts to obfuscate climate science.[267]

4.3.2. Standard of proof

Now we have discussed who must prove an assertion, we turn to the question of what it takes to prove an assertion. This is what the notion *standard of proof* comprises: "the level of certainty and the degree of evidence necessary to establish proof in a criminal or civil proceeding."[268] Whether or not the standard of proof is met, can be evaluated in terms of evidential support, or the extent to which the evidence supports a certain hypothesis. This depends, firstly on the credibility of the evidence; secondly of the sufficiency of the reason(s) or ground(s) it gives for the hypothesis; thirdly on the extent to which significant, weighty aspects of the hypothesis are supported by the evidence (rather than by general or background knowledge), fourthly on how comprehensive the evidence is, whether is is weighty enough (to exclude a sufficiently significant chance that there is a better explanation) even though it is incomplete, and, fifthly, whether the evidence is able to *explain* the hypothesis, whether it offers a *causal* account of the hypothesis.[269]

Regarding causality, a judge must be convinced that a proposed causal explanation of what has been observed is more plausible than any other possible explanation, which is usually done through the counterfactual analysis described above. The more likely the proposed

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[261] K Barnes, 'Democratizing Climate Change: Litigation for the Era of Extreme Weather' (2019) 50 U Pac L Rev 651, 681.
[262] Ibid. Of such disasters, many examples can be found. "In late June 2021 a heatwave of unprecedented magnitude impacted the Pacific Northwest region of Canada and the United States," RH White and others, 'The unprecedented Pacific Northwest heatwave of June 2021' (2023) 14 Nature Communications 727. Underlining by me.
[263] Ho (n 84) 14; Lawson (n 26) 451; Wright (n 24) 1818.
[264] Barnes (n 261) 667.
[265] Minnerop and Otto (n 106) 55-56.
[266] See section 4.2.3.
[267] See section 5.2.2.
[268] <https://www.merriam-webster.com/legal/standard%20of%20proof> accessed 10 May 2023.
[269] Ho (n 84) 165-170.

explanation is in relation to other possible explanations, the higher the chance a judge can be convinced that tortious conduct contributed to the harm, not just to the risk of the harm.[270] When assessing causal claims, the evidence is thus assessed against a standard of proof, and the causal link must be shown with a sufficient degree of certainty.[271] This standard varies from one legal system to another, but substantively, the approach is similar (as a reminder, we discuss *civil cases* in what follows).[272]

In the US, England, Ireland, Denmark and Lithuania, among others, the standard applied is *more probable than not (*also *on the balance of probabilities*, or *on the preponderance of the probabilities*). In Austria, a *high probability* is required, whereas a *reasonable degree of certainty* is required in the Netherlands. In Germany and Switzerland the applied standard is that of *near certainty*, but it may suffice to convince judges of the existence of a causal link.[273] In Bulgaria and Spain, certainty is expected, whereas in Greece, France, Poland, and Italy a judge must be convinced of the existence of a causal link.[274] In Belgium, the causal link between fault and damage should be of *a probability bordering on certainty* ("gerechtelijke zekerheid").[275]

In certain types of negligence cases where a strict causal link between a plaintiff's disease and negligence couldn't be demonstrated, courts in England and Wales have developed the "doubling of the risk" test, such that the plaintiff must show that exposure to a certain disease-causing substance doubles the risk of contracting the disease, compared to the risk without any exposure (i.e. general causation). From this, it is then inferred that the injury was (i.e. actual causation), on the balance of probabilities, caused by the defendant.[276] The test is also applied in this way in the US, Ireland, Denmark and Lithuania.[277]

If this sounds relatively straightforward, some caveats are in order. The more probable than not-standard can literally be taken to mean "with a probability of more than 0,5 or 50%". This can lead to a well known paradox of legal proof, in which belonging to a category of people who are more likely than not to have committed a certain breach or tort (e.g. being present at an event at which 60% of those present entered with counterfeit tickets) could lead to being convicted. This clearly doesn't square with most people's sense of fairness or justice.[278] Judges too, when invoking the balance of probabilities, tend to apply it with common sense. As Lord Brandon puts it:

> "[T]he legal concept of proof of a case on a balance of probabilities must be applied with common sense. It requires a judge [...] before he finds that a particular event occurred, to be satisfied on the evidence that it is more likely to have occurred than not."[279]

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[270] Wright (n 24) 1823-1825.
[271] Rozie and Vansweevelt (n 3) 109.
[272] Stuart-Smith, Otto and Wetzer (n 104) 13-14
[273] M Schweizer, 'The civil standard of proof—what is it, actually?' (2016) 20(3) The International Journal of Evidence & Proof 217.
[274] Stuart-Smith, Otto and Wetzer (n 104) 13-14
[275] Van Quickenborne (n 28) 62.
[276] Marjanac and Patton (n 6), 280-81; Grossman (n 189) 23.
[277] Stuart-Smith, Otto and Wetzer (n 104) 13-14
[278] Ho (n 84) 94, 142. See further O Kerr, 'A Theory of Law' (2012) 16 Green Bag 2D 111.
[279] Cited in Hunt I and Mostyn J, 'Probability reasoning in judicial fact-finding' (2020) 24 The International Journal of Evidence & Proof 75, 84.

Moreover, even within a certain standard, there can be variations of flexibility in the application. The different phrasings of the standard of proof can hardly be said to give an exact indication of how much proof is enough. In practice, the flexibility can go beyond the interpretation of the terms themselves. The European Court of Human Rights, for example, is known to "allow flexibility, taking into consideration the nature of the substantive right at stake and any evidentiary difficulties involved."[280] Another factor is that a judge or juror will inescapably have pre-existing beliefs, which make it so that some things will inherently seem more likely than others to her. The less plausible a hypothesis seems, the more compelling the evidence will have to be to persuade a fact-finder.[281] What it takes for scientific evidence to be convincing is the topic of the following section.

4.4. Bearing the burden: scientific evidence in court

Proving causation along the entire causal chain in climate change litigation presents many complexities, legal as well as scientific. Scientific complexity makes it challenging for judges to assess evidence and issue well-reasoned judgments.[282] In the ICJ's *Pulp Mills* case, two judges stated:

> "The adjudication of disputes in which the assessment of scientific questions [is indispensable,] requires an interweaving of legal process with knowledge and expertise that can only be drawn from experts properly trained to evaluate the increasingly complex nature of the facts put before the Court."[283]

Evaluating scientific evidence confronts judges with the 'uncertainty paradox' or 'knowledge paradox'. In order to judge in a context of uncertainty, they need scientific knowledge and sufficient certainty about its validity. The paradox lies in the fact that a judge is asked to judge precisely *because* the knowledge is (at least according to one of the parties) uncertain.[284]

Supposing that judges are well equipped to handle the legal burdens, can science provide the needed epistemic support to legitimise a judicial decision of legal causality? In climate litigation, a scientifically and legally sound judgement requires a thorough scientific understanding.[285] The cases discussed in this thesis are clear examples that courts increasingly are willing, or forced, to grapple with scientific evidence, weighing its merits and assessing quality and validity of evidence and expert opinion. Elsewhere, it has been argued

[280] Ho (n 84) 217. See, more extensively, K Sulyok, 'Managing Uncertain Causation in Toxic Exposure Cases: Lessons for the European Court of Human Rights from U.S. Toxic Tort Litigation' (2017) Vol. 18. Vermont Journal of Environmental Law 519.
[281] Ho (n 84) 218-219.
[282] Turton (n 244) 148.
[283] *Pulp Mills on the River Uruguay (Argentina v Uruguay) (Judgment)* [2010] ICJ Rep 14 (Pulp Mills) Joint Dissenting Opinion of Judges Al-Khasawneh and Simma, para 3 (110).
[284] K Jansen and E de Jong, 'Rechterlijke toetsing van wetenschappelijke kennis in het aansprakelijkheidsrecht' (2022) 1(2) Nederlands Tijdschrift voor Burgerlijk Recht 5, 7.
[285] Otto and others (n 5) 743

that supranational courts in Europe increasingly show the same willingness.[286] This does not mean this is without practical challenges. I'll discuss these in the following sections.

4.4.1. Admissibility and reliability

For evidence to be considered, it needs to be legally admissible; to help a judge or juror arrive at a legally correct conclusion, it needs to be sufficiently credible, or "evidentiary reliable."[287] However, any science or expert evidence adduced in litigation risks being criticised as 'litigation-driven' science or expertise. This criticism can be directed both at a certain expert or scientist, or at the scientific consensus itself.[288] Advocacy research, in particular, is in danger of bias,[289] but this is mitigated if it has non-judicial as well as judicial uses. [290]

Can criteria be defined that scientific and expert evidence must or should satisfy in order to be accepted in court? Common law systems have legal rules on the admissibility of evidence at trial.[291] While some continental systems adhere to the principle of free proof, in those systems too, judges operate some sort of evaluation of the probative weight of evidence presented (except when there is no argument between the parties on a certain piece of evidence).[292]

The European Union's European Court of Justice requires the assessment of scientific questions to be "entrusted by the institution to scientific experts" who can give their opinion in an "independent, objective and transparent manner". Advice must be "founded on the principles of excellence, transparency and independence."[293]

In the US, the 'Daubert standard' formulated by the Supreme Court (formulated in the case *Daubert v. Merrell Dow Pharmaceuticals*[294]) is used to assess the admissibility of

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[286] P Dąbrowska-Kłosińska, 'Risk, Precaution and Scientific Complexity before the Court of Justice of the European Union' in L Gruszczynski and W Werner (eds), *Deference in International Courts and Tribunals: Standard of Review and Margin of Appreciation* (Oxford University Press 2014) 192, 194; N Schuldt, 'Pavlov v Russia: Welcoming the Court's Proactive Shift in its Handling Of Environmental Complaints, Including their Evidentiary Challenges*' (Strasbourg Observers, 15 November 2022) <https://strasbourgobservers.com/2022/11/15/pavlov-v-russia-welcoming-the-courts-proactive-shift-in-its-handling-of-environmental-complaints-including-their-evidentiary-challenges/> accessed 10 January 2023. For a thorough discussion of the role of scientific evidence before international courts and tribunals, see Foster (n 248).

[287] Pfrommer (n 116) 67.

[288] S Haack, 'What's Wrong with Litigation-Driven Science - An Essay in Legal Epistemology' (2008) 38 Seton Hall L Rev 1053, 1077.

[289] Because "being motivated to seek out all the evidence, the plain-and-simple inquirer will be more thorough than the advocacy researcher looking only for favorable evidence; [...] he will be less partial than the advocacy researcher; [...] he will be more honest than the advocacy researcher trying to disguise what doesn't suit his purpose." Haack (n 288) 1072.

[290] Ibid 1075.

[291] Ho HL, 'The Legal Concept of Evidence' in EN Zalta (ed), *The Stanford Encyclopedia of Philosophy* (Winter 2021 Edition) <https://plato.stanford.edu/archives/win2021/entries/evidence-legal/> accessed 2 March 2023, section 2.3.

[292] Jansen and de Jong (n 284) 6.

[293] Dąbrowska-Kłosińska (n 286) 202.

[294] *Daubert v Merrell Dow Pharmaceuticals, Inc.*, 509 US 579, 23 ELR 20979 (1993).

evidence.[295] When assessing the admissibility and reliability of scientific, technical and other specialised knowledge,[296] judges should assess the following factors:

- Testability: can the scientific theory or technique be tested (and has it been)?
- Peer review: is there peer review and publication?
- Error rate: is there a known or potential margin of error?
- Standard of control: are there standards controlling a theory's operation?
- Is there "general acceptability" within a "relevant scientific community"?[297]

Not allowed is *slicing and dicing*, where pieces of evidence are individually judged and excluded where, taken together, they would meet the criteria; evidence should be weighed as a whole. The range of reasonable disagreement is limited to the opinions of *other scientists*, not the court itself.[298]

Jansen and de Jong propose what Sulyok calls a *hybrid* (scientific as well as legal) *benchmark*, inspired by the *manifest error* criterion, with the following elements:

- Completeness and relevance of the available evidence, in relation to the legal question at hand;
- Transparency and verifiability as regards the production of the scientific evidence, with peer review giving an indication of whether this criterion has been met;
- Methodological acceptation of the methods used in producing the scientific knowledge;
- The internal and external consistency of the piece of scientific evidence in question, with internal consistency referring to the single piece of evidence itself, and external consistency to whether the piece of evidence is part of a wider consensus within the relevant scientific field.[299]

A large body of climate and attribution science meets these admissibility and reliability standards. Climate science is well established, and there is no meaningful, reasonable disagreement in the climate science community about its basic tenets. The admissibility and reliability should thus not present major hurdles.[300] As we discussed in section 3.3, some attribution science is still relatively young, however, and is currently going through the process of standardisation and operationalisation required for it to fully meet the second and third criteria.[301]

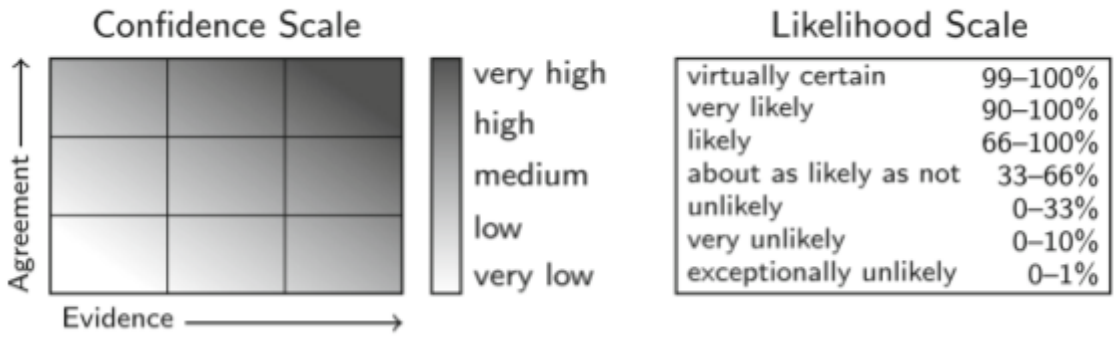
4.4.2. Numbers in court: how are probabilities expressed in words?

As we have seen, climate science often deals in probabilities, expressing knowledge in terms of values from 0-100% or fractions between 0 and 1. We have also seen that in the

[295] It replaced an earlier standard in the context of concerns about juries being confronted with so-called *junk science*, see Jansen and de Jong (n 284) 14.
[296] Ibid 15.
[297] Burger, Wentz and Horton (n 95) 10646; Pfrommer (n 116) 75.
[298] Ibid.
[299] Ibid 16-18.
[300] Burger, Wentz and Horton (n 95) 10646; Schoukens and Billiet (n 12) 285.
[301] Burger, Wentz and Horton (n 95) 10648; Pfrommer (n 116) 67. Progress is sure to have been made in the meantime.

law, and in conversation in general, confidence in statements or predictions, or causal links, is usually expressed in words.[302] A key question is, then, how probabilities expressed in numbers can be 'translated' to words.

