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RESEARCH ARTICLE

Causality and the fate of climate litigation: The role of the social superstructure narrative

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Abstract

Climate litigation has become a strategic tool to push for climate justice, including compensation for losses caused by climate change. Many cases rely on the establishment of a causal relationship between the defendants' emission of greenhouse gases (GHG) and the plaintiffs' losses. All decided cases seeking compensation for a concrete climate related impact have been unsuccessful (thus far). Legal scholars as well as social and natural scientists have looked at individual cases and evidence of these unsuccessful claims, aiming to identify legal and scientific hurdles. Based on previous research where we analysed specific cases, we step back from a case-specific analysis in this article and identify the social context in which law and science operate and intersect. We assert that without a general understanding of the urgency of climate change and the scientifically proven fact that climate change impacts the present, and that it is possible to attribute individual losses to human-caused climate change, the fate and future of climate litigation focusing on losses and damages will continue to encounter major obstacles in courts. This is despite the increasingly sophisticated strategies of litigants; the positive outcome of some strategic litigation and improvements in the field of climate science, all of which would be expected to sway for a successful future of the fight against climate change.

1 | CLIMATE CHANGE IN THE COURTS

With prominent court cases like *Lliuya v RWE* in Germany and, in particular, the decisions of the German Constitutional Court in *Neubauer* et al. *v Germany*, and the Hague District Court (the Netherlands) in *Milieudefensie* et al. *v Royal Dutch Shell repeatedly* making headlines in 2021, climate litigation has successfully gained a role as an important component of achieving ambitious climate goals. Some cases seeking more ambitious emission reductions have been successful whereas, to date, those seeking compensation or restitution for losses or damages have not. Many recent publications argue however, that developments in climate science could lead to favourable outcomes for plaintiffs in some of these loss and damage types of lawsuits, depending on domestic legal framework and

the legal question involved (Marjanac & Patton, 2018; McCormick et al., 2017; Minnerop & Otto, 2020). The main reason why past climate damages suits have not led to a successful outcome for plaintiffs has often been identified to be predominantly procedural in nature (Burger et al., 2020). Recent developments in climate science, in particular climate change attribution (Stuart-Smith, Otto et al., 2021), and increasing public recognition of the link between greenhouse gas emissions and climate change impacts could help to overcome admissibility hurdles. Specifically, such evidence could be used to establish standing, for which plaintiffs may need to prove that they have suffered an injury, that the defendants' actions could have caused the injury, and that a favourable decision of the court could redress the injury. Developments in attribution science could support plaintiffs in satisfying legal tests for causation and thus provide a crucial step in successful litigation with respect to adaptation and losses where no claims for remedies have been successful.

That the emergence of the science of attribution of extreme weather events has for the first time been comprehensively assessed in the most recent IPCC sixth assessment report (Masson-Delmotte et al., 2021) is crucial for the potential of delivering evidence in individual lawsuits. In successful climate cases, such as *Urgenda v The Netherlands* the previous IPCC reports are used as an authoritative source of scientific evidence. *Milieudefensie v Shell* used the IPCC Special Report on 1.5C to argue for a 45% cut in emissions by 2030 and in Australia, *Gloucester Resources v Minister for Planning*[1] used the IPCC reports to evidence the argument that all additional emissions matter.

With attribution science forming the basis of key findings in the IPCC's Sixth Assessment Report (AR6), we already start seeing attribution science as assessed in the IPCC starting to be used in the same way as more established science was in the examples above. The commission on human rights of the Philippines inquiry on Climate Change[2] made ample use of key attribution-based findings, for example, that climate change has altered extreme weather and other climatic impact drivers in all regions of the world. By including attribution, the IPCC now provides the necessary tools and understanding to demonstrate the causal chain (Figure 1), from greenhouse gas emissions through concentrations in the atmosphere to global mean temperature increases to local losses. Minnerop and Otto (2020) detail how these elements of the causal chain translate into legal causality. AR6 systematically incorporates attribution in all aspects of climate impact assessment for the first time, from extreme events (Seneviratne et al., 2021) to a range of concrete damages (O'Neill et al., 2022). As such, AR6 provides the scientific basis to assess losses and damages caused by anthropogenic climate change but also highlights that *fairness* is the key issue of the climate crisis (IPCC, 2022). In other words, climate change is not primarily a physical problem with a technical solution, but a problem of equity and justice. This framing, while prominent in the most recent IPCC report (AR6 WG2) and increasingly used by activists[3] has not yet reached the wider societal narrative in the same way that the existence of climate change and the need to cut emissions have. A clear indication of this provides the UNFCCC itself. In its latest cover decision of COP26[4] Parties highlight the fact that climate change is already affecting every region of the world, but by continuing to focus on mitigation and development, while not financing loss and damage, the already-occurring impacts of climate change today are not addressed. In order to more adequately address equity in all dimensions in the development of decisions under the UNFCCC and the Paris Agreement climate justice must be framed as to encompass equity and justice in a transboundary perspective and in the long-term, as equity between generations, where each generation owes duties of justice to the next generation as a class (Minnerop JEL, 2022). The present narrow narrative of climate change as a *future* problem must be extended in the discourse about climate change as a present problem. Thus far, the concentration on mitigation, with a few exceptional cases that usher in a focus on adaptation, has been dominant in courts across many jurisdictions.

In this article, we explore two central issues which still, in our opinion, lack attention in the discussion of climate litigation currently hindering a breakthrough in addressing losses and damages from climate change in and outside of the courts. The first element is what we will call below 'superstructure narrative' and reflects the above-mentioned societal perception of climate change, as, primarily, a future problem that we can in principle largely avoid through mitigation or adapt to,

Policy Implications

- By changing the public narrative on climate change impacts, losses and damages can be addressed in climate policy and the courts.
- Understanding and education about what the impacts of climate change are, and are not, is crucial to develop policies truly increasing resilience.
- Setting an inventory of impacts of climate change alongside the existing ones of emissions will allow adaptation and loss and damage to be on more equal footing to mitigation.
- Seeing court cases not as a blame game, but legitimate struggle for justice, is central to ultimately determine better laws and governance structures for adaptation.

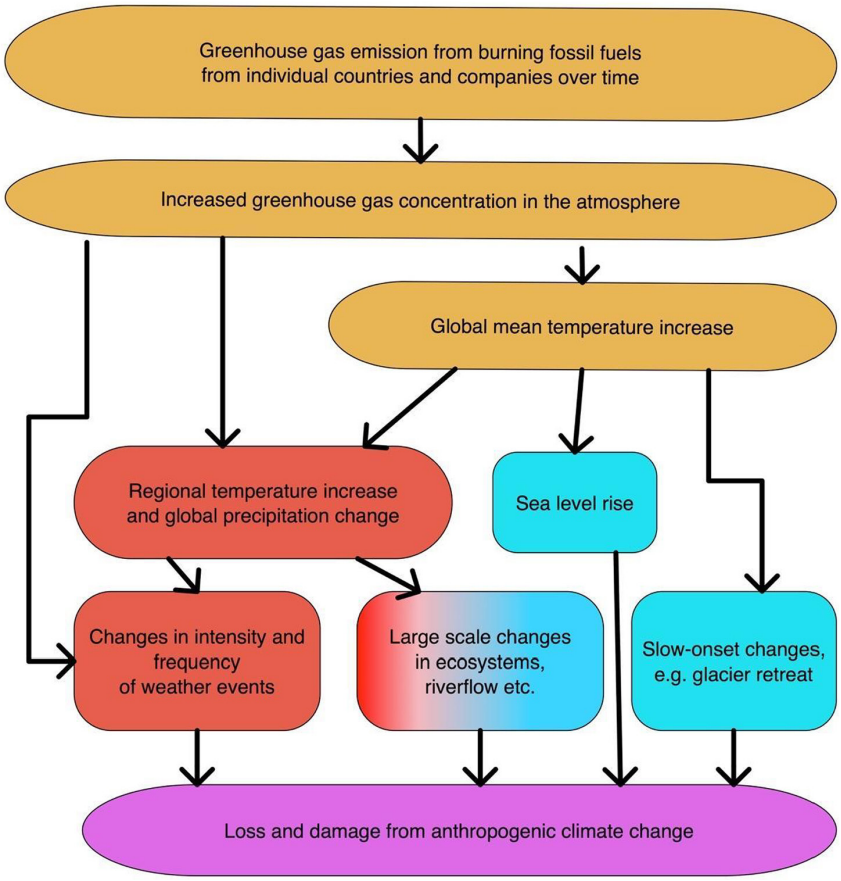

FIGURE 1 Chain of causality from greenhouse gas emissions to loss and damage. The boxes with yellow colour indicate the main driver of regional impacts. The red and blue colours indicate impacts that scale with global mean temperature changes (red) and those that have a lagged response time (blue). Losses and damages result from both types of impacts, indicated in purple. Adapted from (Otto in Brueggemann & Roedder, 2020).

and not as a main cause of irreversible environmental degradation as well as current and historic injustice that is perpetuated through the climate change impacts. The wider societal perception of what constitutes a cause is influenced by scientific evidence. This societal understanding of causation is then tested in courts and the cause in law is identified through applying existing legal parameters. This article examines how the legal analysis is influenced through social perception of climate change and the role of the judiciary in addressing this.

