PROBABILISTIC EVENT ATTRIBUTION AND THE BEST-CASE SCENARIO FOR A SUCCESSFUL CLIMATE TORT IN THE UNITED KINGDOM

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MSc Dissertation

2015

This dissertation is submitted in partial fulfilment of the requirement for the *Master of Science in Nature, Society and Environmental Policy* at the University of Oxford.

Word Count: 14,814

Word Count excludes Cover Page, Acknowledgments, Abstract, Table of Contents, and References.

Acknowledgments:

To my family and friends: thank you for your love, support, and patience.

To my supervisor: thank you for your time, advice, and valuable mentorship.

To my course directors / lecturers: thank you for an insightful and memorable year.

Abstract: Litigation has emerged as a means to hold industry and government liable for damages rendered by climate change, but has been historically unavailable to victims of extreme weather events. While such events are not definitively attributable to human action, ‘Probabilistic Event Attribution’ science can calculate the risk of a weather event occurring due to anthropogenic climate change. This dissertation explores how this science could provoke climate torts in the UK by considering potential scenarios. A public nuisance action following a heatwave offers the best chance of success, because it can include more litigants and heatwaves often have stronger attribution studies. However, establishing causation remains an obstacle for climate torts. This dissertation also examines climate cases in other countries and discusses potential ramifications, including impacts on investor decision-making, lost assets, and shifts in intergovernmental climate policy. It concludes with steps forward, including raising test cases and progressing event attribution science.

Word Count: 149

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1. INTRODUCTION

According to the 5th Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), humans are now “unequivocal[ly]” warming the earth’s climate system. Between 1880 and 2012, overall mean temperatures increased by 0.85°C (Stocker et al. 2014: 4), the key cause being “increasing greenhouse gas [GHG] concentrations in the atmosphere” (Ibid.: 15). The AR5 states that by 2020, we will have burned through enough carbon to surpass a warming threshold of 1.5°C degrees at current emissions rates (Ibid.: 20).

It is clear that the world is not on track to stay below the 2°C threshold established at the 15th Session of the Conference of Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2009. It appears more likely that the world will face major impacts from climate change, including increases in the frequency and magnitude of heatwaves, heavy precipitation events, and other incidents of extreme weather (Stocker et al. 2014: 5).

Damages will occur, and countries are already exploring avenues to address loss and damages resulting from the impacts of climate change, including slow onset events and extreme weather events. At COP 19 in Poland (2013), the UNFCCC established the Warsaw International Mechanism for Loss and Damages associated with Climate Change Impacts (i.e. the Loss and Damage Mechanism): a series of approaches guided by a collaborative effort between international governments and relevant stakeholders to address loss and damage (United Nations Framework Convention on Climate Change 2013). These approaches broadly include enhancing knowledge about climate-related losses and damages, improving and facilitating dialogue between stakeholders, and strengthening responses to adverse effects (Ibid.). The Loss and Damage Mechanism primarily seeks to assist developing countries that are particularly vulnerable to the impacts of climate change.

Alongside such mechanisms, private actors have already sought to take matters in their own hands through climate tort litigation to remedy the damages they have sustained and to prompt more aggressive climate action on behalf of governmental

and industrial actors. Private climate change lawsuits have recently and successfully materialised in a number of countries. In the United States, four major cases have been filed against various parties on the basis that their GHG emissions constitute a public nuisance. No case yet has succeeded. However, arguably the most successful case, *American Electric Power v. Connecticut* (2011), made it to the U.S. Supreme Court, as claimants sought for an injunction against power plants on the basis that their emissions constituted a common law nuisance. In the Netherlands, under the leadership of a sustainable non-profit, 900 co-plaintiffs successfully sued the Dutch government on the basis that current climate goals and policy were insufficient in remedying the impacts of climate change and keeping global temperatures beneath the 2°C threshold (Urgenda 2015). Following suit, a case with over 9,000 co-plaintiffs in Belgium has since emerged, calling for a 40% cut in GHG emissions (from 1990 levels) by 2020 (Climate Case, 2015). More litigation seems likely in the future.

A plausible trigger for climate litigation would be an extreme weather event. However, there are substantial barriers to establishing liability and causation in such cases (Kaminskaitė-Salters 2010; Lord et al. 2012). Scholars have, thus far, largely dismissed the likelihood of a successful climate tort case following an extreme weather event because of the challenges with proving “causation” given the variability of the weather day-to-day. However, new scientific approaches have since surfaced, suggesting it may be possible to prove that such weather events are in some sense caused by human action; that the “weather dice” were indeed loaded (Otto et al. 2013). The science of Probabilistic Event Attribution (PEA), developed over the last decade, employs computer-based modelling to provide probabilistic evidence that an extreme weather event might be attributable to climate change (Allen 2003). This dissertation explores the potential for such methods from the physical sciences, combined with recent development in legal jurisprudence, to open the door for victims of climate-related extreme events to pursue private lawsuits for compensation for damages.

There is great potential for successful climate lawsuits, especially tort litigation. The avenue of tort is examined closely in this dissertation precisely because it provides citizens with the opportunity to provoke changes in policy making and industry behaviour that might not otherwise be achieved through legislative action (Peñalver 1998). However, raising, let alone winning, a case on the basis that a weather event was induced by anthropogenic climate change requires a fertile and effective combination of science and law. There are a number of particularly interesting questions to address in each area, including (but not limited to) how confidently such a science can ascertain that an extreme weather event was more or less likely to occur due to climate change, how probabilistic evidence should be considered and applied in legal cases, who should be held liable and how, and subsequently what societal ramifications emerge at the nexus of event attribution science and tort law.