The IPCC doesn't offer unambiguous yes/no, on/off assessments in its reports. Since 2001, it has sought consistency in its communication of uncertainties by supplying authors with a series of guidance notes. The most recent one[303] published was prepared for the 5th (second to last) assessment report, and is still in use.[304] It distinguishes, usefully, between *likelihoods,* i.e. the probability of a certain hypothesis being (more) true (than another), strength of causal links, etcetera;[305] and *confidence*, a qualitative metric that combines the quality of the underlying evidence and the degree of agreement.[306] The scales are summarised in the figure below.



Confidence and likelihood scales for communicating degree of certainty in key findings of the IPCC AR5. Figures copied from C Helgeson, R Bradley R and B Hill, 'Combining probability with qualitative degree-of-certainty metrics in assessment' (2018) 149 Climatic Change 517, 518, and based on MD Mastrandrea and others, 'Guidance note for lead authors of the IPCC fifth assessment report on consistent treatment of uncertainties' (IPCC 2010).

The discussion above may raise the impression that a straightforward, and relatively unambiguous translation of probabilities into language, ideally combined with a statement of confidence, allows clear verbal communication of probabilities. As the reader may have

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[302] See the next section.
[303] MD Mastrandrea and others, 'Guidance note for lead authors of the IPCC fifth assessment report on consistent treatment of uncertainties' (IPCC 2010) <https://www.ipcc.ch/site/assets/uploads/2017/08/AR5_Uncertainty_Guidance_Note.pdf> accessed 2 March 2023.
[304] A new guidance note focussing on the (more normative) question of expressing risks was prepared for the 6th AR, see A Reisinger and others 'The Concept of Risk in the IPCC Sixth Assessment Report: A Summary of Cross-Working Group Discussions' (IPCC 2020) <https://www.ipcc.ch/site/assets/uploads/2021/02/Risk-guidance-FINAL_15Feb2021.pdf> accessed 19 april 2023.
[305] A likelihood, in contrast to a probability, is meant to compared, as becomes clear from Edwards' 'likelihood axiom': "within the framework of a statistical model, a particular set of data supports one statistical hypothesis better than another if the likelihood of the first hypothesis, [given] the data, exceeds the likelihood of the second hypothesis," A Etz, 'Introduction to the Concept of Likelihood and Its Applications' (2018) 1 Advances in Methods and Practices in Psychological Science 60.
[306] C Helgeson, R Bradley and B Hill, 'Combining probability with qualitative degree-of-certainty metrics in assessment' (2018) 149 Climatic Change 517, 518. The intelligence community is also adopting this distinction, see JA Friedman and R Zeckhauser, 'Handling and Mishandling Estimative Probability: Likelihood, Confidence, and the Search for Bin Laden' (2015) 30 Intelligence and National Security 77, 90.

suspected, this is not the case. Interpretations of the (mathematical) probabilities associated with verbal probability statements differ relatively widely and often lead to misunderstandings.[307]

In the domain of climate science, it was found that not all (climate) experts are equally familiar with the guidance note, and that their estimated probability intervals depend on the context in which a phrase is presented, the associated confidence, and in general don't necessarily match the IPCC guidance.[308] In another survey, it was found that participants without a science background interpreted "very likely" as corresponding to a 65-75% probability, rather than the 90-100% the IPCC means by the term[309]. It stands to reason that judges are not immune in this regard. This creates an obvious problem of moving, or invisible, goalposts, which is at the core of the problem of establishing legal causation in climate litigation.

The discussion is ongoing, and (intended) improvements are regularly proposed in literature.[310] As regards IPCC reports, an integration of the probability and confidence metrics in one variable was proposed by Hekgeson, Bradley and Hill.[311] It hasn't been adopted, and the probability and confidence statements are consistent between the IPCC's fifth and sixth assessment reports.[312] Researchers in the Netherlands usefully recommend continually providing numerical interpretations of phrases between brackets (instead of in one table) to minimise the risk of miscommunication.[313]

4.4.3. Translating the standard of proof to a numerical threshold

Now that we have shown the difficulties involved with translating the numerical probabilities to words in climate science into words, we'll take a look at the problem from the other angle. Can the phrases describing the standard of proof courts apply, be expressed in numbers? The view that standard of proof represents a probabilistic threshold is strongly held by the proponents of *legal probabilism*, a movement which relies on probability theory to analyse, model and (try to) improve the evaluation of evidence and the quality of the decision-making process in legal proceedings. However, this interpretation is controversial and remains

[307] Ibid 77; Willems, Albers and Smeets (n 33) 17.
[308] A Kause and others, 'Confidence levels and likelihood terms in IPCC reports: a survey of experts from different scientific disciplines' (2022) 173 Climatic Change 2.
[309] EA Lloyd and others, 'Climate scientists set the bar of proof too high' (2021) 165 Climatic Change 55, 7
[310] See for example Friedman and Zeckhauser (n 306).
[311] Helgeson, Bradley and Hill (n 306) 517.
[312] Lee (n 61) 3 footnote 4.
[313] Willems, Albers and Smeets (n 33) 18.

minority view.[314] It can also lead to paradoxes with unacceptable results when interpreted literally (see section 4.3.2).

Thus, in court, as in the world at large, the question of how high, exactly, a probability must be (in numerical terms) to meet a certain (verbally expressed) legal standard of likelihood, remains substantively unanswered. Neither is it clear to what degree of confidence this likelihood must be proven. A key principle, in many jurisdictions, is that judges, as triers of facts, have a certain degree of freedom in interpreting and assigning probative value to evidence, and thus in deciding when the burden of proof is met by the evidence presented.[315]

What is clear, is that mere statistical correlation does not suffice: causality must be proven. As Wright puts it: "A causal generalization asserts that the antecedent conditions produce or cause the subsequent event—that they are necessary elements of a set of conditions that is sufficient for the occurrence of the event. It is precisely this quality of causal generalizations that distinguishes them from mere statistical reports and gives them explanatory and predictive power."[316]

To close this section, and as an encouragement to those trying to prove causality, it is useful to keep in mind the contention that scientists set the bar too high, in relation to what courts require. Scientists typically set the bar at 90 or 95% certainty, which is a lot higher than many legal standards required by courts.[317]

4.5. Bringing it all together: towards a general framework for climate causation

Up till now, we have seen that climate science is probably capable of proving causality along the causal chain, to the standard of admissibility, reliability and proof generally required in courts. We have also seen that, in conventional causation tests, the existence of local, confounding factors, may still render it difficult or impossible to prove that it is a *conditio sine qua non* or but-for cause, especially for small shares of historical emissions. More often, climate change will be an INUS condition or NESS (see section 4.2.) In this chapter, we described examples of normative and policy correctives that have been applied in cases where regular causal testing framework breaks down. However, none of these have been generalised beyond the specific context in which they were developed, leaving us without a

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[314] Ho (n 291) 3.2.1-3.2.2; Urbaniak R and Di Bello M, 'Legal Probabilism' in EN Zalta (ed), *The Stanford Encyclopedia of Philosophy* (Fall 2021 Edition) <https://plato.stanford.edu/archives/fall2021/entries/legal-probabilism/> accessed 2 March 2023. "[S]ee Adam Perry, Strained Interpretations (Feb. 11, 2019) (unpublished manuscript), https://papers.ssm.com/sol3/papers.cfm?abstract id=3175410 [for an excellent discussion of the use of the Bayesian theorem and probabilities in jurisprudence]." from Minnerop and Otto (n 106), footnote 4 *in fine*. For a (very) extensive discussion on Bayesian reasoning in criminal cases, see DRHJ Berger, 'Improving Legal Reasoning using Bayesian Probability Methods' (DPhil thesis Queen Mary University of London 2014).

[315] S Sullivan, 'A Likelihood Story: The Theory of Legal Fact-Finding', (2019) 90 University of Colorado Law Review 1, 62.

[316] Wright (n 24) 1823.

[317] The 'on the balance of probabilities' applied in civil litigation, for instance, would require (not too much) more than 50% certainty. Lloyd (n 309) 55, 6; Marjanac and Patton (n 6), 280.

generally applicable framework that is broadly accepted in climate litigation.[318] Is it possible to bring these different threads together in a new framework?

In their paper 'Climate Change and Causation: Joining Law and Climate Science on the Basis of Formal Logic',[319] Minnerop and Otto address this issue by proposing a new model, comprising three pillars. The first of these is derived from the logical causation concepts of *necessary* and *sufficient* conditions, which can be used to identify relevant factors to be proven along the causal chain, taking into account the degree of probability (likelihood) and confidence levels of the evidence along every step. They state that very strong connections can be shown between emissions, temperature increases and the frequency and severity of impacts, such that each is a sufficient and necessary condition for the other. Using the notion that a relationship of necessity *and* sufficiency is transitive,[320] they infer the second pillar of the model: the notion of a *distinctive causal field*, a concept enveloping the strong evidence that supports the links between emissions, climate change and extreme event intensity and frequency. [321]

A final pillar is the concept of *sustenance*, a concept which aims to conceptualise how robust a finding of the degree to which emissions increased the risk of a specific extreme weather event is to changes of other factors in the model, in other words, just *how necessary* an element in the sufficient set (NESS) climate change is, or the degree to which it is non-redundant in the INUS set, by measuring "the capacity of [climate change] to protect or maintain the effect under structural changes in the model."[322] Even though the strength of an individual result will inevitably depend on the strength and availability of scientific evidence, taking *sustenance* into account as a factor when presenting attribution evidence makes it possible to establish causation even if anthropogenic emissions are only a small part of a larger set of conditions. This then allows to show, in legal terms, that even a fraction of emissions is a *concurrent cause*[323] of an event.[324]

This framework presents an interesting effort at bringing together the disparate normative adjustments in a coherent way that's adapted to the multi-stage scenario that the link between GHG emissions and impacts inevitably entails. However, as the authors also stress, pragmatic judicial reasoning remains crucial. Even a framework like this one will have trouble fitting neatly into the classical notion of an individually and exclusively responsible

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[318] Minnerop and Otto (n 106) 66. This is not to say that academics haven't tried to distil generalisable theories on how the causation requirement is applied in practice. These, however, are far from generally accepted in academic jurisprudence, let alone when it comes to the law in action. For a concrete example of the preceding statement, see Kruithof (n 181).
[319] Minnerop and Otto (n 106).
[320] Note that while in logic, a relationship of necessity and sufficiency is transitive, this is not necessarily so in causation in general. To illustrate I cite from Harvard Law Review (n 181) 2179: "While causation's transitivity certainly seems intuitive, see Ned Hall, Causation and the Price of Transitivity, 97 J. PHIL. 198, 198 (2000) ("That causation is, necessarily, a transitive relation on events seems to many a bedrock datum, one of the few indisputable a priori insights we have into the workings of the concept."), it is not self-evident. Counterfactual dependence, after all, is notoriously nontransitive."
[321] Minnerop and Otto (n 106) 72-84.
[322] Ibid 81.
[323] Understood as "an act or event or a state of nature which initiates or permits ... in conjunction with other causes[,] a sequence of events resulting in an effect." Minnerop and Otto (n 106) 55.
[324] Ibid 78-84.

defendant. This is where policy judgements come in.[325] Thus, only by applying frameworks like the one described in this section with a willingness to engage in novel causal reasoning can it be avoided that rigid applications of mechanistic causation tests become an impediment to justice.[326]

4.6. Conclusion

In this chapter, I have discussed the legal causation requirement with a view to proving causation in climate litigation. After having discussed the general, two step test of establishing factual causes by applying the but for test, before selecting legal causes among them, I describe a number of situations in which this leads to unacceptable results, and the policy correctives which judges have applied in such situations. Then I went into the burden of proof, and the standard of proof applied in civil cases. The next section dealt with the challenges cases that require complex scientific evidence present in court, including admissibility, reliability and the specific challenge of matching a verbal standard of proof with numerically expressed scientific probabilities. Finally, I described a proposed framework to bring the different strands together.

Based on this, we can formulate an answer to the second sub-question, what degree of certainty is required to establish legal causation under uncertainty in climate change cases? We find that there are no formal differences between the requirements set in civil law in general and climate litigation. However, the scenarios in climate litigation cases often strain the generally applied causation test. Climate litigation isn't the only domain in which the test leads to unacceptable results; historically, we saw, judges have applied policy correctives to the general framework in such situations in order to align outcomes with what can be considered just, fair or required by the aims of the laws they're applying. [327]

Even though there is no generally applicable translation of probabilities into words, when applying the IPCC confidence and likelihood scales, we find that climate science, along most of the causal chain, offers a degree of certainty that (more than) satisfies the standard of proof courts require. The challenge is greatest when trying to prove causal links between individual weather events and (small) shares of emissions by individual emitters, because the fungibility of GHGs can combine with the residual error margins confounding variables cause in attribution studies to create more uncertainty than a judge can accept. The framework presented in section 4.5, by combining a generalisable *distinctive causal field* along most of the causal chain with proof of the *sustenance* of a small climate forcing through modelling, may help overcome this hurdle.

Notwithstanding this, it may remain unavoidable to accept certain causal inferences.[328] The legal reasoning developed in asbestos and tobacco litigation, shows that hurdles can also engender opportunities, and may inspire novel reasoning in climate litigation. A lot of work has been done and is being done, both at the nexus of legal and climate scholarship and by legal practitioners. This can be expected to improve the odds of success for plaintiffs in

[325] Kysar (n 144) 62; see also, more generally, Wright (n 24).
[326] Minnerop and Otto (n 106) 85-86; Kysar (n 144) 62.
[327] Kruithof (n 181) 320; Moore (n 72) section 5.2; Van den Wyngaert and Vandromme (n 192) 317; Wood and Galpern (n 203) 312; Wright (n 24) 1737-1738, 1827.
[328] Burger, Wentz and Horton (n 95) 10653.

climate-aligned cases.[329] We will study concrete examples of this evolution in the next chapter.

5. (Un)tying the knot between science and law: case studies

In the previous two chapters, we've taken an in-depth look at the scientific and legal sides of proving causation in climate litigation. In what follows, we'll take a look at how this works in practice. After describing what guided the selection of the cases and the approach taken in studying them, I will study the two sets of cases in turn. Specifically, we'll look at what types of and ways to present scientific evidence in court help in proving legal causality in climate change cases, and what types of evidence and ways of presenting them, don't, before offering a brief conclusion.