The second element concerns the exact causal nexus between emitters and plaintiffs' losses in science and law particularly with respect to the unresolved issue of disentangling locally mediated adverse impacts and global and local negligence. This relates to the issue who bears legal responsibility for the resultant losses or damages where vulnerabilities exist and are exacerbated through various factors, including but not limited to climate change. The science has made huge progress, as highlighted in the IPCC AR6, but this has not filtered through systematically and at scale into the evidence provided by litigants in courts (Stuart-Smith, Otto et al., 2021) and public perception (Raju et al., 2022).

The ultimate aim of the courts in a democratic state is to achieve a fair and just outcome for a given dispute; what is 'fair' depends on many factors, individual to the tortfeasor and the plaintiff, as well as on the general societal context. Across the 20th century, we have seen many examples of the difficulties encountered, and the time it requires to change public, socio-legal and courts' perceptions of a given issue. Examples of such fundamental issues are women's or children's rights, same sex marriages, or perhaps closer to the case in matter, the harmful effects of cigarettes, asbestos, drugs or chemicals, subject to product liability litigation, to mention a few. Cases dealing with exposure to harmful substances such as asbestos provide particularly useful analogies to climate damages as discussed in Minnerop & Otto, (2020). It is against this background that plaintiffs need to persuade the courts that climate change impacts today and not in the future alone have become a matter for all levels of government and the courts. While we recognise that public awareness of the present-day threat of climate change has risen, the fact that losses and damages from climate change are still treated as a topic in the 2021 Glasgow Climate Pact as a matter to be discussed in the future rather than

addressed financially in the present, is symptomatic of the need to further improve both, research and communication on damages and losses from climate change for the superstructure narrative to change.

In Section 2 of the article, we will consider how this superstructure narrative of climate change affects courts' decision-making in various jurisdictions, followed in section 3 by an assessment of how the perception of climate justice has changed in civil society.

Calculating probabilities and passing counterfactual tests, like the commonly used 'but for test' (Hart & Honore, 1959; Williams, 1961), is central to tort law in many jurisdictions in determining factual and legal causation. However, even if quantifying changes in events' probabilities is important for establishing causality, legal tests for causation only constitute one important starting point for establishing an acceptable legal chain of causality from the actions of the tortfeasor (emitter) to the harm experienced by the plaintiff. We describe this in Section 4 as the causal nexus, or specific causation, describing how the evidence basis has been further strengthened across the entire causal chain.

The answer to the question of whether the harm would have occurred anyway or is the result of the actions of the defendant, depends on the interactions of physical climate impacts with case specific circumstances. These are shaped by several factors, including the underlying vulnerability of the plaintiff. Disasters may be triggered by natural hazards, with or without the contribution of climate change, but they are always mediated by social and political processes (Blaikie et al., 1994; O'Keefe et al., 1976; Raju et al., 2022). Disasters, and the losses that occur for plaintiffs, are, at least partially, a consequence of dynamic vulnerability of the community affected. This may include historical legacy (van den Berg & Keenan, 2019) poor policy decisions, poverty and/or faulty urban planning. All of these factors mediate and may enhance or reduce the impacts of physical phenomena such as storms or heatwaves.

In law, the risk of interacting with a particularly vulnerable plaintiff traditionally lies with the tortfeasor, often referred to as the 'thin-skull rule' or the *talem qualem* rule (Aman, 1993). However, there are important exceptions to this rule, which we discuss in Section 4, which addresses the features of the plaintiff and existing vulnerability in particular.

The paper concludes with recommendations for addressing the identified challenges and gaps to ultimately turn the tide in climate litigation systematically, with more reliable results on the issue of causation.

2 | CLIMATE CHANGE AS A QUESTION FOR LAW AND JUSTICE

Overarching any legal claim is a consideration of whether the dispute or claim concerns a subject that a judge accepts as belonging in the courtroom. This assessment crucially depends on generally accepted norms. Thus, the political, social and cultural context that pre-determines and frames the letters and interpretation of a particular law, is central to understanding and developing future legal practice. Law is in other words both an *idealised* order and a *cultural and social* practice. In a famous private nuisance case from 1956, the claimant won the case in arguing that the sight of sex workers and their clients entering and leaving neighbouring premises interfered with the claimant's enjoyment of the house (*Thompson-Schwab v Costaki*). The judge followed the argument, and the defendants were held to account for causing nuisance as the activity was considered offensive in and of itself. History spans further examples of this nature, and they highlight the importance of judges' and broader society's moral and factual understanding of scientific evidence.

Thus, submitting and arguing a legal case successfully, without robust precedent, largely depends on the legal interpretation of criteria and thresholds, and this interpretative process does not take place in a value-free vacuum. Instead, courts are at the centre of issues with which societies are concerned. A legal case is decided within a given political, social and cultural context. Of course, a positivist approach to law entails that the 'black letters' of a provision are applied coherently and in a similar fashion across a whole range of situations.

The application of the law to facts is, however, never purely mechanistic. Adjudication proceeds within an often intangible, but nevertheless influential, superstructure narrative (from different perspectives see Dworkin, 1972; MacCormick, 1978; Peczenik, 1989; Tuori, 2002). Tort law aims to balance risk, the ability to control risk and to compensate those who suffered injuries without own wrongdoing. In the context of climate change, there is no broad societal agreement on what constitutes wrongdoings.

The American–Polish political philosopher Judith Shklar illustrates how the superstructure works, by distinguishing between injustices and misfortunes (Shklar, 1990). According to Shklar, a loss or a limitation in our lives is always either understood as an injustice or a misfortune. This distinction, however, is something constantly negotiated in the societal discourse, and ultimately is 'a puzzle in which our preferences, status, perspective, and political ideology are all implicated, especially when public policy may be at stake' (Shklar, 1990, p. 58).

In the prominent tort cases of mesothelioma, courts have framed the injuries as injustices and accordingly recognised that the claimant had to be compensated even though the criteria of the 'but for' causal analysis were not met. Consequently, the strict application of the causal test would not have served to give effect to law's purpose of creating justice (see

Minnerop & Otto, 2020 for details). In the context of climate litigation, courts have not found a reason to 'soften' the causal analysis. (First instance in Lliuya *v* RWE is an illustrative example). These expectational cases demonstrate that the justice discourse in courts is 'outcome' oriented, and it is shaped by a changing superstructure narrative. The change of this superstructure narrative occurs rapidly, through legal and political developments, in particular with the approval of the Paris Agreement (2015). The superstructure is never static and remains susceptible to societal changes, including courts' decisions on climate protection.