5.1. Cases selected and study approach

I did not endeavour to make a taxonomy or typology of climate litigation. It wouldn't help answer my research questions, and has been done already. In order to understand where the cases I selected can be situated in the wider field, it is useful to briefly explain two typologies. In the first, cases are classified by strategy. The main distinction made is between *climate-aligned* strategies, and non-climate-aligned strategies. "Climate-aligned is used to describe cases seeking to advance climate measures. 'Non-climate-aligned' is used to describe both anti-regulatory cases aimed at delaying climate action" as Setzer and Higham explain.[330] Within each of these main streams, a total of twelve strategies are defined.[331]

A second relevant distinction is that between a first and second wave of private climate litigation, as described by Ganguly, Setzer and Heyvaert. The first wave spanned 2005-2015, with cases, mainly in the US, with energy companies as defendants being sued for compensation. The first case I study, Native Village of Kivalina, is an example of this wave, which also includes *Comer v Murphy Oil*[332] and other cases in which public authorities were the plaintiffs. They were unsuccessful: the plaintiffs failed, among other things, to offer convincing proof of the causal link between the defendant fossil fuel companies' emissions and the harm they suffered. They sometimes simply presumed a causal link to exist, without

[329] Paiement (n 133) 283.
[330] This classification is taken from Setzer and Higham (n 12) 6 and 18-23. Other relevant parameters are the types of plaintiffs and defendants, type of claims, legal arguments deployed, etc. See, among other interesting sources, A Kodivera and others, 'The significance of climate litigation for the political debate on Loss & Damage' (Germanwatch eV and Climate Litigation Accelerator 2023) <https://www.germanwatch.org/sites/default/files/PolicyBrief_L%26D.pdf> accessed 2 April 2023
[331] Related to this, I want to briefly explain that, while I try to keep a neutral point of view in this thesis, my personal convictions inform my research. Concisely put, I think climate change is a major threat to the world, and human well-being, on an unprecedented scale. I am convinced that it is necessary to reduce emissions as soon as possible, and to take adaptation measures; taking into account the common but differentiated responsibilities and capabilities across the globe.
[332] *Comer v Murphy Oil USA Inc*, 607 F.3d 1049 (5th Cir 2010).

demonstrating it with scientific evidence.[333] The second wave, of which the third case I study is an early, and the second and fourth cases are late examples, comprises cases which may have better chances of overcoming the causation hurdle due to the evolving scientific context and legal discourse we have discussed in the previous chapters.[334]

In all the cases I selected, compensation is sought for damage or harm caused by climate change. Plaintiffs are individuals or sub-national governmental entities, defendants are large emitters. I selected similar cases for two main reasons. First, selecting cases following similar strategies allows for comparison. Second, the standard of proof for causality is often most stringent in compensation cases.[335] Since *qui peut le plus peut le moin*s,[336] succeeding in these cases opens paths for success in less stringent contexts.[337]

The main difference between the cases is that the two sets are from different legal traditions, common and civil law. Legal concepts involved in proving causation overlap, but there are differences. Different solutions have been sought to challenges of proving causation in both traditions. It can be hoped that by comparing different methods, jurisdictions can inspire each other, and useful legal ideas, principles, decisions etc. can circulate in the domain of climate law, as they have fruitfully done for a long time in other domains.[338] A second difference is temporal: I selected two older cases, and compared them with the two (very) recent cases in each set.

I will analyse the cases with a view to answering subquestion 3, studying what types of and ways to present scientific evidence in court help, or don't help, in proving legal causality in climate change cases. I will look at what evidence is presented, whether it's in line with the state of the art and how it is judged. Further, I will examine how climate science and legal practice interact, and how these interactions could alleviate the difficulties plaintiffs encounter when trying to prove causality.

5.2. Case study 1 - Native village of Kivalina V. ExxonMobil et al. (US, 2008) and Municipalities of Puerto Rico v. ExxonMobil et al. (US, 2022)

In this section, I study two cases in which one or more local governments sue a group of fossil fuel companies for compensation for damages they alleged were caused by climate change. The first case is part of the 'first wave' of private climate litigation, the second is very recent, and represents the second wave. I will give a short summary of both cases, and discuss them in turn.

[333] Ganguly, Setzer and Heyvaert (n 19) 846.
[334] Ibid 849-50.
[335] See chapter 4.
[336] He who can do the most, can also do the least.
[337] Stuart-Smith, Otto and Wetzer (n 104) 25.
[338] I Alogna, 'The Circulation of Legal Models: Towards the Evolution of Environmental Law' in Sancin V and Kovič Dine M (eds) *International Environmental Law: Contemporary Concerns and Challenges in 2014* (GV Publishing 2014) 60-61.

5.2.1. Native Village of Kivalina v. ExxonMobil Corp.

5.2.1.1. Case summary

The case of Native Village of Kivalina v ExxonMobil Corp was first judged by the United States District Court, N.D. California on 30 September 2009.[339] The village appealed the ruling to the United States Court of Appeals for the 9th Circuit, which upheld the first judges' ruling on 21 September 2012.[340] The plaintiffs filed a petition for *certiorari*, a review of the ruling on appeals to the United States Supreme Court, but this was denied.[341]

Kivalina is a village of the Iñupiat eskimos where about 400 people live. The village is about 1,000 km northwest of Anchorage, the capital of the US state of Alaska. It is built on a barrier reef between the Kivalina River and the Chukchi Sea (see image).[342] The village is severely affected by climate change: the sea ice that protected the land has calved and the storms that the ice provided protection against, especially in autumn, winter and spring, now affect the village directly. As a result, the coastline is eroding and people in the village are suffering damage.[343] There is even talk of a possible relocation of the village.[344]

Kivalina. Picture by ShoreZone, <https://www.flickr.com/photos/shorezone/11471418433> © CC BY 2.0

[339] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009).
[340] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009), *aff'd*, 696 F.3d 849 (9th Cir 2012).
[341] *Native Village of Kivalina v ExxonMobil Corp,* 696 F.3d 849, 853 (9th Cir 2012), *cert. denied*, 569 US (No. 12 1072)
[342] <https://en.wikipedia.org/wiki/Kivalina,_Alaska> accessed 14 August 2023.
[343] Johnson (n 51) 558; Lawson (n 26) 446.
[344] Kivalina Strategic Management Plan Kivalina, Alaska September 2016. <https://kivalinaarchive.org/system/files/atoms/file/2016_09_KivalinaStrategicManagementPlan_AlaskaDCCED.pdf> accessed 15 August 2022.

5.2.1.2. Proving causation

To obtain monetary compensation, the village filed a public nuisance claim,[345] jointly and individually, against 22 companies, including utilities, power producers and oil companies. The claim was based on the allegation that the defendants, through the greenhouse gases they emit, are contributing to the climate change that is at the root of the damages suffered, thus causing “a substantial and unreasonable interference with public rights, including the rights to use and enjoy public and private property in Kivalina.”[346]

The claim was declared inadmissible, both at first instance and on appeal.[347] However, in assessing admissibility, the ruling also discussed causation.[348] To establish standing, it is required that the plaintiffs demonstrates a causal link, specifically a "fairly traceable connection" between a defendant's conduct and the alleged public nuisance.[349] They couldn’t convince the Court, which states:

> "(...) the harm from global warming involves a series of events disconnected from the discharge itself. In a global warming scenario, emitted greenhouse gases combine with other gases in the atmosphere which in turn results in the planet retaining heat, which in turn causes the ice caps to melt and the oceans to rise, which in turn causes the Arctic sea ice to melt, which in turn allegedly renders Kivalina vulnerable to erosion and deterioration resulting from winter storms."[350]

This case is a far cry from a simple torts constellation, where one party can be proven to be the direct and sole cause of harm to another party.[351] The identification requirement and cumulative causation form the main hurdles in this case.[352] The causal chain doesn’t necessarily fail because it consists of many links, as long as the links aren’t hypothetical or tenuous, and remain plausible.[353] The plaintiffs couldn’t convince the judges at any stage though. The first instance judges said:

> “Plaintiffs' global warming claim is based on the emission of greenhouse gases from innumerable sources located throughout the world and affecting the entire planet and its atmosphere. [...] there is no realistic possibility of tracing any particular alleged effect of global warming to any particular emissions by any specific person, entity, group at any particular point in time.”[354]

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[345] “Under federal common law, ‘public nuisance is an unreasonable interference with a right common to the general public.’” Johnson (n 51) 558.
[346] Ibid 557.
[347] Ibid 558.
[348] Lawson (n 26) 448.
[349] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009) number 877.
[350] Ibid number 867.
[351] Lawson (n 26) 448.
[352] See section 4.2.
[353] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009), *aff’d*, 696 F.3d 849 (9th Cir 2012) 11673.
[354] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009) number 880.

The appeals court followed this argument. [355]The defendants, unsurprisingly, echoed this reasoning in a brief opposing *certiorari*, which was indeed denied.[356]

5.2.1.3. Discussion

The challenges of proving causation along the entire chain is put into focus here. It is true that the evidence plaintiffs provided is rather weak, to present standards. For one, the carbon majors sturdy wasn't yet available, so the plaintiffs had to collate data from disparate sources, including self-reporting, to quantify the defendant's emissions.[357] To attribute climate change to emissions, they relied on IPCC reports (explaining the confidence level of some statements)[358] and some other scientific reports.[359] The evidence gets weaker when it comes to impacts:[360] they mainly describe global phenomena, supporting them with IPCC evidence and the Arctic Climate Impact Assessment, a study which even then was 10 years old.[361] To prove the impacts, they rely on evidence from governmental organisations in the US. Only general claims could be made however.[362]

The case is part so-called first wave of private climate litigation in the US, also including the *Comer v Murphy Oil*[363] and other cases in which public authorities were the plaintiffs. They all failed, among other things, to offer convincing proof of the causal link between the defendant fossil fuel companies' emissions and the harm they suffered. They sometimes simply presumed a causal link to exist, rather than offering scientific evidence to demonstrate it.[364] "Plaintiffs [do not] offer any guidance [...] that would enable the Court to reach a resolution of this case in any 'reasoned' manner," according to the first instance judges.[365] Less solid evidence was available to first wave plaintiffs. Legal reasoning, as well, was less developed. As we have shown in chapter 3, the current state of the art in climate science could make success for plaintiffs more plausible.[366] The next case in this set will illustrate vividly how much has changed since Kivalina.

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[355] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009), *aff'd*, 696 F.3d 849 (9th Cir 2012) 11675.
[356] *Native Village of Kivalina v ExxonMobil Corp,* 696 F.3d 849, 853 (9th Cir 2012), *cert. denied*, 569 US (No. 12 1072) Brief in Opposition
[357] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009) Complaint, section III. B.
[358] Ibid para 161.
[359] Ibid section IV. A
[360] Ibid section IV. B.
[361] See <https://en.wikipedia.org/wiki/Arctic_Climate_Impact_Assessment> accessed 11 May 2023.
[362] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009) Complaint, section IV. C.
[363] *Comer v Murphy Oil USA Inc*, 607 F.3d 1049 (5th Cir 2010).
[364] Ganguly, Setzer and Heyvaert (n 20) 846.
[365] *Native Village of Kivalina v ExxonMobil Corp*, 663 F. Supp. 2d 863, 883 (N.D. Cal 2009) number 867.
[366] Stuart-Smith, Otto and Wetzer (n 104) 10-11. Plaintiffs nonetheless often fail to cite state-of-the-art scientific evidence to support their claim, per Stuart-Smith and others (n 19) 12.

5.2.2. Municipalities of Puerto Rico v. ExxonMobil et al.

5.2.2.1. Case summary

At the end of 2022, 16 municipalities from Puerto Rico sued a group of major coal and oil companies in the US federal district court for Puerto Rico, seeking to hold them liable for damages from storms during the 2017 hurricane season, and ongoing economic losses since then. Puerto Rico, an island in the Caribbean sea, is an unincorporated territory of the United States with a population of about 3,25 million.[367]

The municipalities sue on their own behalf, as well as on behalf of a proposed class of all of Puerto Rico's municipalities. They claim to have suffered "catastrophic damage" from the 2017 hurricanes Irma and Maria, including damage to infrastructure and property, as well as increased costs for emergency response and adaptation measures. Plaintiffs claim the damage was intensified by climate change, which was in turn caused by the defendants products and activities. In the selection of the courses of action, direct claims of tort liability are explicitly excluded, taking into account the results of the *Kivalina*-case.[368]

5.2.2.2. Proving causation

The claim includes 14 causes of action under federal and Puerto Rico law, including common law consumer fraud, conspiracy to commit fraud, deceptive business practices, false advertising, RICO,[369] antitrust, nuisance, strict liability, negligent design defect, and unjust enrichment/restitution. The municipalities are asking the defendants to pay for the costs that the plaintiffs have incurred and will continue to incur as a result of climate change. They are also seeking punitive damages, disgorgement of profits, pre-judgment interest, attorneys' and expert witness fees, as well as other costs and equitable relief to ensure an effective remedy.[370]

The defendants are claimed to be responsible for 40.01% of global industrial GHG emissions from 1965 to 2017, and thus, jointly and severally, a substantial cause for the hurricanes and thus the losses of the plaintiffs. The emissions numbers are based on the Carbon Majors report,[371] as well as numerous other sources,[372] including reports by the defendant companies themselves.[373]

The plaintiffs make a careful and well-supported case, following along the causal chain carefully.[374] Starting out with increased atmospheric GHG concentrations, leading to a

[367] <https://en.wikipedia.org/wiki/Puerto_Rico> accessed 30 April 2023.
[368] *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Complaint; Interview with Melissa Sims (n 50).
[369] Racketeer Influenced and Corrupt Organizations (RICO) Act, 84 Stat. 922-3, a US federal statute enacted in the fight against organised crime or other corrupt conduct.
[370] *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Complaint.
[371] Citing Heede (n 134).
[372] Such as Chen, Toledano and Brauch (n 119).
[373] *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Complaint para 52 and ch IC. section B.
[374] *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Complaint ch VI. Allegations of Fact.

changing climate, with rising average temperatures, sea level, going on to impacts in the US as reported by government agencies. The case is thoroughly reported with solid scientific evidence. Interestingly, they cite a study proving the accuracy and consistency of climate models with observations to support their case.[375]

They go on to make the case for increasing intensity of hurricanes due to climate change, again supporting the case with a lot of scientific reports. They make use of a report by a climate scientist at MIT they consulted, Dr. Emanuel, who they also plan on calling upon as an expert witness, when the time comes. He reports how the above-average warming of the waters around Puerto Rico leads to stronger hurricanes with more rainfall, making the case that hurricanes and rainfall of the magnitude experienced during the 2017 hurricane season were made more likely by a factor 8-10.[376]

They also estimate and attribute damage, including heightened migration from the areas and harm to the agricultural sector, as well as health impacts and excess deaths,[377] social, educational and economic losses and property damage.[378] Furthermore, the vulnerabilities of Puerto Rico (and how climate change makes them worse), are discussed extensively.[379] Finally, evidence is adduced showing that the effects persist.[380] Based on this factual evidence, plaintiffs claim factual and proximate causation linking the defendants' acts and the losses suffered, as required for the different causes of action.[381]

Crucial to their case (albeit less central to the theme of my thesis), using damning internal communications, plaintiffs show that the defendants (and/or their trade organisations), have known about climate change and predicted its effects to a great degree of accuracy, starting more than 50 years ago. This is followed up with extensive evidence of the defendant's failure to disclose their knowledge of these harms, documenting the sector's efforts, including lobbying, PR and advocacy campaigns, to cast doubt on the consensus in climate science. This amounts to a campaign of disinformation, aiming to delay or impede public policy aimed at GHG emissions reductions, all while internally admitting to the soundness of climate science.[382] The plaintiffs then go on to show that the defendants' actions increased the damage they suffered:

> "A critical corollary of the non-linear relationship between atmospheric CO_2 concentrations and SCC [Social Cost of Carbon] is that delayed efforts to curb those emissions have increased environmental harms and increase the magnitude and cost to remediate harms that have already occurred or are locked in by previous emissions. Therefore, Defendants' campaign to obscure the science of climate

[375] Hausfather Z and others, 'Evaluating the Performance of Past Climate Model Projections' (2020) 47 Geophysical Research Letters e2019GL085378.
[376] *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Complaint para 242, citing notably D Keellings D and JJ Hernández Ayala, 'Extreme Rainfall Associated With Hurricane Maria Over Puerto Rico and Its Connections to Climate Variability and Change' (2019) 46 Geophysical Research Letters 2964; *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Exhibits 1-15, 213.
[377] Citing Kishore (n 149).
[378] *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Complaint For Damages ch VI section E.
[379] Ibid ch VI section E.
[380] Ibid ch VI section H.
[381] Ibid ch IIX.
[382] Ibid ch VI sections K-U..

change and to expand the extraction and use of fossil fuels greatly increased and continues to increase the losses and rate of losses suffered by [Plaintiffs] [...]"[383]

Moreover, they show that the defendants were well aware of the costs of inaction on climate change mitigation.[384] Similar arguments based on climate denial have been made in other cases. The report of the Commission on Human Rights of the Philippines (CHRP)'s National Inquiry on Climate Change, supports these claims.[385] This is related to the central focus on RICO claims, which are explicitly modelled on earlier tobacco-cases–a first in climate litigation. If plaintiffs succeed in proving a conspiracy, and in holding it liable, all participants, even those not currently among the defendants, could be held liable as an entity. This could be groundbreaking.[386]

5.2.2.3. Discussion

At the time of submitting this thesis, the outcome of the case is still open. For further information see https://dockets.justia.com/docket/puerto-rico/prdce/3:2022cv01550/174053 or http://climatecasechart.com/case/municipalities-of-puerto-rico-v-exxon-mobil-corp/.

The plaintiffs are convinced that the science on climate change, and causation in their case, is clear and hard to refute. The standard of proof to meet is *on the balance of probabilities*, and they're quite confident they can convince a jury that what they claim is more likely than not.[387] They didn't find building scientific evidence for the causal chain very difficult, having consulted (and used an ad-hoc study written by) climate scientist Kerry Emanuel at MIT.[388] They indeed adduce a lot of strong evidence, and are convinced it meets the Daubert standard.[389] Recent advances in attribution science made them more confident in their case.[390]

A lot of scientific reports on the 2017-18 hurricane season and its impacts are indeed available, not all of them (as yet) cited in this case.[391] In one, Clarke and others note that Cuba, which was also impacted by very strong hurricanes in the 2017 season, recovered quicker and suffered less long term damage, due to a range of factors including better

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[383] Ibid para 613.
[384] Ibid para 594-629.
[385] K Silverman-Roati, 'Municipalities of Puerto Rico v. Exxon: a unique class action against fossil fuel companies presses for climate accountability in the United States' (Climate Law blog, Columbia Law School Sabin Center for Climate Change Law 2 December 2022) <https://blogs.law.columbia.edu/climatechange/2022/12/02/municipalities-of-puerto-rico-v-exxon-a-unique-class-action-against-fossil-fuel-companies-presses-for-climate-accountability-in-the-united-states/> accessed 18 April 2022.
[386] Ibid; Interview with Melissa Sims (n 50).
[387] Ibid; Plaintiffs are currently more preoccupied with the expected procedural wrangling, in which many US climate cases are stuck. A recent decision by the Supreme Court might create a breakthrough though. See The Guardian 'US supreme court denies oil companies' bid to move venue of climate lawsuits' (London, 24 April 2023) <https://www.theguardian.com/law/2023/apr/24/supreme-court-oil-climate-lawsuits-state-federal> accessed 24 April 2023
[388] *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Exhibits 1-15, 212.
[389] See section 4.4.1.
[390] Interview with Melissa Sims (n 50).
[391] See Clarke (n 128) 14.

risk-management and disaster planning. This illustrates the importance of taking such factors into account when engaging in end-to-end attribution.[392]

Due to the fact that they sue a large number of defendants, they needn't worry as much about partial causation as the plaintiffs in the next case study: they trust a jury will find that 40% is a substantial contributing factor. Proving the historical emissions wasn't as challenging, and the plaintiffs place much faith in the carbon majors studies.[393] A greater challenge is trying to prove the existence of a "criminal enterprise" under RICO. If they succeed however, that criminal enterprise itself will become liable, automatically including the defendants who participated and any other, currently unnamed participants in it.[394]

Even though the case isn't framed by the plaintiffs as strategic litigation in the usual sense, they are well aware that their novel claims and arguments may break new ground for climate litigation, and that eyes are upon them. It would indeed open possibilities if the racketeering law applied to opioid, tobacco and the emissions cheating cases, could also be applied to climate change denial and obfuscation.[395] Having studied these two US cases, we now move to the next set of two European, civil law cases.

5.3. Case study 2 - Luciano Lliuya v. RWE (DE, 2015) and Asmania et al. v. Holcim (CH, 2022)

In the two cases I study in this section, one or more plaintiffs (from Peru and Malaysia, respectively) alleging climate change damage sue large emitters in their home countries Germany and Switzerland.[396] These cases are part of the second wave of private climate litigation, one early and one very recent. I will give a short summary of both cases, discussing them both, before discussing the findings of the case studies.

5.3.1. Luciano Lliuya v. RWE

5.3.1.1. Case summary

The plaintiff, Luciano Lliuya, owns a house in Huaraz in Peru's Cordillera Blanca region, which lies in the Andes, some 450 km north of Peru's capital Lima. His property is at risk of flooding due to increased water levels in the upper Palcacocha Lake (see illustration). That lake is fed by meltwater from glaciers, which are melting faster under the influence of the warming climate, causing the water in the lake to rise to dangerous levels. An ice avalanche at any time could trigger a so-called glacial lake outburst flood, threatening to flood Lliuya's property as well as large parts of Huaraz. That risk is not hypothetical: more than 30,000

[392] Ibid; see also the discussion on the framing attribution studies in sections 3.3 and 3.5.
[393] Interview with Melissa Sims (n 50).
[394] Ibid; *Municipalities of Puerto Rico v Exxon Mobil Corp*, 3:22-cv-01550 (D.P.R. 2022), Complaint For Damages, para 182-184.
[395] Interview with Melissa Sims (n 50); D Drugmand, 'Puerto Rican Cities Sue Fossil Fuel Companies in Major Class-Action, Climate Fraud Case' (DeSmog, 2 December 2022) <https://www.desmog.com/2022/12/02/puerto-rico-climate-liability-lawsuit-racketeering-fraud-shell-bp-chevron-exxon/> accessed 12 May 2023.
[396] The legal approach taken by Mr Lliuya defines as neighbours those who are able to act on one another. See also Walker-Crawford (n 212).

people have died in such disasters in the Cordillera Blanca region since 1941. To protect Huaraz from the risk, the current dam needs to be reinforced and the pumps upgraded.[397]

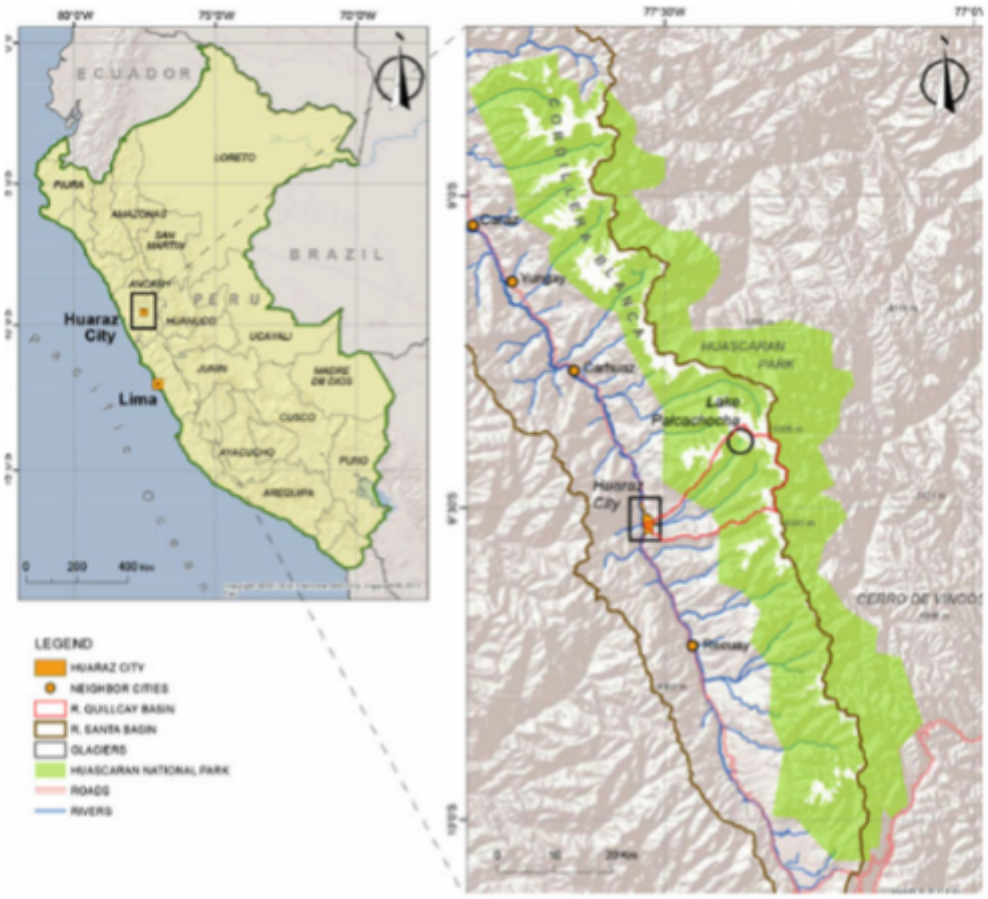

Figure from R Mechler and others (eds), *Loss and Damage from Climate Change - Concepts, Methods and Policy Options* (Springer Open 2019) 477.

5.3.1.2. Proving causation

The plaintiff seeks compensation for the damages he suffers, in particular the costs of the preventive (climate adaptation) measures necessary to secure his property. He claims this compensation from RWE AG, a major German energy company.[398] According to the plaintiff, RWE is responsible for 0.47% of global greenhouse gas emissions from 1751 to 2010, a claim based on the Carbon Majors report.[399] Through these emissions, the claim says, the company is responsible for climate change, for the increased water volume in Lake Palcacocha and thus for the flood risk affecting the plaintiff. In particular, it claims RWE should pay for about 0.5% of the damage (some €17,000), a contribution proportional to the

[397] Chatzinerantis and Appel (n 52) 280; D Ennockl, 'Climate Change Litigation in Austria and Germany: Climate Change Litigation in Germany and Austria - Recent Developments' (2020) 2020 CCLR 306, 309; Mechler (n 13) 476.
[398] Mechler (n 13) 476.
[399] *Lliuya v RWE,* Essen Regional Court (DE) Case No 2 O 285/15, Complaint (unofficial English translation) 18.

company's historical emissions.[400] The plaintiff bases his claim on article 1004 of the German Civil Code,[401] i.e. a disruption of property rights.[402]

The causation reasoning is grounded extensively in theory, with a discussion of cumulative causation to support a partial causation claim, arguing that the defendant's emissions in this context aren't required to be a *necessary* condition.[403] A number of scientific studies (and case law) supports the claim along the causal chain, discussing the confidence level expressed by the IPCC in linking emissions to climate change and on to the impacts in the Andes to the standard of 'almost absolute certainty' that's applicable in Germany, thus not requiring a probabilistic interpretation.[404] Further, they argue that precedent shows that uncertainty doesn't need to be completely eliminated in proving causation along the chain.[405] The plaintiffs also cite climate change-related legal scholarship to support their case.[406]

The first instance court argued nonetheless that no linear causal chain between the one emitter of greenhouse gases (RWE) and the one defendant's harm could be established. The court strictly applied the but-for test and Germany's adequacy doctrine, which requires a certain 'proximity' between damaging event and damage.[407] The plaintiffs arguments that attribution to the defendants was sufficiently shown[408] didn't convince the Essen Landgericht which, echoing the decisions in the *Kivalina*-case, said:

> "[...] the chain of causes [is] in the case of climate change much more complex, multipolar and therefore more diffuse and at the same time controversial in science. If countless large and small emitters release greenhouse gases that are indistinguishably mixed with each other [and] cause climate change via a highly complex natural process, it is no longer possible to identify even an approximately linear causation chain from a specific emission source to a specific damage."[409]

The plaintiff appealed[410] to the Oberlandesgericht Hamm, which took a different view. It accepted, *prima facie*, that even though RWE's emissions are not responsible for the entirety of the flood risk in Huaraz, partial responsibility for the actual risk suffices. Thus accepting the possibility of partial causation,[411] the court has accordingly ordered further evidence gathering on 17 November 2017, with experts to help determine whether RWE AG shares

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[400] Mechler (n 13) 476.
[401] German Civil Code (*Bürgerliche Gesetzbuch*) (DE) art 1004 <https://www.gesetze-im-internet.de/bgb/> accessed 14 August 2022.
[402] Ennockl (n 397) 310.
[403] *Lliuya v RWE,* Essen Regional Court (DE) Case No 2 O 285/15 Complaint ch II, sections 4.2.1 and 4.2.5.
[404] Ibid ch II, section 4.2.2.
[405] Ibid ch II, section 4.2.6.
[406] Ibid 33.
[407] Chatzinerantis and Appel (n 52) 282; C Huggel and others, 'Anthropogenic Climate Change and Glacier Lake Outburst Flood Risk: Local and Global Drivers and Responsibilities for the Case of Lake Palcacocha, Peru' (2020) 20 Natural Hazards and Earth System Sciences 2175; *Lliuya v RWE,* Essen Regional Court (DE) Case No 2 O 285/15 8.
[408] *Lliuya v RWE,* Essen Regional Court (DE) Case No 2 O 285/15 8, Complaint ch II section 4.3.
[409] Ibid.
[410] *Lliuya v RWE*, Oberlandesgericht Hamm (DE) Az. 5 U 15/17 OLG Hamm*,* Grounds of appeal (unofficial English translation).
[411] And standing by it after an appeal by the defendant, see *Lliuya v RWE*, Oberlandesgericht Hamm (DE) Az. 5 U 15/17 OLG Hamm, Order 7 February 2018 (unofficial English translation) para 8.

responsibility for the damages suffered by the plaintiff.[412] The proceedings are ongoing. The case can be followed via http://climatecasechart.com/non-us-case/lliuya-v-rwe-ag/, https://rwe.climatecase.org/ or https://www.olg-hamm.nrw.de/behoerde/presse/pressemitteilung_archiv/02_aktuelle_mitteilungen/index.php.