The Paris Agreement in 2015 was a major milestone recognising the changing superstructure narrative providing an agreement that clearly accepted climate change as not only potentially dangerous and thus the need to prevent future warming but also recognising the occurrence of loss and damage today in Article 8. The Paris Agreement is a binding international treaty and sets forth legal obligations of states, normative expectations and shared understandings (Rajamani & Bodansky, 2019). Some courts have given effect to the Paris Agreement's objectives. Most recent examples are, in particular, the order of the German Constitutional Court (published on 29 April 2021[5]) stating that the climate protection act postponed more drastic emission reductions into the future. This 'offloading' of emission reductions into the future interfered with the fundamental rights of the young claimants, the current targets therefore had an 'advance interference-like effect' (*eingriffsähnliche Vorwirkung*) (see further Minnerop, 2022). The Norwegian Supreme Court confirmed the finding of the Borgarting Court of Appeal that extraterritorial emissions from combustion of exported petroleum can pose a threat to the right of a healthy environment that is protected under Article 112 of the Norwegian Constitution (Minnerop & Røstgaard, 2021). However, a different example is provided by the UK Supreme Court's finding that ratification of the Paris Agreement did not constitute 'government policy' under section 5(8) of the Planning Act 2008.[6]

These cases are strong signals that shape the superstructure, influence public opinion and understanding and, even if some outcomes are less favourable for the claimants, contribute to increased public awareness.

3 | CLIMATE JUSTICE AND CIVIL SOCIETY

It is important to highlight here, that while the Paris Agreement provided the legal basis for these court decisions, the predecessor, the Kyoto protocol would also have allowed for rulings in favour of more stringent climate policies. However, the Paris agreement introduced temperature targets which allowed carbon budgets, and thus very concrete national goals to be derived. Further, the Paris Agreement and recent court rulings happened at a time where there is a general understanding in the public discourse that climate change can generate negative impacts is doubted by few. This is certainly a noticeable change in the 21st century compared to the 1990s even though the scientific basis long existed (Hulme, 2009), notably highlighted by Section 1 of the Glasgow Climate Pact.[7]

Climate change issues have started to mobilise people across the world since the turn of the century and reached many more parts of society so that the 'green debate' has even been in the limelight during the elections in many countries of the Global North. Yet, the level of understanding and engagement is still very different across geographies and demographics. A study in the UK highlights that while people may be concerned about climate change, some of them might view it as a low salience issue (Crawley et al., 2019). The Global Warming's Six Americas study categorised their respondents into six groups based on their views of climate change: the alarmed, the concerned, the cautious, the disengaged, the doubtful and the dismissive (Leiserowitz et al., 2021; Maibach et al., 2009). Education and access to information play a key role in people's knowledge and awareness of climate change. A study in Bangladesh, one of the countries worst affected by disasters, shows that people with higher education and better access to information have more knowledge about climate change and its related health impacts (Kabir et al., 2016).

We have seen that public opinion and perception can be influenced by different forms of communication, by social media, other forms of news which further influences whether or not people seek more information on climate change (Metag et al., 2015). This mobilisation and communication has led to a widespread recognition of climate change as an issue, and also brought the recognition of climate justice (Cassegård et al., 2017) into a broad public debate. For this debate to start, communication has been essential and audiences outside the scientific community were instrumental in communicating science in a way that made it possible for a broad public debate on climate change and climate justice to unfold (Eide & Kunelius, 2021). But recognising climate change as an injustice does not automatically lead to recognition of disproportionate responsibility to mitigate and fund adaptation to help alleviate the impacts of loss and damage. In fact, it could be argued the consistent treatment of climate change as a future issue and the heightened awareness of climate change as an intergenerational injustice has further increased the international dimension of injustice by giving high-income countries a way to take on responsibility for future high-income country citizens, without ever recognising or addressing historic and international responsibility. This is an interpretation

highlighted by many least-developed country delegates after the Glasgow Decision was made.[8] Only recognising this responsibility allows for the recognition of neglect of that responsibility be it by states or corporations.

In situations where the defendant is a corporation, the legal obligations that apply to private actors in the context of climate change are thus challenged. It is not hard to argue that it has been known for a long time, in particular by fossil fuel corporations (Bonneuil et al., 2021; Franta, 2021) that their business model leads to potentially dangerous climate change. In a general sense, that the burning of fossil fuels leads to losses has of course also been known at the latest since the publication of the first IPCC report in 1990, where the causal relationship between greenhouse gas emissions and climate change has been clearly demonstrated and accepted by governments across the world. Whether and to what extent this general understanding translates into responsibility of specific corporations or governments for climate-change-induced losses is however not generally accepted (Otto et al., 2017; Skeie et al., 2017). Even more important for accepting evidence of concrete causal chains would be recognising how a general awareness of negative consequences of climate change translates into a concept of measurable loss and damage that is distinct from weather-related losses.

Currently this is lacking. There is limited understanding of and consensus on defining and recognising loss and damage from human-induced climate change (Boyd et al., 2017, 2021) and the absence of this potentially hinders the recognition of causal chains. Thus, one might argue that the largest lever to changing public opinion concerning climate damages lawsuits is to alter the narrative from their perception as 'activist driven blame games' to increasingly and more widely accepted legitimate struggles for justice. This shift in public awareness and opinion is supported by a better understanding of the actual losses incurred, and the direct link that these losses have with global climate change. The above-mentioned shift in framing within the IPCC, that was published after COP26 could provide an important step in this direction but will not alone be sufficient. As exemplified, for example, in corporate settings (Damert & Baumgartner, 2018) a change in public perception towards seeing climate change as an important issue led to corporate responses to climate change spearheaded by costumer facing players in the industry.

Framing plays a huge role in public perception and, accordingly, in climate change litigation, and is shaped by the superstructure narrative as evidenced above with large changes in social norms. Previous research highlights social movements have either used protests, lobbying or litigation as different strategies and these are influenced by the type of resources available to them (Noonan, 2018). Vanhala (2018) argues that it is important to understand how different groups 'frame and interpret the idea of "the law"' as this has an impact on the decision if a group might turn to the courts. In recent years, we have seen a proliferation of different groups mobilising in different forms across the world on the climate theme. An important question to be reflected in future research is what influences people to join these mobilisations and what kind of framing likely leads to acceptance of the existence of and evidence for causal chains. Influence can be sought through a variety of mechanisms which include litigation as well as shaping public opinion and engaging in international politics (Kolb, 2008).

This means framing the public discourse in a way that 'the law' is seen as an essential and integral part towards for finding solutions for a carbon neutral future that is just and fair. The causal inquiry in law and science is situated within this wider transformation and it could become an essential tool to address inequality.

Successful litigation that uses scientific evidence serves to strengthen the understanding of climate change impacts and the legal dimensions at the same time and that, in turn, will impact on the superstructure narrative.

4 | ELEMENTS OF THE CAUSAL CHAIN

Changing perception and the outcome of some litigation depends on understanding of what can and cannot be said with confidence by way of a causal chain from a scientific perspective. Stuart-Smith, Otto et al. (2021) highlighted that there appears to be a large discrepancy of this understanding between the scientific literature and legal practitioners. Given that courts mostly recognise general causation, that is, the link that exists between GHG emissions and climate change, the major hurdle remains to satisfy legal tests for specific causation. This requires establishing the causal chain from emission to loss as illustrated in Figure 1.

Damages from climate change arise either through slow onset events, like sea-level rise or glacier retreat, or through extreme weather events like droughts, floods, heat waves or compound events. These two types of impacts from human-induced climate change are very different with respect to the timescales over which they arise (Masson-Delmotte et al., 2021) and thus immediacy of damages and cause and effect. Those impacts highlighted in red in Figure 1 emerge approximately concurrently with emissions and global warming levels (Seneviratne & Hauser, 2021) and increase linearly with warming whereas those depicted in blue have some degree of inertia, responding over periods of decades to centuries. In cases where thresholds are crossed (e.g., some ecosystems like

coral reefs; Harrington & Otto, 2019) the timing of the emissions are also crucial for determining which entities contributed to threshold exceedance. This has consequences for our scientific ability to evidence the causal chain.

Most climate science has been developed with anything but courts in mind, even when specifically addressed at decision-makers outside the climate science community. This is different for the attribution of extreme weather events to anthropogenic climate change which has, following epidemiological concepts, suggested explicitly a causal nexus (Allen, 2003). Extreme event attribution has thus a logical focus on climate litigation, especially for establishing the causal chain across several factors. and in situations where concurrent causes exist.

Extreme-event attribution describes a set of scientific methods which calculate the relative increase in the probability of occurrence, or intensity, of a given extreme event. This is done by comparing the defined event's likelihood of occurrence in simulations of the present-day climate with some modelled estimate of a counterfactual climate where some or all anthropogenic influences have been removed (Philip et al., 2020; van Oldenborgh et al., 2021).

Attribution methods are also available for persistent and slow-onset changes, such as glacial retreat. These include comparing observed changes, for instance in glacier extent, with modelled estimates of those that would have been possible over a given time period in response to natural climatic variability alone (Roe et al., 2017). Since slow-onset impacts accumulate over decades, rather than occurring instantaneously, attribution of these slow-onset impacts must consider the changing anthropogenic climatic influence over time. By contrast, extreme-event attribution assessments consider the overall impact of human influence to date.

4.1 | Scientific framing of the scientific evidence

In event attribution, the exact numbers and inference of human contribution to the event strongly depend on how the event is defined (Otto et al., 2016). An analysis becomes more specific to the particular weather event when the boundary conditions used to simulate the factual and counterfactual distributions are conditioned to the observed state of the ocean or atmosphere at the time of the event. The subsequent statement about how much an entity's greenhouse gas emissions have exacerbated the severity (or likelihood) of a recently-observed extreme event will also change, since the specific physical mechanisms which are being evaluated are no longer the same. Leach et al. (2020) explore different spatio-temporal definitions of the 2018 European heatwave finding primarily that longer temporal and spatial scales lead to more consistent assessments across different methodologies and also higher likelihood ratios which indicate the human contribution to the event. This finding is further corroborated by Yiou et al. (2020), who defined the heatwave over a large part of Europe at a temporal scale of 19 days. An event definition which closely matches the observed meteorological event does however not mean, that the attribution assessment better captures the observed damages (Cattiaux & Ribes, 2018). The latter can only adequately be captured if the interplay between hazard and vulnerability is known and taken into account when collecting the evidence of the causal nexus (Philip et al., 2020; Stone et al., 2021).

From the perspective of litigants, it is important that scientific probabilities still allow us to satisfy the standard of proof to establish a causal relationship between GHG emissions and plaintiffs' losses (Minnerop & Otto, 2020). The latter depends much less on the specific framing of the attribution question, however in the public discussion of results in the past (Otto et al., 2012) an impression has arisen that the science is highly uncertain and thus not fit for legal interpretation (Pfrommer et al., 2019). Scientific uncertainty in the context of climate change generally and event attribution specifically is neither particularly high, nor is scientific uncertainty unbeknownst to courts (Minnerop & Otto, 2020). In order to successfully argue a causal nexus, it is important that the aspect of the causal argument that is sensitive to the exact framing is understood while at the same time the facts independent of specific framing differences are established. In order to do that the causal nexus will need to be built on an existing body of evidence by, for example, referring to a number of studies on similar events, theoretical arguments on the general attributability of different types of climate impacts and meta-assessments like the IPCC reports (called distinct causal field in Minnerop & Otto, 2020). Continuing the use of well-studied European heat waves as an example, a causal nexus could thus be established for specific impacts, for example, excess mortality in London during the 2018 heatwave, by identifying the most relevant event definition for heat-related mortality and conducting an attribution assessment for this specific event (Clarke et al., 2021). In addition, an assessment of the dependence on framing and event definition was provided for this heatwave on the basis of the relevant literature (Kew et al., 2019; Leach et al., 2020; Vautard et al., 2020). Crucially, if the latter is absent the results are essentially useless. Therefore, conducting these further assessments on framing and event definition are an important responsibility of the ‘science community’ in the communication or results to the ‘legal community’.

4.2 | Defining the comparative unit of assessment: the counterfactual

While the arguments above focus on the causal chain connecting climate change to losses, the other side of the causal chain pertaining to individual emitters, timeframe and atmospheric composition of the atmosphere is important when determining what should constitute the counterfactual. In particular, the timeframe considered is relevant for slow-onset impacts but may also influence the attribution assessment for extreme weather and climate-related events. A counterfactual could either be a hypothetical world with all human influence on the climate system removed or a point in history when climate change was not happening, not known about or not observable.

The first evidence that increasing global mean temperatures could accompany changes in atmospheric CO_2 concentrations could be arguably traced back to the work of Eunice Foote in 1856, or the more commonly cited work of John Tyndall in 1861 (Jackson, 2020). However, as discussed in Fischer and Knutti (2016) the first climate models demonstrating robust changes in global temperatures and humidity in response to rising CO_2 concentrations emerged in the 1960s and 1970s, while only in the late 1980s did the first published evidence demonstrate that heavy rainfall responds differently to a warming atmosphere than annual mean rainfall. Even from a scientific perspective alone, there is thus a spectrum of possible counterfactual baselines and thus 'foreseeability' ranging from the early 1850s through to the late 1980s.

Selecting a historical time-period as a counterfactual experiment when the climate during that period has already been heavily influenced by the radiative forcing of preceding emissions, creates challenges. For example, regional temperatures in the 1960s and 1970s were heavily influenced by significant aerosol emissions associated with European air pollution, which peaked during this period, offsetting some greenhouse-gas-induced warming. In other parts of the world we still see masking of warming effects from aerosols (Kumari et al., 2019; van Oldenborgh et al., 2018). Open questions consequently arise about which radiative forcing attributable to fossil fuel use should be incorporated into an attribution framework, particularly if the climate change signal associated with these different forcings act in opposing directions and persist for different lengths of time. There remains ambiguity over which anthropogenic contributors to radiative forcing are relevant in the legal context and should therefore be included in assessing defendants' contributions to climate impacts. The importance of these (non-scientific) choices for calculations of historical contributions to global warming, is discussed in depth by Skeie et al. (2017).

These considerations are potentially important to prove an actual causal nexus and almost certainly important to be aware of in the context of arguments from the defendant but probably not ultimately decisive. They are however relevant with respect to whether losses are foreseeable and thus in the context of arguing if a defendant acted negligently and much of the literature regarding climate litigation has focussed on this aspect (Franta, 2021).

4.3 | General causation and concrete causal nexus

Acknowledging the challenges in determining the counterfactual and thus deducing when the emissions of a tortfeasor will cause an injustice, two ways to develop a concrete causal nexus emerge.

The first, particularly for some types of extremes and continuously changing slow-onset events, highlighted in red in Figure 1, is to employ attribution techniques in a legal setting using a 'but for' counterfactual reasoning (Hannart et al., 2015; Minnerop & Otto, 2020; Otto et al., 2017). In this setting, a counterfactual experiment would consider model simulations comparable to the present-day climate, *but for* the cumulative emissions associated with that individual tortfeasor. Of course, since the emissions associated with even the largest tortfeasor make up a small fraction of global emissions, the harm for which they are responsible will not be detectable for all types of extreme events. For example, using nationwide emissions as potential tortfeasors Otto et al. (2017), for example, showed that for a specific extreme rainfall event the attributable signal was not significant.

Directly assessing the contribution to harm by conducting an event attribution study is in many cases arguably the physically most accurate approach, but not always feasible and not necessarily the most equitable, for example for a slow-onset event where there is a long lag-time between emissions and impacts (Stuart-Smith, Roe et al., 2021). An alternative option to apportion historic contributions from individual emitters to harm in such circumstances is employing a market share approach as has been suggested in *Lluyia v RWE* for example.

This means that the evidence required for the causal nexus and the strategy to prove the causal chain depends on the type of damages, and the specific elements of the causal chain depicted in Figure 1, and also the strength of the climate change signal. For a scientifically sound and fair legal reasoning that encompasses the entire causal chain, including attributing a specific climate related impact to a specific emitter, a high scientific understanding is crucial in individual cases, and this will influence but also depend upon how specific causation is framed and understood beyond the

concrete case at hand. The discourse about the causal nexus in court and across society is interactive and interdependent.

5 | ADDRESSING THE POSSIBLE COUNTERARGUMENT: FEATURES OF THE PLAINTIFF

Generally, tort law is agnostic in respect of the vulnerability of the victim, unless there is a legally relevant contribution of the victim to the damage that has occurred. The relevant analogies from, for example, toxic torts, are for cases where the losses result from a source people are in regular contact with but where the breach of duty can lie in the fact that, for example, an employer failed to provide changing facilities which led to a prolonged exposure to a harmful substance. In those circumstances, an underlying vulnerability of the employee will not reduce the responsibility of the employer. This could be different if the employee would neglect own duties of due diligence.