The defendants tried to argue that their small share of global emissions fall within the margin of error of any scientific proof that can be provided.[413] The appeals judges, in my opinion correctly, didn't follow this reasoning, but rather saw climate change as a global process, which by itself doesn't entail very large scientific uncertainty, and in which the defendants have a share.[414] The plaintiffs refined their causation argument and adduced further evidence throughout the proceedings, commissioning additional reports[415] in response to judgements or arguments made by the defendants.[416] Interestingly, the plaintiffs explicitly refer to non-German cases adapting the but-for standard in the interests of fairness,[417] as well as foreign climate litigation.[418]

Notwithstanding a number of classic counterarguments from the defendants, the plaintiffs managed to convince the appeals court to gather further evidence. This, at least, shows a willingness to follow reasoning that, on the strength of the prima facie evidence, accepts in principle the possibility of proving a causal link. Likewise, the Hamm court's judges show themselves ready to dive deeper into the scientific evidence, and to grapple with the complexities climate litigation presents, asking for specific evidence[419] and even organising a fact-finding mission in Huaraz.[420] The judges, and the parties, will thus be able to make full use of new developments in climate science, including the attribution studies.

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[412] Ennockl (n 397) 310; Ganguly, Setzer and Heyvaert (n 20) 855.
[413] *Lliuya v RWE,* Essen Regional Court (DE) Case No 2 O 285/15, Summary of the submission of the defendant's legal counsel (unofficial English summary) and *Lliuya v RWE*, Oberlandesgericht Hamm (DE) Az. 5 U 15/17 OLG Hamm*,* respondent's written submission (unofficial English summary).
[414] *Lliuya v RWE*, Oberlandesgericht Hamm (DE) Az. 5 U 15/17 OLG Hamm, Order 7 February 2018 (unofficial English translation) 4. See also A Kling, 'Die Klimaklage gegen RWE – Die Geltendmachung von Klimafolgeschäden auf dem Privatrechtsweg' (2018) 51 Kritische Justiz 213, 221-223.
[415] *Lliuya v RWE,* Essen Regional Court (DE) Case No 2 O 285/15, plaintiff's written submission after oral proceedings (unofficial English translation) 1.
[416] *Lliuya v RWE*, Oberlandesgericht Hamm (DE) Az. 5 U 15/17 OLG Hamm*,* Grounds of appeal (unofficial English translation) 13; *Lliuya v RWE*, Oberlandesgericht Hamm (DE) Az. 5 U 15/17 OLG Hamm, Plaintiff's letter 29 September 2018 2.
[417] Ibid 25.
[418] As did the defendants, by referring to the *Kivalina*-case. See *Lliuya v RWE,* Essen Regional Court (DE) Case No 2 O 285/15, plaintiff's written submission after oral proceedings (unofficial English translation) 16.
[419] *Lliuya v RWE*, Oberlandesgericht Hamm (DE) Az. 5 U 15/17 OLG Hamm, Order 27 February 2021 (unofficial English translation).
[420] The Economist, 'A Peruvian farmer takes on Germany's largest electricity firm' (London, 2 June 2022) <https://www.economist.com/the-americas/2022/06/02/a-peruvian-farmer-takes-on-germanys-largest-electricity-firm> accessed 15 August 2022. See also <https://www.olg-hamm.nrw.de/behoerde/presse/pressemitteilung_archiv/archiv/2022_Pressearchiv/19_22_PE_Beweisaufnahme-in-Peru-im-Rechtsstreit-Lliuya-___-RWE/index.php>.

5.3.1.3. Discussion

The damages claimed are unlikely to make it worthwhile for Lliuya to engage in an extremely complex litigation in Germany. The importance of the case does not lie in the damages alone, but rather in the potential consequences should a different decision follow on appeal.[421] That could set a precedent that opens the door for a tidal wave of climate liability cases against companies and states, which, I think, may also explain the reluctance of the first instance court to find for the plaintiffs. Policy considerations interfere inevitably, and the legal and scientific complexity of cases allows reasonable judgements either way.

This case is a striking example of strategic litigation. The plaintiffs and the NGOs supporting them[422] run an extensive PR, advocacy and fundraising campaign alongside the case, explicitly advancing climate justice as one of its aims.[423] As such, it is a good example of how this type of climate litigation reinforces broader campaigning, and vice-versa.[424] Well publicised strategic cases apparently can raise scientific interest, or in any case can become stronger when new science appears–see for instance the new studies on lake Palcacocha. Dr Noah-Walker Crawford is involved in the case, is doing PhD research into the Lliuya-case, and is a co-author of the latter cited study. It is safe to assume that networks between legal and scientific practitioners are also strengthened in this way, improving the communication between both communities and helping them mutually reinforce.[425] The next case we discuss, offers further support for the trends observed in *Lliuya v RWE*.

5.3.2. Asmania et al. v. Holcim

5.3.2.1. Case summary

In July 2022, four inhabitants[426] of the small Indonesian island of Pari, close to the capital Jakarta, filed a request for conciliation with the Swiss-based multinational building materials and cement group Holcim, before the Justice of the Peace of the Canton of Zug in Switzerland.[427] They allege to suffer damage due to climate change, which is caused in part

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[421] See also P Rebelo and X Rebelo, 'Avenues for private climate change litigation: the advancement of a South African constitutional rights approach' (London City Law School Research Paper 2020/13) <https://openaccess.city.ac.uk/id/eprint/25139/> accessed 15 August 2022 14-15.
[422] GermanWatch, Foundation for Future sustainability, Wayintsik and Salvemos los Andes, see <https://climatecase.org/en/about-us> accessed 30 April 2023.
[423] See <https://climatecase.org/en> accessed 30 April 2023.
[424] See also chapter 7.
[425] Such as Huggel (n 407) and A Motschmann and others, 'Losses and damages connected to glacier retreat in the Cordillera Blanca, Peru' (2020) 162 Climatic Change 837; RF Stuart-Smith and others, 'Increased outburst flood hazard from Lake Palcacocha due to human-induced glacier retreat' (2021) 14 Nature Geoscience 85.
[426] Ms. Asmania (39 years old), Edi Mulyono (37 years old), Arif Pujianto (51 years old) and Mustaghfirin (known as 'Bobby'; 50 years old), see https://callforclimatejustice.org/en/plaintiffs/arif/ and HEKS-EPER, 'An island demands justice. Dossier for the press conference on 12 July 2022' (2022) <https://callforclimatejustice.org/wp-content/uploads/EN_Media-dossier_CallForClimateJustice.pdf> accessed 28 January 2023.
[427] Choosing or finding a forum for cases such as this one create impactful questions of international private law, which are outside the scope of this thesis. For a discussion of forum shopping in the context of PFAS-litigation, see E Sevrin and S Van Eekert, 'Shoppen voor een aantrekkelijk recht voor

by Holcim as a large emitter of GHGs. This request is a step required by the Swiss Civil Procedure Code before lodging a (civil) complaint against a party.[428] The conciliation not having led to any results, they subsequently filed a complaint at the Cantonal Court of Zug, where the headquarters of the defendant, cement company Holcim, are located.[429] Three NGOs support the plaintiffs in the proceedings: HEKS/EPER[430] (Switzerland), the European Center for Constitutional and European Rights[431] (ECCHR, Germany) and WALHI[432] (Indonesia).

The plaintiffs demand that Holcim compensates them for the damage they suffer on Pari island (proportionally to Holcim's part in historical GHG emissions); a reduction, by 2030, of Holcim's absolute[433] GHG emissions by 43%, or according to what climate science recommends to limit global warming to 1,5 °C, as compared to 2019, as well as a (proportional) contribution to finance adaptation measures on Pari. The plaintiffs are seeking about 4.000 USD each, or 16.000 USD in total.

5.3.2.2. Proving causation

The claim is primarily based on article 28 of the Swiss Civil Code,[434] which grants a right to petition the court for protection to anyone whose personality rights (physical, moral, and social) are unlawfully infringed, as well as on article 41 of the Swiss Code of obligations,[435] which obliges any person who causes damage to another unlawfully, or wilfully and in an immoral manner, to provide compensation.[436] This allows the plaintiffs to combine two approaches for possible remedies in a novel way: an injunction for emissions reductions and compensation for damage, both actually incurred and in the form of compensation for the costs of required adaptation measures, such as mangrove plantations.

According to the complaint submitted, the required standard of proof differs for the claims based on infringement of personality rights and the tort-based ones. A plaintiff claiming injury of her personality rights, proving causation is not strictly speaking required under the formulation of article 28 of the Swiss Civil Code; although a causality test is sometimes applied to limit the range of possible defendants. Enough evidence needs to be adduced to

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PFOS-slachtoffers en angstschade? - Een illustratie van de potentiële meerwaarde van het internationaal privaatrecht' (2022) 5 Tijdschrift voor Milieurecht 532.

[428] Swiss Civil Procedure Code (*Schweizerische Zivilprozessordnung*) (CH) art 202 <https://www.fedlex.admin.ch/eli/cc/2010/262/en#part_2/tit_1/chap_2> accessed 25 April 2023.

[429] See <https://callforclimatejustice.org/en/four-indonesians-file-climate-litigation-holcim-must-take-responsibility/> accessed 25 April 2023.

[430] See <https://en.heks.ch/about-us>.

[431] See <https://www.ecchr.eu/en/about-us/>.

[432] See <https://en.walhi.or.id/>.

[433] I.e. scope 1, 2 and 3 emissions, see section 3.4.

[434] Swiss Civil Code *(Schweizerisches Zivilgesetzbuch*) art 28 <https://www.fedlex.admin.ch/eli/cc/24/233_245_233/de> accessed 25 April 2023.

[435] Federal Act on the Amendment of the Swiss Civil Code (part five: The Code of Obligations) (*Bundesgesetzbetreffend die Ergänzung des Schweizerischen Zivilgesetzbuches (Fünfter Teil: Obligationenrecht)*) art 41 <https://www.fedlex.admin.ch/eli/cc/27/317_321_377/de> accessed 25 April 2023.

[436] <https://callforclimatejustice.org/en/four-indonesians-file-climate-litigation-against-holcim/> consulted 25 April 2023.

make plausible that climate change, when viewed objectively and according to the usual course of events, can cause the personal injuries the defendants suffered.[437]

More elaborate reasoning is presented in relation to the tort-based claim, where, according to Swiss law, it needs to be proven that a *natural and adequate causal relationship* (Natürlicher und adäquater Kausalzusammenhang) exists between the tortious act and the damage suffered. What plaintiffs must prove is that, in the normal run of things and according to common sense,[438] the tortious conduct can cause or contribute to the damage. In this formulation, increasing the risk of damage occurring can suffice (cf. the theory of adequate cause and the concept of *causal contribution*, section 3.3.1). The standard of proof is that of *overwhelming probability*,[439] so that other possible explanations can not reasonably be taken into account.[440] This standard is stringent in relation to those applied in some other jurisdictions.

When the causal link is proven, it can be *interrupted* by force majeure, gross negligence on the part of the victim or third-party fault. Given that the defendant in this case, according to the evidence presented, is responsible for a mere 0,42% of GHG emissions in the 1750-2021 period, this last point can be troublesome.[441] However, plaintiffs argue that it is not because other tortfeasors equally contribute to damage occurring, that the causal chain can be considered 'broken'. It just means that there is a concurrence (Konkurrenz) of adequate causes (so-called 'alternative causation', see part 3.3.1.). Here, the plaintiffs claim damages from the defendant in proportion to the share of GHG emissions the company caused. Indeed, this argument is supported by the refutation of the *drop in the ocean*-defence in several other cases (see previous section and section 3.4.).