Similarly, in the context of climate change, losses from extreme weather and climate-related events or disasters are caused by a complex interaction between social, political and institutional, economic factors and natural hazards. Climate change adds to this by changing the intensity and likelihood of natural hazards to which plaintiffs are exposed, and vulnerabilities are often pre-determined by a variety of different factors (sometimes including climate change which leads to a spiralling effect of exposure and vulnerabilities) (Stone et al., 2021).

In other cases, the natural hazards only exist because of human-caused climate change, a situation that is comparable to cases where the legal principle of taking 'victims as they find them', also known as the eggshell skull or thin-skull rule (Aman, 1993), will apply. This general rule states that the varying degrees of vulnerability, including the potential of very high vulnerability of the plaintiff, is a risk the tortfeasor is generally expected to carry, unless it can be shown that the harm either in full or partially would have occurred anyway.

While natural hazards exist, climate change can alter them, for example in terms of their intensity and frequency The question is thus whether the traditionally conceived 'thin-skull rule' allows the defendants to evade their responsibility with the argument that that natural hazards can occur also independently of anthropogenic climate change – in other words, the harm would have occurred anyway.

We argue that there is a different side to this argument. The fact that vulnerabilities are often created by climate change, makes the case even stronger in those situations. Not only the general risk for the plaintiff has changed through climate change, but also the concrete risk of loss because of further climate change impacts. In those circumstances, climate change perpetuates and exacerbates the underlying vulnerabilities. This is in fact a very similar iterative process that shaped the thin-skull-rule, where the heightened risk and the extent of the harm are influenced through pre-existing conditions. To use an analogy in the public health sector, if an underfunded public health service has led to a deterioration of the general health across the population and the population is subsequently exposed to a public health emergency such as a pandemic, the effect of the pandemic on the population might exceed the effects it would have had in a situation of general good health. However, this does not diminish the responsibilities of those who control risk-spheres, on the contrary, it amplifies it.

Counterarguments have been brought though. In particular, as economic development usually leads to decreasing vulnerability, it could thus be argued that fossil fuel burning and the economic development it allowed has in fact lowered vulnerability and thus damages. While it has been shown, particularly in relation to adaptation finance, that this is a flawed argument and does not mean that emitters do not have responsibility for harm caused by greenhouse gas emissions it also does not mean that vulnerability is irrelevant and local governments can wash their hands of management failure (Colenbrander et al., 2018; Nalau et al., 2015; Raju et al., 2022).

In fact, the questions that arise with respect to vulnerability and thus the features of the plaintiff in climate litigation are very similar to those discussed in the context of loss and damage from climate change.

With the realisation that there are many adverse impacts already occurring and that adaptive limits exist and develop further due to the delay in mitigation, the concept of Loss and Damage has been introduced into the United Nations Framework Convention on Climate Change (UNFCCC) climate negotiations where it became an independent pillar alongside adaptation and mitigation under the UNFCCC in the Paris Agreement (Article 8; UNFCCC (United Nations Framework Convention on Climate Change), 2015). Loss and Damage have been discussed for decades in the context of international climate negotiations, but never been formally defined.

In fact, there are widely differing views of what constitutes Loss and Damage amongst negotiators (Boyd et al., 2017) ranging from the attributable losses and damages of human-induced climate change to any past and future losses and damages associated with climate-related natural hazards. The differences between these interpretations are to a large degree whether the role of the big historical emitters of greenhouse gases in contributing to changing hazards and leading to losses and damages, is considered to be important or not. For actually addressing loss and damages there are good arguments for both interpretations

as there are important differences between remedial responsibility and outcome responsibility (Wallimann-Helmer et al., 2019).

However, for the development of the superstructure narrative, even acknowledging the concept of loss and damage elevates its significance and it stresses that loss does occur. With the emergence of loss and damage, the law is challenged – who bears the responsibilities for harm caused by major emitters? Can the law contribute to organising responsibilities in this area, given that emitting greenhouse gases per se is not unlawful? Scientifically evidencing the specific causality challenges the law, because it provides the evidence that could allow to allocate responsibilities for harm. Alleviating the pressure on those who suffered the harm and thereby, create justice, is law's core function. Increasingly, there is recognition that scientific evidence from attribution science serves as an important basis for identifying Loss and Damage in particular when addressing remedial responsibility and restitution (Mechler et al., 2020; Minnerop & Otto, 2020; Thompson & Otto, 2015), even though the exact interpretation of what constitutes Loss and Damage is still highly controversial as well as the role of attribution in building resilience (Hulme, 2020).

Allocating responsibility for harm does not always involve a breach of a duty or unlawful action. It can be sufficient that the situation that has occurred as a result of the lawful activity is unlawful. In the case *Lliuya v RWE*, pending before the Higher Court of Appeal in Hamm at the time of writing, a claim is brought under German nuisance law (section 1004 Civil Code). The plaintiff claims that the increased risk of flooding represents a disturbance of his property and the largest German energy provide RWE is partially responsible for this flood risk. The argument here is that the size of the increased flood risk is determined in part by the additional hazard which can be linked to anthropogenic climate change, while recognising that systemic vulnerability and exposure of who and what is being harmed of course plays a role in the magnitude of the absolute damages.

Despite this framing, vulnerability has been brought forward in the academic literature as important when commenting on the case, with Huggel et al. (2020) attempting a thorough assessment of the drivers of vulnerability in the case of the city of Huaraz (*Lliuya v RWE*), noting inter alia that the Spaniards in the 16th century founding the city in its current location exposed it to flooding. True though this may be, it does not answer the question if the concrete harm would have happened in the absence of human influence on the climate. However, this is the crucial question in this situation that does not forbid those concurrent causes can exist. A recent study has demonstrated that the flood hazard to which Huaraz is exposed (Emmer & Vilímek, 2013; Somos-Valenzuela et al., 2016) has increased substantially with climate change (Stuart-Smith, Roe et al., 2021). Thus, finding that vulnerability is high, as argued above, does not diminish the additional contribution to the risk that is caused by GHG emissions, provided this contribution is measurable. Underlying vulnerability is not an argument that allows the defendant to evade the responsibility for this additional contribution.

While providing no argument in favour of the defendant (note that RWE is no tortfeasor), looking at other drivers of the loss is per se not misplaced in the context of climate litigation. It is not always possible to causally link losses to climate change. For some economic losses and health impacts this is comparatively straightforward (Clarke et al., 2021; Frame et al., 2020) but in many cases will only be partly possible, if at all, and in particular for non-economic losses (Serdeczny, 2019).

However, even in such cases, a general causal link between climate change and vulnerabilities can exist, and acknowledging this requires using and referring to normative concepts and ideas, implicitly and explicitly, on the value of nature, acceptable levels of inequality, etc. (Adger et al., 2018).

While anthropogenic climate change influences hazards/extreme events, vulnerability influences the magnitude of impacts that affect some communities disproportionately. Disasters hardly ever occur without vulnerability and this is primarily driven by socio-political and economic structures (Wisner et al., 2012). One of the challenges within the social sciences of disaster research is the lack of research on disentangling drivers of vulnerability. Therefore, there is insufficient disaggregated data on vulnerability and there are numerous factors impacting vulnerability and risk creation. Vulnerability is complex and created at multiple levels- ranging from structural practices at the local level to global economic paradigms. These processes are very often deliberate and have created and exacerbated disaster risk and vulnerability over a long period of time (Lewis & CICERO, 2012). While the responsible parties for increase in vulnerability and climate change can be identical (e.g., developed nations), they can also be very different and the relevant time horizons vary as well. Currently, there is too little research in meaningfully assessing these responsibilities in individual cases from a literature basis.

This begs the question, is it necessary for successful climate litigation to provide a thorough literature basis on disentangling drivers of vulnerability first?