A lot of scientific evidence was assembled to support the claims. Scientific reports commissioned by the plaintiffs[442] are combined with analyses prepared in house.[443] Generally available reports[444] were also used to a large extent, reducing the risk of aspersions being cast that the body of evidence is litigation driven.[445] This was supported by

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[437] *Asmania et al v Holcim* Kantonsgericht Zug (CH) 2023, Complaint (*Klage*) submitted 30 January 2023, shared confidentially with the author.
[438] "Nach dem gewöhnlichen Lauf der Dinge und nach den Erfahrungen des Lebens."
[439] "Der überwiegenden Wahrscheinlichkeit."
[440] S Oneyser '4A_558/2020: natürlicher Kausalzusammenhang im Haftpflichtrecht' (Swissblawg, 21 June 2021) <https://swissblawg.ch/2021/06/4a_558-2020-natuerlicher-kausalzusammenhang-im-haftpflichtrecht.html> accessed 24 April 2023. The standard of proof here seems to me to lie close to the 'beyond a reasonable doubt'-standard often applied in criminal matters.
[441] R Heede, 'Carbon History of Holcim Ltd: Carbon dioxide emissions 1950-2021' (Climate Accountability Institute 2022) <https://callforclimatejustice.org/wp-content/uploads/Heede-Report.pdf> accessed 18 April 2023.
[442] Ibid; J Hinkel and others, 'Heutige und zukünftige Auswirkungen des Klimawandels und Meeresspiegelanstiegs auf der Insel Pari' (Global Climate Forum 2023 Working Paper 01/2023 <https://doi.org/10.5281/zenodo.7566046> accessed 18 April 2023.
[443] HEKS-EPER, 'Holcim's Climate Strategy Too little – too late' (2023) <https://callforclimatejustice.org/wp-content/uploads/Climate_Analysis_FINAL.pdf> accessed 29 March 2023, supported with publicly available scientific research.
[444] Including IPCC WG I (n 8), Ekwurzel and others (n 145); IPCC, 'Summary for Policymakers' in PR Shukla and others (eds), *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2022).
[445] See section 4.4.1.

numerous pieces of evidence substantiating and supporting what is claimed in the complaint, including World Bank reports on Indonesia's vulnerability to climate change, news reports, interviews, NGO reports from the Island substantiating the damage the plaintiffs suffered, etc.[446] The report of the Commission on Human Rights of the Philippines (CHRP)'s National Inquiry on Climate Change, which contains many findings which can lend support to arguments of causality in climate litigation, was also cited.[447]

5.3.2.3. Discussion

At the time of submitting this thesis, the outcome of the case is still open. The complaint was lodged at the Cantonal Court of Zug on 30 January 2023; no information is publicly available on if a further schedule has been set by the court. For further information on the case, see https://callforclimatejustice.org/en/ or http://climatecasechart.com/non-us-case/four-islanders-of-pari-v-holcim/.

In my opinion, this case is an interesting evolution of an interesting class of strategic climate litigation, in which plaintiffs who directly suffer damages from climate change sue large GHG emitters directly. By combining a claim for past damages and for compensation for the costs of adaptation, the plaintiffs had to prove that both are caused by climate change, further linking climate change to the emissions of Holcim, the defendant. While this broadens the amount of proof required, it also allows to sketch a complete factual story, which was proven with compelling scientific evidence.

The plaintiffs' legal team confirms that assembling scientific evidence was one of the most challenging parts of building their case. They took a top-down approach to building the evidence up, starting with the more general reports, such as those from the IPCC, followed by more specific evidence for the source attribution and impact attribution parts of the causal chain.[448] They were in touch with a number of climate scientists, but this process wasn't very easy. Raw data isn't easily accessible and the available science doesn't always match what's needed to build a case. They eventually got in touch with Jochen Hinkel at Global Climate Forum, an international research organisation which performs research with and for a range of actors including governments, NGOs and businesses.[449] They commissioned an impact report on Pari island,[450] which forms the core of the impact attribution evidence, basing its conclusions on the impact and future risks created by current and expected sea level rise, which systematically worsens any damage caused by floods, storms, large waves etc.[451]

Source attribution was initially based on the Climate Accountability Institute's Carbon Majors report, as well as a specific report on Holcim's GHG emissions commissioned by the

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[446] *Asmania et al v Holcim,* Kantonsgericht Zug (CH) 2023, Complaint (shared confidentially)
[447] Commission on Human Rights of the Philippines, 'National Inquiry on Climate Change Report' (Commission on Human Rights of the Philippines 2022) <https://chr.gov.ph/wp-content/uploads/2022/12/CHRP_National-Inquiry-on-Climate-Change-Report.pdf> accessed 11 May 2023.
[448] Interview with Cybèle Schneider, Juristische Fachperson Klimagerechtigkeit, HEKS-EPER (online from Bern, Switzerland and Genoa, Italy, 26 April 2023).
[449] See <https://globalclimateforum.org/about/gcf-history/> consulted 26 April 2023.
[450] Hinkel (n 442).
[451] Interview with Cybèle Schneider (n 50).

plaintiffs.[452] The Institute is often cited when giving emissions shares of large companies, and according to the plaintiffs, the credibility of its reports has never been substantively challenged in litigation.[453] Compared to fossil fuel companies, Holcim, as a cement company, has a very large share of scope 1 emissions. The production of cement itself is very polluting. The complaint also draw extensively on the defendant's own publications on its human rights policies and carbon reduction plans to make their case, among other things to show how the emissions reductions initiatives currently planned will be insufficient to limit global warming to 1,5°C and how this contradicts the stated aims of Holcim's ESG (environmental, social and governance)[454] policies.

While they're aware that proving but-for causation for *just* Holcim's emissions is very difficult, they feel–and I would agree–that they've made a strong argument. The plaintiffs' team feel they have access to state of the art science. The experts they consulted can be called to testify in court. While a degree of uncertainty inevitably remains, they hope that the proof of causation is at least strong enough to support personality rights infringement.[455] For damages, even though the case is strong, I think the outcome will hinge on whether the judges can apply reasoning that allows partial causation to be accepted (as, *prima facie*, happened in *Lliuya v RWE*). It can be hoped that the case will attract more research, as also happened in *Lliuya v RWE*, a case the plaintiffs' team drew inspiration from.[456]

The evidence is also used as part of a broad advocacy campaign, which aims at the general public and has garnered considerable exposure in the press, with (at the time of writing) more than 300 articles and reports by press outlets all over the world.[457] To enable this campaign, a multimedia website in four languages[458] was set up, and the scientific evidence and extensive reports produced are summarised and explained in layman's terms. The way in which the case is made and argued is explained, and illustrated with interviews with the plaintiffs, photo's and movies. The plaintiffs are all community leaders.[459]

This case, thus, is also an example of strategic climate litigation, explicitly advancing climate justice as one of its aims. As such, it is a good example of how this type of climate litigation reinforces broader campaigning, and vice-versa.[460] Since, as was made clear in chapter 4, judgements on causality don't operate in a vacuum, the outreach campaigns in cases such as this one can be seen as an integral part of the legal strategy, not just an external 'add-on'. The plaintiffs and the NGOs supporting them are well aware of this.[461]

5.4. Comparison and conclusion

The first set of American cases shows how far both climate science and legal reasoning have come since the first wave of private climate litigation. The plaintiffs in the most recent of

[452] Heede (n 441).
[453] Interview with Cybèle Schneider (n 50).
[454] See <https://www.cfainstitute.org/en/research/esg-investing> consulted 26 April 2023.
[455] Interview with Cybèle Schneider (n 50).
[456] Ibid.
[457] Ibid. See <https://callforclimatejustice.org/en/media/> consulted 26 April 2023. .
[458] See <https://callforclimatejustice.org/> consulted 26 April 2023. .
[459] Interview with Cybèle Schneider (n 50).
[460] See chapter 7.
[461] Interview with Cybèle Schneider (n 50).

the two cases, seem to be keenly aware of what went wrong in *Kivalina*-like cases, and adapted their claims, legal argumentation (with RICO as a basis being especially novel) and the evidence they present. They make better use of the advances in science, such as the new state of the art in extreme event attribution. This is made easier by consultations with scientists active in the field. By suing a large group of large emitters, they join a substantial share of total historical emissions, thus reducing the challenge posed by cumulative causation.

The second set of cases are both more recent. They make similar use of state of the art science to support their claims, and also use legal reasoning along broadly similar lines, referring to judgements in other jurisdictions to support their claims. Strong legal reasoning, along with comparable jurisprudence, can help offer support to judges to find for a plaintiff. Referring to foreign jurisdictions promotes legal transplants, which when successful can help build a more integrated corpus of climate-aligned precedent.[462]

A deep scientific understanding well-supported by evidence is a second success factor, as is shown by the improving quality of reasoning and evidence through time. This can be helped by interaction between climate scientists and legal practitioners, where progress is being made but hurdles remain. Coverage, especially as regards event attribution, is uneven, as we saw. Recourse to commissioned studies is hard to avoid, but it may not be easy to find the right scientists available for this. Offering proof consistent with the strictest application of the classical but-for context is what's most challenging for plaintiffs. Climate science made great strides, but some residuary uncertainty will remain unavoidable when trying to prove causation along the entire chain.

Impactful PR campaigns alongside the litigation, by generating exposure and public interest, may also attract scientific interest. By influencing how climate change causality is viewed in society at large, strategic litigation may also help influence the fairness considerations judges apply when deciding cases. This may be the missing piece of the puzzle, helping judges to apply new correctives to the standard causation framework. The decision on appeal in *Lliuya v RWE* offers a peek into what this may look like.

Put together, the cases give a better idea of what evidence is required (or not) to maximise chances of convincing a judge of causation. We saw that both thorough legal reasoning and the support of state-of-the art science are crucial. This requires (access to) a deep scientific understanding for plaintiffs. Especially proving but-for causal links between impacts and emitters remains challenging for plaintiffs. Contact with experts is very useful in that regard, and should be intensified. Given the unavoidable uncertainties, however, novel legal reasoning may be required as well. Promoting the interchange of legal reasoning and models, as well as influencing the way climate change is viewed in society at large to recalibrate judges' fairness considerations, may be helpful in this regard. In the preceding paragraphs, we've formulated answers to subquestion three. In the next chapter, we will formulate an answer to the main research questions.

[462] See Alogna (n 338) 60.

6. Findings: crossing the bridge between science and law

> "As science begins to change the social world, great transformations of factual inquiry lie ahead for all justice systems."[463]
>
> –Mirjan Damasˇka

The main research question I want to answer in this thesis is what are ways to translate scientific evidence of the causal link between anthropogenic climate change drivers, climate change and climate change impacts to prove legal causation in climate change litigation for plaintiffs seeking damages for climate impacts or mitigation/adaptation orders. This requires firstly, scientific proof of causation along the causal chain. Secondly, it requires insight in what evidence judges require to find the existence of a causal link, and if and how scientific and expert evidence can meet that requirement in complex causal settings. A last element brings the previous two together, in looking concretely at how the scientific evidence of causation that's available, fares in practice: do plaintiffs have access to it, can they use it well, and could they manage to convince courts?

I studied the scientific evidence of causation along the chain in chapter 3. When examining the scientific state of the art, I found that science is capable of showing causal links across the causal chain, along the various pathways between GHG emissions and impacts, in fine detail and with remarkable reliability. The most uncertainty remains at the outer ends of the causal chain, when linking (individual) emitters to localised impacts and events. A remaining challenge is further standardisation and operationalisation of event and impact attribution studies, which are sensitive to parameter choices and geographical distribution. The theories and frameworks which address these challenges have been developed however, and efforts are being undertaken to address them.

When digging into the issue of proving legal causation in climate litigation, we found that the scenarios in climate litigation cases often strain the generally applied causation test that consists of first establishing factual causes by applying the but for test, before selecting legal causes among them. As we have seen, climate litigation isn't the only domain in which the test leads to unacceptable results; historically, we saw, judges have applied policy correctives to the general framework in such situations in order to align outcomes with what can be considered just, fair or required by the aims of the laws they're applying.

Regarding the degree of certainty required to establish legal causation under uncertainty in climate change cases, I examined the burden and standard of proof, finding that there are no formal differences between the requirements set in civil law in general and climate litigation: the proof should be brought by the party making a claim, and it should be up to the standard applicable in the jurisdiction where a claim is brought, be that near-certainty or on the balance of probabilities.

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[463] Citation from Mirjan Damasˇka, taken from Foster (n 248) vii, which seemed *a propos* in light of the discussion that will follow.

Complex scientific evidence presents additional challenges, both to litigants and to judges. The first is assessing its admissibility and reliability; I found that most climate science meets broadly applied standards of this, with some caveats as regards event attribution. The second challenge is how to match the numerical likelihoods of climate science into the verbal phrases used by courts. I found that, even though there is no generally applicable translation of probabilities into words, climate science, along most of the causal chain, offers a degree of certainty that (more than) satisfies the standard of proof courts require when we translate the probabilities using the IPCC confidence and likelihood scales.

This may stop applying when it comes to proving causal links between individual weather events and (small) shares of emissions by individual emitters, however. The fungibility of GHGs, combined with the residual error margins (related to confounding variables and modelling choices) in attribution studies, may leave more uncertainty than a judge can accept. Otto and Minnerop's framework presented in section 4.5 may overcome this hurdle by combining a generalisable *distinctive causal field* along most of the causal chain with proof of the *sustenance* of a small climate forcing through modelling. Notwithstanding this, it may remain required to apply novel reasoning in climate litigation, adapting the causation requirement in the interest of fairness in certain cases, as was done in asbestos and tobacco litigation.

The cases I studied made tangible what evidence is needed (or not) to maximise chances of convincing a judge of causation. To support thorough legal reasoning with state-of-the art science, (access to) a deep scientific understanding is required. Contact with experts is very useful in that regard, and should be intensified. The case studies support the finding that proving but-for causal links between impacts and emitters remains the greatest challenge for plaintiffs. Likewise, they support that novel legal reasoning may be what is required to overcome this hurdle. This can be helped by the interchange of legal reasoning and models, as well as by influencing the way climate change is viewed in society at large to recalibrate judges' fairness considerations.

My research has shown that a lot of work has been done, and that the work that is still required is being done, both at the nexus of legal and climate scholarship and by legal practitioners. This can be expected to improve the odds of success for plaintiffs in climate-aligned cases. In the next chapter, I will discuss these findings.

7. Discussion: waiting for the dam to break

> "Human knowledge is personal and responsible, an unending adventure at the edge of uncertainty"
>
> – Jacob Bronowski[464]

[464] M du Sautoy, *What we cannot know. From consciousness to the cosmos, the cutting edge of science explained* (paperback edn, 4th Estate 2017) 420.

In a courtroom, a judge or juror is often sworn to give a true finding of fact according to the evidence. While the maxim of *actori incumbit probatio*, the claimant has the burden of proof, is often thought to imply that (especially in civil cases, in inquisitorial settings) *only* the adduced evidence can be considered, this shouldn't be taken literally, as it could exclude even general background knowledge about the world, which inevitably is taken into account.[465] A better account is offered by the *narrative model of trial deliberation*, which takes into account the fact that judgements are rarely made on the basis of isolated pieces of evidence, "but rather in large cognitive structures, most familiarly in the form of narratives, stories or global accounts".[466]

Apart from the judges' knowledge about the world, the societal, political and cultural context also plays a role. Judges don't interpret the criteria and thresholds for finding causality in "a value-free vacuum."[467] Likewise, the different normative goals that can be served by the causation requirement[468] play in the background.[469] Throughout my research, I read time and again that the primary objective of the courts (in democratic states) should be, or is, to attain just and equitable outcomes. In tort law, this is operationalised as the principle that the person who suffered the harm, should be compensated.[470] This changes however, when the harm is seen as a *misfortune*, rather than an *injustice*. Whether a loss constitutes one or the other is constantly debated in society.[471] Climate change, however, seems to involve a convergence of factors that challenge moral behaviour and standards.[472]

The ways in which causation is discussed in court and in society at large are interdependent, the discourses continually influence each other.[473] The evidence shown in court also influences the public discourse on climate change and responsibility for impacts, and vice versa. The question then is how, or when we can get to the point where the law, as well as the public can be convinced that climate harms and losses are not mere misfortune, but the consequence of a process caused by anthropogenic greenhouse gas emissions.

Climate science is not substantially more or less uncertain than other fields which have been called upon to provide evidence in court.[474] However, climate science is fighting back against a long and, on its own terms, successful campaign of obfuscation and creating doubt by those same major private carbon producers.[475] Communication thus remains a key challenge, engaging with society to advance acceptance of the fact that proof of causation by, and thus responsibility of GHG emitters is possible. Legal scholars, scientists and practitioners in the field of climate litigation are in a good position to contribute to this.[476]

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[465] Ho (n 84) 93.
[466] Ibid 161; see also Moore (n 72) section 5.1.1.
[467] Otto and others (n 5) 739
[468] See section 2.4.
[469] Otto and others (n 5) 739
[470] Minnerop and Otto (n 106) footnote 67.
[471] Otto and others (n 5) 739, referring to the distinction made by the American–Polish political philosopher Judith Shklar.
[472] Minnerop and Otto (n 106) 49.
[473] Otto and others (n 5) 743-44
[474] Otto and others (n 5) 746.
[475] As we have seen, notably, in *Municipalities of Puerto Rico v ExxonMobil*. See section 5.2.2.
[476] Otto and others (n 5) 747.

Convincing legal argumentation, evolving societal norms alongside the best scientific evidence available will be needed to allow judges to apply novel legal and evidentiary reasoning (or old reasoning to the novel context), so they can routinely find legal causation in climate cases as well.[477] Luckily, the law's flexibility in dealing with new challenges shouldn't be underestimated,[478] as the examples cited in chapter 2 have shown. Another example is the recognition of the 'advance interference-like effect' of climate targets with the enjoyment of rights by future generations, recognized by the German Constitutional Court in the *Neubauer* case.[479] The novel climate tort that was (unsuccessfully) proposed in *Smith v Fonterra Co-Operative Group Limited*[480], is another.[481]

An openness to the circulation of legal models, has long been a mechanism for the development of the legal rules and concepts around the world.[482] In climate change, the global problem par excellence, this should form an essential contribution to the development of jurisprudence. I would like to draw attention to two interesting projects relevant to the topic of my thesis. The first is the 'Model Statute for Proceedings Challenging Government Failure to Act on Climate Change', which outlines legal remedies, such as injunctive relief, declaratory relief, and judicial review, and studies precedents to enable individuals facing climate-related threats to effectively seek legal redress in their respective countries. [483] The second are the *Oslo Principles on Global Climate Obligations*, a set of principles outlining the legal responsibilities of states and companies to mitigate climate change under existing legal systems, based on human rights law, international law, national environmental law, and tort law.[484]

The role of climate science in court will grow along with the volume of climate litigation, leading to calls for more dialogue between scientists and legal scholars and practitioners,[485] in order to help align climate science methods and priorities as much as possible with the requirements of legal settings.[486] As the cases we discussed show, and what aligns with the feeling I get of this field in general, an international community of legal and science practitioners is in fact developing. It will play a growing role in informing international and domestic courts about climate justice, and how the courts can help achieve it.[487]

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[477] Ibid 841; Stuart-Smith, Otto and Wetzer (n 104) 26.
[478] Marajanac and Patton (n 6) 277 and 283.
[479] The explanation of the concept is outside the scope of this thesis. For a full analysis, see Minnerop (n 250).
[480] *Smith v. Fonterra Co-Operative Group Limited*, [2020] NZHC 419.
[481] See CE Foster, 'Novel climate tort? The New Zealand Court of Appeal decision in Smith v Fonterra Co-operative Group Limited and others' (2022) 24 Environmental Law Review 224.
[482] Alogna (n 338) 69.
[483] International Bar Association Climate Change Justice and Human Rights Task Force , 'Model Statute for Proceedings Challenging Government Failure to Act on Climate Change' (International Bar Association 2020) <https://www.ibanet.org/medias/47AE6064-9A61-42F6-AC9E-4F7E1B5B4E7B.pdf> accessed 9 June 2022.
[484] Expert Group on Global Climate Obligations, *Oslo Principles on Global Climate Obligations* (Eleven International Publishing 2015).
[485] Of whom Rupert Stuart-Smith is a prominent one, see for instance Stuart-Smith, Otto and Wetzer (n 104) 27.
[486] Harrington and Otto (n 152) 15.
[487] Ganguly, Setzer and Heyvaert (n 20) 863.

Judges too, should indeed engage with (climate) science and scientists. As we have discussed, scientifically complex cases, requiring judges to weigh the reliability and merits of scientific evidence, seem certain to proliferate quickly. It is thus crucial that judges have the required baggage to grapple with this complexity and evidence effectively. As Judge Posner puts it: "Knowledge increasingly is statistical, and judges must not let themselves lag too far behind the progress of knowledge."[488]

Beyond being needed to issue correct judgements, the judicial review of scientific knowledge plays a broader societal role related to the legitimacy of the judiciary and science. In a society where the acceptance of science (and even 'truth') is under pressure from 'alternative facts' (or fossil fuel sector disinformation), judges can provide scientific findings with legal legitimacy, which can increase the legitimacy of later judgements, and so on.[489]

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Holmes defined the law thus: "The prophecies of what the courts will do in fact, and nothing more pretentious, are what I mean by the law."[490] While this is perhaps not pretentious, it certainly isn't simple. In the field of climate litigation, in particular, the law is in flux, so formulating the law in a way that allows prophecies of judgements, is (to me at least) impossible.

Certainly, my research didn't show that, given the right evidence, courts will be compelled to find a causal link in climate litigation, if they correctly apply the law. What I did find, however, is that this causal link exists, and can be scientifically proven in a way that will satisfy a lay person's understanding of causation. Likewise, in legal systems as diverse as the Netherlands and the Philippines, decisions have been leaning in the same direction. Why that is, is hard to say. But I can agree with Ganguly, Setzer and Heyvaert:

> "Perhaps a factor is that, as extreme weather events become ever more frequent and warning signs that our planet is teetering on the brink of catastrophic change multiply, something simply has got to give." A wave of climate litigation is breaking. "While it remains unlikely that all claimants will emerge victorious, it is even more improbable that this wave of momentum will leave the law unchanged."[491]

8. Conclusion

Climate change is one of the great challenges of this age; so all-encompassing that it's impossible to grasp. The impacts, however, become more and more tangible, impacting ever larger groups of people. In line with this, the number of climate litigation cases is growing rapidly. The outcomes of many of those hinge on proving a causal link. In this thesis, I researched ways to translate scientific evidence of the causal link between anthropogenic climate change drivers, climate change and climate change impacts to prove legal causation

[488] Kysar (n 144) 62.
[489] Jansen and de Jong (n 284) 19.
[490] Holmes (n 31) 461.
[491] Ganguly, Setzer and Heyvaert (n 20) 868. My underlining.

in climate change litigation for plaintiffs seeking damages for climate impacts or mitigation/adaptation orders.

Following an introductory chapter 1, in which I described my research aims, question and methods, I sketched, in chapter 2, the theoretical framework around the different threads of my thesis, examining climate and climate change, the metaphysical background to the question of causation, and how this translates to scientific and legal accounts of causation. In the following three chapters, I described the results of my research into three sub research questions. Chapter 3 addressed the state of the art in climate science and how it supports the case for a causal link. In Chapter 4, I moved to the legal angle, studying what degree of certainty is required to establish legal causation under uncertainty in climate change cases. In chapter 5, I explored how the theory works in practice, studying how the argument for causation was made in four different climate cases. Putting the different threads together, I set out the findings of my research in chapter 6. In chapter 7, I discussed the findings. After this concluding chapter, I offer some advice to practitioners and suggest avenues for further research.

I found that science is capable of showing causal links across the causal chain with remarkable reliability. Climate science provides proof with likelihood high enough to meet the standard of proof applicable in civil lawsuits. It meets admissibility and reliability standards for use in court. However, I also found that the constellations of facts in climate litigation cases often strain the generally applied causation test, and proving but-for causal links between individual impacts and emitters remains challenging for plaintiffs. This hurdle may be surmounted by novel legal reasoning, which can be helped by the interchange of legal reasoning and models between jurisdictions and from other toxic tort cases. Leveraging litigation to influence the way climate change is viewed in society at large can also help. My research has shown that a lot of the required work has been done and is being done, both at the nexus of legal and climate scholarship and by legal practitioners.

“Few of our subspecies stop advising on what the law says for long enough to consider what it ought to say,” contends Cullinan about lawyers.[492] I would disagree. Discourses on justice and fairness permeate both society and the courts, with judges having shown their readiness to apply normative corrections to avoid unfair outcomes at countless junctures, as legal reasoning and models circulate around the globe. The wider debate on climate justice and compensation for the loss and damage is ongoing.

A trickle of news about extreme weather events devastating communities is turning into a stream. Climate science is helping to show that this is not mere misfortune, but an injustice. All this will continually improve the odds for plaintiffs in climate-aligned cases. A wave of climate litigation is breaking. The law can’t and won’t emerge unchanged. Something will have to give. Onwards.

[492] Cullinan C, *Wild Law. A Manifesto for Earth Justice* (2nd edition, Green Books 2011) 12.

Advice to practitioners

Here, I (humbly) offer some advice to practitioners, based on my research findings.

- Communication:
    - When expressing probabilities in words, always include numerical translation between brackets (instead of in a table). Explain what is meant by likelihood/probability and confidence in documents (see section 4.4.2).
    - Use correct terminology, using, for instance, the IPCC glossary as a reference.[493]
    - Be aware of how high scientists usually set the bar of proof, and communicate the likelihood and confidence levels of scientific evidence without understating them.[494]
- Attribution study results are sensitive to design and framing choices such as timeframes, geographical areas and the type of event studied. Be aware, and where useful, explain the properties and possible weaknesses of a study (see section 3.3).
- Try to maximally find evidence that meets the most stringent admissibility and reliability standards, and avoid, in so far as possible, the use of advocacy or litigation driven science (see section 4.4.1).
- Try to find an optimal match between what you claim, what evidence you have access to, such that you can meet the standard of proof optimally. When discussing causation, make sure it's clear (for yourself, and where appropriate, the audience) about whether you are discussing necessary or sufficient, general or actual causation.[495]
- When attributing damage to small fractions of total emissions, try to prove GHG emissions in general as a but-for cause, of which a small percentage is a partial or concurrent cause (see sections 3.4 and 4.5).
- Help the judge to find for you (and advance climate aligned litigation in general), by specifically explaining referring what causal corner cases apply,[496] and by referring to interesting and relevant findings in foreign cases, other toxic tort cases. This helps spread legal transplants.
- Study the arguments defendants used in other cases. Study how plaintiffs refuted them. Be prepared to fail: even a failed climate case will help future cases to better arguments. See section 1.4 for links to climate litigation databases.
- Join or set up trans-disciplinary research groups, joining legal and climate science researchers. Co-organise conferences and courses, to increase communication between the law and climate science communities of practice. Invite climate scientists to law courses and vice versa.

[493] <https://www.ipcc.ch/sr15/chapter/glossary/>
[494] See Lloyd (n 309) 1 and Hassol, Torak and Luganda (n 108).
[495] Hannart (n 116) 108.
[496] See section 4.2.

Avenues for further research

Here, I will list some possible avenues for further research. This list is far from exhaustive, evidently.

- An extensive study of the ways in which the causation requirement was or is a hurdle in other toxic or environmental liability cases, and the scientific evidence, legal reasoning and possible normative correctives applied by judges and/or legislators. Useful examples in tobacco, DES, asbestos, PFAS and opioids.
- Relatedly, a study of how judicial decisions which fill certain gaps in the law lead to legislative action, for instance through product liability, legislative adaptations to tort law frameworks, the shifting or reversing of the burden of proof through legislative intervention, etc.[497]
- Again, relatedly, a comparative study of how 'legal transplants', the circulation of legal concepts and reasoning, functioned in the context of toxic tort or environmental law. The market-share liability concept from the *Sindell*-jurisprudence, for instance, was also applied in the Netherlands.[498]
- A systematic, comparative study of the counter-arguments defendants in climate-aligned litigation use, and whether and how they can be countered by plaintiffs.
- Climate science could help climate-aligned litigation's odds of success by establishing standardised, operationalised attribution study frameworks, which make a distinction between climate and non-climate contributions to the impact. The coverage of data on extreme weather events and impacts, as well as the coverage of related attribution studies, should be improved.[499]
- The establishment of a database of evidence across the causal chain would also be useful. This could support wider acceptance of a *distinctive causal field* in climate science (see section 4.5).
- The interplay between the way causal chains are framed in court, and how evidence presented in court helps promote, or not, a wider societal acceptance of their existence, would also be an interesting topic to study.[500] Likewise, the role advocacy campaigns linked to strategic litigation cases plays in the wider societal debate, and how this feeds back into the courtroom, would be an interesting topic for more research.

[497] Akhtar (n 21) 213; Minnerop and Otto (n 106) 52; Otto and others (n 5) 737.
[498] See <https://uitspraken.rechtspraak.nl/#!/details?id=ECLI:NL:HR:1992:ZC0706>.
[499] Otto (n 96) S22; Clarke (n 128) 012001
[500] Otto and others (n 5) 741.

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Interviews

Interview with Cybèle Schneider, Juristische Fachperson Klimagerechtigkeit, HEKS-EPER (online from Bern, Switzerland and Genoa, Italy, 26 April 2023)

Interview with Melissa Sims, Senior Counsel, Milberg Coleman Bryson Phillips Grossman LLC (online from Illinois, United States and Genoa, Italy, 27 April 2023)

Recording and notes are kept by the author according to the research data management plan and what was agreed with the interviewee through the information note and consent form. Blank versions of information and consent sheets that were presented to and approved by the interviewees are attached as an annex.

Annexes

Research Data Management (RDM) plan

The Research Data Management plan was created through the DMPonline.be-tool and can be found in its current version as an annex.

Information and consent sheets for interviews

Blank versions of information and consent sheets that were presented to and approved by the interviewees are attached as an annex.

Proving a causal link in climate change litigation
Law & Criminology DMP +

Administrative Data

14 August 2022

9 May 2023

1. Data Collection

Reuse existing data
This research makes use of qualitative data on climate and tort law: treaties, national statutes and constitutions, declarations, judicial decisions, general comments, law scholarship, and grey literature on the research topic.
Interviews
I have conducted two interviews with key players involved in cases I studied.