The answer depends on the circumstances of each case. However, it is important to note that with the shifting of the superstructure narrative towards a firm recognition of concrete climate change losses as an injustice, and the recognition of science and the law's ability to evidence specific chains of causality. As long as we can measure, quantitatively or qualitatively, the increase in risk or the damage, and demonstrate all

elements of the causal chain, the plaintiffs' vulnerability is of little legal concern (Minnerop & Otto, 2020). When a specific chain of causality can be evidenced, vulnerability assessments and the fact that multiple drivers of damages exist are not legally relevant to establish justiciability and standing. When the causal chain has evidentiary gaps because multiple causal factors that cannot be scientifically disentangled, for example because data and models are of poor quality, vulnerability cannot be ignored (Raju et al., 2022). These latter cases are not automatically predestined to fail but do need to take vulnerability into consideration when evidencing the chain of causality in a very similar way as is argued in the context of loss and damage and non-economic losses in particular. This clearly requires more research on the interplay of exposure, vulnerability and hazard in concrete harm. In the same way specific causality will only be successfully tested in legal contexts when general knowledge of the scientific basis is given in the legal profession, the role of vulnerability and standard of assessment will need to penetrate from scientific specialist knowledge to the courts. Thus, these types of cases will likely not be successful until the use of state-of-the-art science in lawsuits has progressed (Stuart-Smith, Otto et al., 2021) but for climate litigation where the causal nexus can be evidenced in a scientifically sound way, the vulnerability of the plaintiff and any potential difficulties in assessing it are legally and scientifically no hindrance.

6 | CONCLUSION

Resolving the complexity of climate change demands deep societal changes, and neither law nor science can bring this change about 'unilaterally'. Climate litigation has triggered political and legal changes already, however, the general 'fate' of climate litigation will only change in parallel with changes in the superstructure narrative within which the law operates. While important steps towards recognition of climate change as an issue of injustice, and hence a topic for the courts, has made huge progress, we have shown that recognising a reliable concept of losses and damages (independent of UNFCCC processes) as well as the control of riskspheres in the context of climate change is still missing. Court rulings and political decisions today primarily continue to frame climate change as a predominantly future problem (Section 2). Changing this framing will require wide access to climate education on the science/law intersection across nations and generations, including civil society and stakeholders. This includes the information that climate science is indeed capable to provide the proof that losses of an individual plaintiff can in some circumstances be attributed to a specific emitter. In turn, this would also send a strong signal to societies and enter the political debate that surrounds the climate crisis. Successful lawsuits send a strong signal to courts in other jurisdictions (Minnerop & Røstgaard, 2021) and to governments as well as major emitters. Especially for the latter much effort is spent in developing strategies to avoid the litigation risk. For many climate vulnerable communities and states, much more is at stake. A case that successfully uses climate science contributes to re-defining the normative superstructure in which climate change is adjudicated.

It is important to recognised that; (i) the fact that it is possible to evidence the whole chain of causality in many cases; but (ii) not every impact of an extreme weather or climate-related event is due to climate change and there are cases for which it is currently not possible to demonstrate a causal link across all elements. This is essential to disentangle misfortune from injustice in the context of climate change. Climate change already has a huge impact on society, particularly on the most vulnerable and the costs are enormous. This knowledge stems however from in depth studies and strong evidence on some impacts in some parts of the world, and some sectors (Frame et al., 2020; Hansen et al., 2016). Therefore, this knowledge is not comprehensive nor comparable across different countries or sectors and currently, there is no overview, no comprehensive inventory of the impacts of climate change, making these facts invisible for most of society. This is very much in contrast to the other end of the causal chain, where we do have an inventory of emissions at the country level and agreed upon metrics to measure these (Calvo Buendia et al., 2019). This lack of globally agreed metrics on climate impacts makes it harder for individuals to judge pieces of evidence independent of where the burden of proof lies. In particular when considering that the existing scientific evidence is looked at in the context of decades of the politicised framing of climate science and deliberate miscommunication (Franta, 2021; Supran & Oreskes, 2021).

Climate science is not more or less uncertain in itself compared to other scientific disciplines that are used to provide evidence in court but the doubts in the science have been sown very efficiently, thus characteristics of climate science are seen as an obstacle to causation, including by climate scientists (Lloyd et al., 2021). This point should not be underestimated. If climate litigation is to be conceived as any other litigation scenarios where scientific evidence is at the core of the claim, the narrative and thus, public perception, around climate science and the legal response to it must change. It needs to be aligned with these other cases where scientific evidence is determining the outcome of litigation, if the criteria of the law are met and if law's objective to deliver fair and just outcomes is also fulfilled. The latter point is important for the framing of criteria, which especially in tort law cases, has led courts to soften thresholds through normative correctives (see asbestos examples) in order to serve the injured party justice.

A key challenge to change the fate of climate litigation is thus communication, as with other aspects of climate change (Leombruni, 2015), and discussed in Section 2. This does not mean that there are no other challenges, legally and scientifically, in the latter case particularly in attribution and vulnerability, or that they are not important. However, without a broad acceptance and realisation that proof is possible advances in these areas, that are happening all the time, will likely not be enough.

These communication efforts are ultimately a mission for the whole climate community however, there are steps to take for legal scholars, scientists and practitioners working on climate litigation. As we have seen with the broader acceptance of climate change as an issue to be dealt with in all parts of society, it needed the mobilisation and voices of those outside the science to achieve it (Eide & Kunelius, 2021). Lawsuits on climate frequently get media coverage but rarely is this used to discuss the science underlying the cases or the reasons for their dismissal. The reason that the science has not been the immediate reason for their lack of success (Burger et al., 2020) could offer huge opportunities to change the popular conception of these legal struggles at a time when journalists are looking for comment from people with expertise.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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ENDNOTES

[1] Gloucester Resources Limited v Minister for Planning [2019] NSWLEC 7.

[2] https://chr.gov.ph/wp-content/uploads/2022/05/CHRP-NICC-Report-2022.pdf

[3] https://www.politico.eu/article/greta-thunberg-climate-change-activism-fridays-for-future-profile-doesnt-want-you-to-talk-about-her-anymore-2022/

[4] https://unfccc.int/sites/default/files/resource/cop26_auv_2f_cover_decision.pdf

[5] Order of the First Senate of the Court (Beschluss des Ersten Senats), 24 March 2021, 1 BvR 2656/18—paras 1–270, published on 29 April 2021. The full German version is available at accessed 22 November 2021; a shorter English version is available at accessed 22 November 2021 (hereinafter BVerfG); references are made to the English translation. Decisions of the Federal Constitutional Court are available here accessed 22 November 2021.

[6] R (on the application of Friends of the Earth Ltd and others) (Respondents) v Heathrow Airport Ltd (Appellant)[2020] UKSC 52. On appeal from: R (on the application of Plan B Earth) v Secretary of State for Transport [2020] EWCA Civ 214.

[7] https://unfccc.int/sites/default/files/resource/cmp16_auv_2c_cover%20decision.pdf

[8] https://www.ldc-climate.org/press_release/least-developed-countries-group-react-to-cop26/

REFERENCES

Adger, W.N., Brown, I. & Surminski, S. (2018) Advances in risk assessment for climate change adaptation policy. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 376(2121), 20180106.

Allen, M.R. (2003) Liability for climate change. *Nature*, 421(6926), 891–892.

Aman, A.C. (1993) The earth as eggshell victim: a global perspective on domestic regulation. *The Yale Law Journal*, 102(8), 2107–2122.

Blaikie, P., Cannon, T., Davis, I. & Wisner, B. (1994) *At risk: natural hazards, people's vulnerability and disasters*. Routledge.

Boyd, E., James, R.A., Jones, R.G., Young, H.R. & Otto, F.E.L. (2017) A typology of loss and damage perspectives. *Nature Climate Change*, 7, 723–729.

Bonneuil, C., Choquet, P.-L. & Franta, B. (2021) Early warnings and emerging accountability: total's responses to global warming, 1971–2021. *Global Environmental Change*, 71, 102386. Available from: https://doi.org/10.1016/j.gloenvcha.2021.102386

Boyd, E., Chaffin, B.C., Dorkenoo, K., Jackson, G., Harrington, L., N'Guetta, A. et al. (2021) Loss and damage from climate change: a new climate justice agenda. *One Earth*, 4, 1365–1370. Available from: https://doi.org/10.1016/j.oneear.2021.09.015

Brueggemann, M. & Roedder, S. (Eds.) (2020) *Global warming in local discourses: how communities around the world make sense of climate change*.

Burger, M., Wentz, J. & Horton, R.M. (2020) The law and science of climate change attribution. *Columbia Journal of Environmental Law*, 45(57), 57–88.