In the first phase, I reviewed the extensive extant overviews of climate change cases in which the question of establishing (legal) causality is discussed. I used databases such as the Climate Case Chart, the Climate Change Laws of the World Database as well as case law overviews such as those published by Setzer and Higham.

Both causes of climate change and its consequences are global phenomena. Similarly, climate science, activism and policy only make sense if they are viewed across borders. For these reasons, I will, certainly at the outset, not limit the geographical scope when starting to collect cases. Since climate change litigation is a relatively recent phenomenon, neither will I initially explicitly limit the temporal scope.

I will limit the research to cases before domestic courts, since this is where the majority of cases (especially litigation in which damages or injunctions are sought), are to be found. As to law systems, I will set out with a very broad scope: including civil and common law systems. This does, however, exclude a number of legal traditions (chthonic or indigenous, talmudic, Islamic, Hindu and Confucian law, when borrowing Glenn's taxonomy of legal traditions).

Within this broad set, I looked for cases that concern plaintiffs seeking damages for climate impacts and/or mitigation injunctions and/or compensation for adaptation measures, and that have a scientific-legal translation aspect, in which scientific evidence is used in trying to establish or prove legal causality. In a second phase, I selected cases, which severely but naturally limited the scope. This raises the question of the *case selection* method. My thesis can be typified as descriptive (as opposed to causal). Thus, selected 4 cases, a small number, to analyse in-depth, collecting as much material related to the case as possible (cf. next subsection).

In order to maximise the validity of the answer to the MRQ, I selected relatively diverse cases, in order to capture the diversity of possible answers to the MRQ. The cases span two major legal traditions, common law and civil law, as well as 15 years and two 'waves' of climate litigation. During this timeframe, climate science also evolved a lot, as we will see in section 4. The climate itself, as well, changed, and climate change's impacts became more and more visible, as shown by the progression of IPCC reports released over the period.

In a second phase, I made an in-depth analysis of the cases, in an approach inspired by the dissecting method developed by Marie-Bénédicte Dembour. I analysed the use of evidence in the documents that are available for the different cases. These include submissions by the plaintiffs and the defendants, export testimony, as well as court decisions. I also reviewed the literature (jurisprudence and climate science) related to the cases. The goal here is to get a thorough understanding of the cases, specifically studying the use of scientific evidence over their whole course.

This enables a comparison over time and with the tow (very) recent cases I studied. On these, less documents are available since they have only recently been first submitted to courts. For these cases, I did however interview a key person involved in each case.

The qualitative data will be of .doc, .docx (or the equivalent gdocs formats) and .pdf format and be processed in Google Docs, Drive, and MS Office. It does not require more than 1GB in storage space.

2. Data Documentation and Metadata

The metadata will are collated in the bibliography to my thesis, acoording to the Oscola 4th edition citation style (https://www.law.ox.ac.uk/sites/default/files/migrated/oscola_4th_edn_hart_2012.pdf). The bibliography is organised into different categories for ease of access. All files are stored in a google drive (mirrored locally), according to a basic taxonomy separating literature review sources and files related to the case studies.

Attention was paid to file and folder names. If the file consists of case law, the files will be classed in folders by case. For legal doctrine and other literature review sources, the following naming system will be used: Year AUTHOR title. This ensures that relevant data can be retraced easy. Given that the data are stored in common, easily accessible file formats, future reuse will be straightforward.

3. Ethics, Legal Issues and Confidentiality

- Approval by the Ethical Committee of the Faculty is neither required nor desirable

n/a

The legal doctrine and case law are copyrighted; as a consequence of this, these cannot be shared without explicit permission of the author(s). Therefore the correct rules regarding legal references (based on OSCOLA, cf. above) will be applied, in order to avoid accusations of plagiarism. Any data generated through the course of the research, can be shared, except for the interviews, use of which is subject to the conditions the interviewees consented to. Some material under creative commons licence was used; the licence type is referred to where applicable. The use of these data falls under the provisions of copyright and source reference is always necessary.

4. Data Storage and Backup during Research

Both during and after the research, the data will be stored on my personal computer and on a personal external hard drive, as well as on my personal Google Drive.
I will be responsible for backup and recovery and will ensure that multiple backups of the data are available at all times.

I use 2-factor authentication for all my cloud-accounts where data is stored. I further use a password manager with strong, random generated passwords for all my online accounts. Locally stored data (computer, back-up HDD, cell-phone) are encrypted.

5. Data Selection and Preservation after Research

The primary data is hosted primarily in legal databases, scientific journals, published works and the case law databases. They will consequently remain accessible to future researchers.
I will keep tagged records/copies of all primary data I downloaded and annotated. Iwill keep recordings and notes of the interviews taken.

I will keep the records described in this DMP for at least five years on my personal computer, cloud accounts and backup HDD and bear any associated costs personally.

6. Data Sharing

The data related to legal doctrine are freely accessible online or subject to an agreement between Ghent University and the rights holder. This means that, in the latter case, sharing these data is strictly limited. Sharing of the interviews is subject to the conditions the interviewees consented to. Sharing of content licensed under creative commons licences is subject to the applicable provisions. As far as any other data are concerned, no restrictions on the sharing of the data will be required.

Any reader of the dissertation will be able to trace the primary data through the references in the bibliography. Any notes and analysis will be saved as discussed above, so that fellow researchers can access it if necessary and subjects to applicable conditions. I see no need for further, active, sharing of data.

7. Responsibilities and Resources

Jozef Seghers, the student doing the research.

No.

Proving a causal link in climate change litigation
GDPR Record

Collection and processing of personal data

- Yes

Names and other identifiers may be included in the documents I collect for the cases to be included in the case-study. I may also keep contact data for persons involved in the cases I study and take notes including personal data. These will not be published. Data of the interviewees and the interviews themselves are kept and used subject to the conditions specified in the information and consent forms, which were approved by them.

- Digital

I may keep records of names and contact data in digital form.

- Primary personal data

Data of the interviewees and the interviews themselves are kept and used subject to the conditions specified in the information and consent forms, which were approved by them and a copy of which will be annexed to my thesis.

- Raw personal data, i.e. non-pseudonomysed or non-anonymised (explain below)

Data of the interviewees and the interviews themselves are kept and used subject to the conditions specified in the information and consent forms, which were approved by them.

Categories of personal data & data subjects

- None of the above

- Identification data (names, titles, addresses, phone numbers, passport numbers, IP addresses, cookies, electronic location data (GPS, mobile phone)…)
- Occupation and profession
- Audio and video recordings

Data of the interviewees and the interviews themselves are kept and used subject to the conditions specified in the information and consent forms, which were approved by them. The approval included the recording of (audio) from the interviews and notes by the researcher.

- Others (please specify below)

I interviewed a key person involved in each of two cases I studies, in their professional capacity.

- No

The interviews are interesting but not crucial to my research. No direct quotes from the interviewees will be included. If the interviewees exercise the above mentioned rights, this may hamper possible further future research.

Purpose(s) of the processing

I will process and keep contact data in order to be able to communicate with persons in the course of my research. Regarding the interviewees, the data support an in-depth analysis of the cases. I analysed the use of evidence in the documents that are available for the different cases. These include submissions by the plaintiffs and the defendants, export testimony, as well as court decisions. I also reviewed the literature (jurisprudence and climate science) related to the cases. The goal here is to get a thorough understanding of the cases, specifically studying the use of scientific evidence over their whole course. This enables a comparison over time and with the two (very) recent cases I studied. On these, less documents are available since they have only recently been first submitted to courts. It is for the latter cases I took the interviews.

- The research will be performed in the public interest, which means that it will lead to an increase of knowledge and insight to the direct or indirect benefit of society.
- The research is necessary for the purposes of the legitimate interests of Ghent University and/or Ghent University Hospital, yet results in no high risks for the individuals participating in the research.
- The individuals participating in the research have freely given their explicit consent for the processing of their personal data for one or more specific purposes.

GDPR responsibility

- Ghent University

Contacts

My supervisor, Prof Marie-Benedicte Dembour.
Postal address: Human Rights Center, Ghent University, Universiteitstraat 4, B-9000 Ghent, Belgium
Email: mariebene.dembour@ugent.be
Tel: 0032 9 264 68 98
Myself: Jozef Seghers, student at Ghent University Law and Criminology faculty.
Visitors' address: Faculty of Law and Criminology, Campus Aula, Voldersstraat 3, B-9000 Gent, Belgium
Postal address: Faculty of Law and Criminology, Universiteitstraat 4, B-9000 Ghent, Belgium
Email: jozef.seghers@ugent.be or jef.seghers@gmail.com
Tel: 0032 498 432 448
The Data Protection Officer at Ghent University – currently Ms. Hanne Elsen.
Postal address: Sint-Pietersnieuwstraat 25, B-9000 Gent, Belgium
Email: privacy@ugent.be
Tel: 0032 9 264 32 39

- No

- This is determined within Ghent University: UGent is the data controller.

Data transfers & categories of recipients

- No

Retention period

The interview files will be kept for the lifetime of my research project and, as is common practice in academic research, for five years afterwards.
In a departure from common practice, and subject to explicit agreement by the interviewee, these files may remain accessible to me for as long as I remain professionally active, for use in the context of other research related to environmental law.

Risk analysis

- The research involves the processing of non-pseudonymised personal data.

- No

Security measures

- I hereby confirm that I carry out my research in accordance with the guidelines on information security of UGent and/or UZ Gent.
- Additional security measures will be or have been taken (please specify below)

I use 2-factor authentication for all my cloud-accounts where data is stored. I further use a password manager with strong, random generated passwords for all my online accounts. Locally stored data (computer, back-up HDD, cell-phone) are encrypted.

GHENT UNIVERSITY

FACULTY OF LAW AND CRIMINOLOGY

Proving the causal link in climate change litigation – MA dissertation

Information sheet

My name is Jozef Seghers and I am a student in Ghent University's Master of Laws programme, currently writing my MA thesis. My thesis research deals with proving the causal link in climate change litigation. Given your expertise I would appreciate the opportunity to discuss some of my research questions with you. This document provides you with information about the context of my research, as well as the kind of questions I may ask you. This is to enable you to make an informed decision on whether you wish to participate in my research. If you are willing to be interviewed, I will first ask you to sign a consent form. The consent form will clarify the terms under which the interview will be held, including the fact that you can withdraw consent at any stage during the interview, or afterwards.

My MA thesis: The general aim of my research is to identify, specify and analyse the hurdles a plaintiff may encounter in proving a causal link when seeking damages or injunctions in climate change litigation. I will do this to study ways to translate scientific proof of causation to help establish legal causation in climate change litigation.

Main research question: In the context of climate change litigation, what ways to translate scientific evidence of the causal link between anthropogenic climate drivers, climate change and its impacts, either help, or do not help, to prove legal causation for plaintiffs who are seeking damages or mitigation/adaptation orders?

Sub-question: What types of and ways to present scientific evidence in court help in proving legal causality in climate change cases, and what types of evidence and ways of presenting them, don't?

Research methods: doctrinal legal analysis combined with case studies. The case studies are researched through reading of related materials, and research interviews with relevant stakeholders involved in selected key cases.

Outcomes: MA thesis (possibly leading further to conference attendances, academic articles, blog posts).

Affiliation: Ghent University's Faculty of Law and Criminology. My promotor is Prof. Marie-Benedicte Dembour, who is affiliated notably to the Human Rights Centre at the faculty. See https://hrc.ugent.be/ and https://www.ugent.be/re/en

My email: jozef.seghers@UGent.be or jef.seghers@gmail.com
My phone number: 0032 0498 432 448

GHENT UNIVERSITY

FACULTY OF LAW AND CRIMINOLOGY

Consent form for interviewees

Jozef Seghers, student in the Master of Laws programme at Ghent University, thanks you for your willingness to be interviewed.

Please note the following:

- Your participation in this research interview is voluntary.
- You are free not to answer any question. You can stop the interview at any time. You can ask for the record of the interview to be destroyed at any point in the future. You do not need to give any reason for withdrawing from this study.
- The interview may be recorded. In this case, it may be transcribed either by the interviewing researcher or a person who has signed a confidentiality agreement. If you agree to this, please add your initials here: _____
- If the interview is not recorded, the researcher will appreciate taking notes as you speak. If you agree to this, add your initials here: _____
- The information you provide during the interview will be used as background and not be attributed to you in any publication or public forum – except if your permission is requested and you specifically consent to this attribution.
- Electronic files of your interview's recording/transcription will be password-protected and saved on a secure server or cloud storage. If hard copies of the record of your interview are made, they will be kept in a locked space.
- These files will be accessible to the researcher who is interviewing you for the lifetime of his research project and, as is common practice in academic research, for five years afterwards.
- In a departure from common practice, you are asked if you agree for these files to remain accessible to the interviewing researcher for as long as he remains professionally active, for use in the context of other research related to environmental law. If you agree to this, add your initials here:_____

If you withdraw consent at any time in the future, the data provided up to that point will be destroyed. It will also cease to be used for research. However, it may not be possible to alter publications already in preparation (or out).

Declaration: I confirm I have read the above as well as Jozef Seghers's information sheet. I agree to participate in Jozef Seghers's research project in accordance with the terms indicated in these two documents.

_____	_____	_____
Printed name	Participant's Signature	Date

Contacts

If you have any further questions or concerns about this study, please contact Jozef Seghers's supervisor, Prof Marie-Benedicte Dembour.
Postal address: Human Rights Center, Ghent University, Universiteitstraat 4, B-9000 Ghent, Belgium
Email: mariebene.dembour@ugent.be
Tel: 0032 9 264 68 98

The student interviewing you is Jozef Seghers, student at Ghent University Law and Criminology faculty.
Visitors' address: Faculty of Law and Criminology, Campus Aula, Voldersstraat 3, B-9000 Gent, Belgium
Postal address: Faculty of Law and Criminology, Universiteitstraat 4, B-9000 Ghent, Belgium
Email: jozef.seghers@ugent.be or jef.seghers@gmail.com
Tel: 0032 498 432 448

If you have any questions or concerns regarding the data the researcher may hold on you, or if you would like to have your data rectified or erased, obtain a copy of it, or withdraw your consent, you can contact at any time, in addition to Jozef Seghers, either Prof. Dembour or the Data Protection Officer at Ghent University – currently Ms. Hanne Elsen.
Postal address: Sint-Pietersnieuwstraat 25, B-9000 Gent, Belgium
Email: privacy@ugent.be
Tel: 0032 9 264 32 39