Calvo Buendia, E., Tanabe, K., Kranjc, A., Jamsranjav, B., Fukuda, M., Ngarize, S. et al. (2019) *IPCC 2019, 2019 refinement to the 2006 IPCC guidelines for national greenhouse gas inventories*.

Cassegård, C., Soneryd, L., Thörn, H. & Wettergren, Å. (Eds.) (2017) *Climate action in a globalizing world comparative perspectives on social movements in the global north*. Routledge.

Cattiaux, J. & Ribes, A. (2018) Defining single extreme weather events in a climate perspective. *Bulletin of the American Meteorological Society*, 99(8), 1557–1568.

Clarke, B.J., Otto, F.E.L. & Jones, R.G. (2021) Inventories of extreme weather events and impacts: implications for loss and damage from and adaptation to climate extremes. *Climate Risk Management*, 32, 100285.

Colenbrander, S., Dodman, D. & Mitlin, D. (2018) Using climate finance to advance climate justice: the politics and practice of channelling resources to the local level. *Climate Policy*, 18(7), 902–915.

Crawley, S., Coffé, H. & Chapman, R. (2019) Public opinion on climate change: Belief and concern, issue salience and support for government action. *The British Journal of Politics and International Relations*, 22(1), 102–121.

Damert, M. & Baumgartner, R.J. (2018) External pressures or internal governance – what determines the extent of corporate responses to climate change? *Corporate Social Responsibility and Environmental Management*, 25, 473–488. Available from: https://doi.org/10.1002/csr.1473

Dworkin, R.M. (1972) Social rules and legal theory. *The Yale Law Journal*, 81(5), 855–890.

Emmer, A. & Vilímek, V. (2013) Review article: lake and breach hazard assessment for moraine-dammed lakes: an example

from the Cordillera Blanca (Peru). *Natural Hazards and Earth System Sciences*, 13(6), 1551–1565.
Eide, E. & Kunelius, R. (2021) Voices of a generation the communicative power of youth activism. *Climatic Change*, 169, 6. Available from: https://doi.org/10.1007/s10584-021-03211-z
Fischer, E.M. & Knutti, R. (2016) Observed heavy precipitation increase confirms theory and early models. *Nature Climate Change*, 6(11), 986–991.
Frame, D.J., Wehner, M.F., Noy, I. & Rosier, S.M. (2020) The economic costs of hurricane harvey attributable to climate change. *Climatic Change*, 160, 271–281.
Franta, B. (2021) Early oil industry disinformation on global warming. *Environmental Politics*, 31:4 555–575.
Hannart, A., Pearl, J., Otto, F.E.L., Naveau, P. & Ghil, M. (2015) Causal counterfactual theory for the attribution of weather and climate-related events. *Bulletin of the American Meteorological Society*, 97(1), 99–110.
Hansen, G., Stone, D., Auffhammer, M., Huggel, C. & Cramer, W. (2016) Linking local impacts to changes in climate: a guide to attribution. *Regional Environmental Change*, 16(2), 527–541.
Harrington, L.J. & Otto, F.E.L. (2019) Attributable damage liability in a non-linear climate. *Climatic Change*, 153(1), 15–20.
Hart, L.A. & Honore, A.M. (1959) *Causation in the law*. Cambridge: Oxford University Press.
Huggel, C., Carey, M., Emmer, A., Frey, H., Walker-Crawford, N. & Wallimann-Helmer, I. (2020) Anthropogenic climate change and glacier lake outburst flood risk: local and global drivers and responsibilities for the case of Lake Palcacocha, Peru. *Natural Hazards and Earth System Sciences Discussions*, 2020, 1–31.
Hulme, M. (2009) *Why we disagree about climate change: understanding controversy, inaction and opportunity*. Cambridge University Press.
Hulme, M. (Ed.) (2020) *Contemporary climate change debates*. Routledge.
IPCC. (2022) Summary for Policymakers. In: Pörtner, H.-O., Roberts, D.C., Poloczanska, E.S., Mintenbeck, K., Tignor, M. & Alegría, A. (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: Cambridge University Press.
Jackson, R. (2020) Eunice Foote, John Tyndall and a question of priority. *Notes and Records: the Royal Society Journal of the History of Science*, 74(1), 105–118.
Kabir, M.I., Rahman, M.B., Smith, W., Lusha, M.A.F., Azim, S. & Milton, A.H. (2016) Knowledge and perception about climate change and human health: findings from a baseline survey among vulnerable communities in Bangladesh. *BMC Public Health*, 16(1), 266.
Kew, S.F., Philip, S.Y., Jan van Oldenborgh, G., van der Schrier, G., Otto, F.E.L. & Vautard, R. (2019) The exceptional summer heat wave in southern Europe 2017. *Bulletin of the American Meteorological Society*, 100(1), S49–S53.
Kolb, F. (2008) *Protest and opportunities the political outcomes of social movements*. Frankfurt: Campus.
Kumari, S., Haustein, K., Javid, H., Burton, C.A., Allen, M., Paltan, H. et al. (2019) Return period of extreme rainfall substantially decreases under 1.5°C and 2.0°C warming: a case study for Uttarakhand, India. *Environmental Research Letters*, 14, 044033.
Leach, N., Li, S., Sparrow, S., van Oldenborgh, G.J., Lott, F.C., Weisheimer, A. et al. (2020) Anthropogenic influence on the 2018 summer warm spell in Europe: the impact of different spatio-temporal scales. *Bulletin of the American Meteorological Society*, 101, S41–S46.
Leiserowitz, A., Roser-Renouf, C., Marlon, J. & Maibach, E. (2021) Global Warming's Six Americas: a review and recommendations for climate change communication. *Current Opinion in Behavioral Sciences*, 42, 97–103. Available from: 10.1016/j.cobeha.2021.04.007
Leombruni, L.V. (2015) How you talk about climate change matters: a communication network perspective on epistemic skepticism and belief strength. *Global Environmental Change*, 35, 148–161.
Lewis, J., Oslo, C. (Center for I.C. and E.R.) 2012. The Good, The Bad and The Ugly: Disaster Risk Reduction (DRR) Versus Disaster Risk Creation (DRC). *PLoS Curr.* 4, e4f8d4eaec6af8-e4f8d4e-aec6af8. https://doi.org/10.1371/4f8d4eaec6af8
Lloyd, E.A., Oreskes, N., Seneviratne, S.I. & Larson, E.J. (2021) Climate scientists set the bar of proof too high. *Climatic Change*, 165(3), 55.
MacCormick, N. (1978) Does the United Kingdom have a constitution – reflections on MacCormick v Lord Advocate. *Northern Ireland Legal Quarterly*, 29(1 + 2), 1–20.
Maibach, E., Roser-Renouf, C. & Leiserowitz, A. (2009) *Global warming's six Americas 2009: an audience segmentation analysis*.
Marjanac, S. & Patton, L. (2018) Extreme weather event attribution science and climate change litigation: an essential step in the causal chain? *Journal of Energy & Natural Resources Law*, 36(3), 265–298.
Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S., Péan, C., Berger, S. et al. (Eds.) (2021) IPCC, 2021: summary for policymakers. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.
McCormick, S., Simmens, S.J., Glicksman, R.L., Paddock, L., Kim, D., Whited, B. et al. (2017) Science in litigation, the third branch of U.S. climate policy. *Science*, 357(6355), 979–980.
Mechler, R., Singh, C., Ebi, K., Djalante, R., Thomas, A., James, R. et al. (2020) Loss and damage and limits to adaptation: recent IPCC insights and implications for climate science and policy. *Sustainability Science*, 15(4), 1245–1251.
Metag, J., Füchslin, T. & Schäfer, M.S. (2015) Global warming's five Germanys: a typology of Germans' views on climate change and patterns of media use and information. *Public Understanding of Science*, 26(4), 434–451.
Minnerop, P. & Otto, F.E.L. (2020) Climate change and causation – joining law and climate science on the basis of formal logic. *Buffalo Journal of Environmental Law 27*. http://doi.org/10.2139/ssrn.3522519
Minnerop, P. & Røstgaard, I. (2021) In search of a fair share: article 112 Norwegian constitution, international law, and an emerging inter-jurisdictional judicial discourse in climate litigation. *Fordham Int'l LJ*, 44, 847.
Minnerop, P. (2022) The 'advance interference-like effect' of climate targets: fundamental rights, intergenerational equity and the German Federal Constitutional Court. *Journal of Environmental Law*, 34(1), 135–162. Available from: https://doi.org/10.1093/jel/eqab041
Nalau, J., Preston, B.L. & Maloney, M.C. (2015) Is adaptation a local responsibility? *Environmental Science & Policy*, 48, 89–98.
Noonan, D. (2018) Imagining different futures through the courts: a social movement assessment of existing and potential new approaches to climate change litigation in Australia special issue: imagining a different future, overcoming barriers to climate justice. *University of Tasmania Law Review*, 37(2), 25–69.
O'Keefe, P., Westgate, K. & Wisner, B. (1976) Taking the naturalness out of natural disasters. *Nature*, 260(5552), 566–567.
O'Neill, B., van Aalst, M., Zaiton Ibrahim, Z., Berrang Ford, L., Bhadwal, S., Buhaug, H. et al. (2022) Key risks across sectors and regions. In: Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A. et al. (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. in press.
Otto, F.E.L., Massey, N., van Oldenborgh, G.J., Jones, R.G. & Allen, M.R. (2012) Reconciling two approaches to attribution of the 2010 Russian heat wave. *Geophysical Research Letters*, 39(4), L04702.
Otto, F.E.L., van Oldenborgh, G.J., Eden, J., Stott, P.A., Karoly, D.J. & Allen, M.R. (2016) The attribution question. *Nature Climate Change*, 6, 813–816.
Otto, F.E.L., Skeie, R.B., Fuglestvedt, J.S., Berntsen, T. & Allen, M.R. (2017) Assigning historic responsibility for extreme weather events. *Nature Climate Change*, 7, 757–759.
Peczenik, A. (1989) The doctrine of the sources of the law. In: Peczenik, A. (Ed.) *On law and reason*. Dordrecht: Springer, pp. 313–371.
Pfrommer, T., Goeschl, T., Proelss, A., Carrier, M., Lenhard, J., Martin, H. et al. (2019) Establishing causation in climate litigation: admissibility and reliability. *Climatic Change*, 152(1), 67–84.
Philip, S., Kew, S., van Oldenborgh, G.J., Otto, F., Vautard, R., van der Wiel, K. et al. (2020) A protocol for probabilistic extreme event attribution analyses. *Advances in Statistical Climatology, Meteorology and Oceanography*, 6, 177–203.
Rajamani, L. & Bodansky, D. (2019) The Paris rulebook: balancing international prescriptiveness with national discretion. *International and Comparative Law Quarterly*, 68(4), 1023–1040. Available from: https://doi.org/10.1017/S0020589319000320
Raju, E., Boyd, E. & Otto, F.E.L.O. (2022) Stop blaming the climate for disasters. *Communications Earth & Environment*, 3, 1–2.
Roe, G.H., Baker, M.B. & Herla, F. (2017) Centennial glacier retreat as categorical evidence of regional climate change. *Nature Geoscience*, 10(2), 95–99.
Seneviratne, S.I. & Hauser, M. (2020) Regional climate sensitivity of climate extremes in CMIP6 vs CMIP5 multi-model ensembles. *Earth's Future*, 8, e2019EF001474. Available from: https://doi.org/10.1029/2019EF001474
Seneviratne, S.I., Zhang, X., Adnan, M., Badi, W., Dereczynski, C., Di Luca, A. et al. (Eds.) (2021) I.P., 52, 54, 53 Date: August 2021, 55 this document is subject to copy-editing, corrigenda and trickle backs. & 345, 11–1 Total pages: 2021, Weather and climate extreme events in a changing climate. In: V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger et al. (Eds.) *Climate change 2021: the physical science climate, contribution of working group I to the sixth assessment report of the intergovernmental panel on change*. Cham, Switzerland: Cambridge University Press.
Serdeczny, O. (2019) Non-economic loss and damage and the warsaw international mechanism. In: Mechler, R., Bouwer, L.M., Schinko, T., Surminski, S. & Linnerooth-Bayer, J. (Eds.) *Loss and damage from climate change: concepts, methods and policy options*. Springer International Publishing, pp. 205–220.
Shklar, J. (1990) *The faces of injustice – storrs lectures on jurisprudence*. Yale University Press.
Skeie, R.B., Fuglestvedt, J., Berntsen, T., Peters, G.P., Andrew, R., Allen, M. et al. (2017) Perspective has a strong effect on the calculation of historical contributions to global warming. *Environmental Research Letters*, 12(2), 24022.
Somos-Valenzuela, M.A., Chisolm, R.E., Rivas, D.S., Portocarrero, C. & McKinney, D.C. (2016) Modeling a glacial lake outburst flood process chain: the case of Lake Palcacocha and Huaraz, Peru. *Hydrology and Earth System Sciences*, 20(6), 2519–2543.
Stone, D.A., Rosier, S.M. & Frame, D.J. (2021) The question of life, the universe and event attribution. *Nature Climate Change*, 11, 276–278.
Stuart-Smith, R.F., Otto, F.E.L., Saad, A.I., Lisi, G., Minnerop, P., Lauta, K.C. et al. (2021) Filling the evidentiary gap in climate litigation. *Nature Climate Change*, 11(8), 651–655.
Stuart-Smith, R.F., Roe, G.H., Li, S. & Allen, M.R. (2021) Increased outburst flood hazard from Lake Palcacocha due to human-induced glacier retreat. *Nature Geoscience*, 14(2), 85–90.
Supran, G. & Oreskes, N. (2021) Rhetoric and frame analysis of ExxonMobil's climate change communications. *One Earth*, 4, 696–719.
Thompson, A. & Otto, F.E.L. (2015) Ethical and normative implications of weather event attribution for policy discussions concerning loss and damage. *Climatic Change*, 133(3), 439–451.
Tuori, K. (2002) *Legislation between politics and law. Wintgens L. Legisprudence: a new theoretical approach to legislation*. Oxford-Portland: Hart Publishing.
UNFCCC (United Nations Framework Convention on Climate Change) (2015) *Paris agreement*.
van den Berg, H.J. & Keenan, J.M. (2019) Dynamic vulnerability in the pursuit of just adaptation processes: a Boston case study. *Environmental Science & Policy*, 94, 90–100.
van Oldenborgh, G.J., Philip, S., Kew, S., van Weele, M., Uhe, P., Otto, F. et al. (2018) Extreme heat in India and anthropogenic climate change. *Natural Hazards and Earth System Sciences*, 18(1), 365–381.
van Oldenborgh, G.J., van der Wiel, K., Kew, S., Philip, S., Otto, F., Vautard, R. et al. (2021) Pathways and pitfalls in extreme event attribution. *Climatic Change*, 166(1), 13.
Vanhala, L. (2018) Shaping the structure of legal opportunities: environmental NGOs bringing international environmental procedural rights back home. *Law & Policy*, 40(1), 110–127.
Vautard, R., Van Aalst, M., Boucher, O., Drouin, A., Haustein, K., Kreienkamp, F. et al. (2020) Human contribution to the record-breaking June and July 2019 heatwaves in Western Europe. *Environmental Research Letters*, 15(9). 094077
Wallimann-Helmer, I., Meyer, L., Mintz-Woo, K., Schinko, T. & Serdeczny, O. (2019) The ethical challenges in the context of climate loss and damage. In: Mechler, R., Bouwer, L.M., Schinko, T., Surminski, S. & Linnerooth-Bayer, J. (Eds.) *Loss and damage from climate change: concepts, methods and policy options*. Cham, Switzerland: Springer International Publishing, pp. 39–62.
Williams, G. (1961) Causation in the Law. *Cambridge Law Journal*, 19(1), 62–85.
Wisner, B., Gaillard, J.C. & Kelman, I. (2012) Framing disaster: theories and stories seeking to understand Hazards. In: *Handbook hazards disaster risk reduction*. Routledge, pp. 18–34.
Yiou, P., Cattiaux, J., Faranda, D., Kadygrov, N., Jézéquel, A., Naveau, P. et al. (2020) Analyses of the Northern European summer heatwave of 2018. *Bulletin of the American Meteorological Society*, 101, S35–S40.

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