This dissertation explores and addresses these questions, examining how PEA may put victims of extreme weather events in a position to bring GHG emitters to court and thus improve the chances of such a climate tort coming to fruition. This requires a methodological approach that carefully considers the physical science of PEA and applies it through the legal framework and jurisprudence of climate tort litigation. Two event attribution studies, one of the 2003 European heatwave and the other of the 2000 flooding of England and Wales, are reviewed closely and funneled through the elements of tort law as it is laid out in English common law. The United Kingdom is selected as a case study for climate torts for a couple of reasons: (1) because no climate litigation, let alone climate torts, has been filed in the country as of yet, and (2) because the UK is home to many of the climate scientists working on PEA, and consequently offers some of the most detailed event attribution studies in all of the literature. The 2000 floods and 2003 heatwave are selected because: (1) rigorous attribution studies have been performed for these specific events and are useful for examination, and (2) heatwaves and floods are two commonly occurring extreme weather events in the UK and are thus relevant for observation. As there are various causes of action that can be raised in tort law, the jurisprudential analysis is limited to actions of *negligence* and *public nuisance,* primarily because they are largely

regarded as the best opportunities for plaintiffs to raise a climate tort within the UK (Kaminskaitė-Salters 2010).

In examining these questions, this dissertation fills a gap in climate litigation and PEA literature. Climate litigation literature has applied tort principles to climate change (Peñalver 1998; Grossman 2003) and has examined the prospects of a climate tort in the UK (Kaminskaitė-Salters 2010; see Sections 2.1-2.2), but does not consider extreme weather events. Furthermore, PEA literature has addressed the role of the science in the courts, but only insofar as to how it ought to be communicated (Allen et al. 2007) and obstacles in the way of its application (Lord et al. 2012; see Section 3.2). This work covers new ground by directly applying PEA studies through a UK tort law framework, taking into account more recent case law and international legal developments. It also more thoroughly considers the potential ramifications of a successful climate tort than has been the case in previous works. Overall, it advances the fields of PEA and climate litigation by identifying and exploring the nexus between the two, ultimately offering a best-case scenario for a case to emerge in the UK.

This dissertation is organised as follows: Section 2 discusses the jurisprudence of climate torts. This discussion includes a review of academic and legal literature and lists the elements of negligence and public nuisance causes of action. It is followed by an overview of the physical science of PEA in Section 3, including a review of relevant literature and prominent event attribution studies. Section 4 briefly discusses the potential claimants, defendants, alleged losses and sought remedies of a prospective climate tort in the UK. The two attribution studies of the 2003 heatwaves and 2000 floods are then explained in detail, followed by the testing of their results through negligence and public nuisance actions. The section addresses the primary obstacle faced in such cases, establishing causation, by examining case precedent and the relevant attribution case examples (e.g. asbestos, tobacco). Section 4 concludes with a “best-case scenario,” which would be a public nuisance case raised in the aftermath of a heatwave like that of 2003, since nuisance-based claims include more litigants and because the attribution study indicates a substantially stronger link

between anthropogenic GHG emissions and the occurrence of the heatwave. This is followed by a discussion of the ramifications of a successful climate tort in the UK as it pertains to intergovernmental and industrial actors, and a closer look at other international climate cases in Section 5. The final section identifies the necessary next steps in order to raise a successful climate tort.

Ultimately, this dissertation emphasises the broader directive of climate litigation as a means to rectify the harms that individuals and society will face due to harmful climate change. It is this reality that motivates this dissertation. As American University Law Professor David Hunter explains:

> "… climate change is just another, albeit distinctly modern, common law nuisance, threat to cultural property, or human rights violation… climate change may be global, it may be complex, but climate change is also strangely familiar. Real people, typically those already marginalised with few resources, will suffer real harm because of the activities of others. Isn't this precisely what the law is meant to address?" (Hunter 2007: 2).

2. THE JURISPRUDENCE OF CLIMATE TORTS

As we improve our understanding of the drivers and impacts of climate change, we face questions regarding who is responsible and how they will be held accountable. Litigation has emerged in the literature and courts as a viable means with which to impose liability on public and private actors (e.g. the state, the fossil fuel industry, etc.). There are many avenues of litigation (Lord et al. 2012), though raising a case is difficult as it can be costly and time-intensive (Kaminskaitė-Salters 2010). This dissertation focuses specifically on tort liability, which in common law jurisdictions primarily concerns itself with "civil wrongs" (Jones et al. 2014: Chapter 1, Section 1, citing Birks 1995: 91) that are "breach[es] of duty primarily fixed by the law; such duty [being] towards persons generally and its breach [being] redressible by an action for unliquidated damages" (Ibid., citing Winfield 2013: 32). In other words, a tort is an act that causes damage or loss to someone for which the responsible entity, or tortfeasor, can be held liable. Torts are classified as civil wrongs, as opposed to criminal, largely because they do not necessarily emerge from intentional or illegal actions (i.e. negligence) and because generally a lower burden of proof is required to impose liability (Ibid.). This section provides an overview of how climate torts emerged as a prospective course of action and subsequently discusses the elements that must be met to establish a negligence- or nuisance-based claim.

2.1 Literature Review

Cornell Law Professor Eduardo Peñalver first posited that applying tort principles to climate change could help determine who should bear the costs associated with its impacts (Peñalver 1998: 563). He asserts that the very nature of anthropogenic climate change calls for the application of tort principles, as many of the costs of climate change "take the form of damage to persons and property… a concern that lies at the heart of tort law" (Ibid.). Since particular groups will suffer a disproportionate share of the costs, it follows that those costs could be transferred to other parties. This would potentially provoke policy responses that would be "sensitive to the diversity of *individual* losses" resulting from GHG emissions (Ibid.: 569-570, emphasis added).

Peñalver's argument for tort application is primarily economic: "Reduction of total accident costs is… one of the main goals of tort law… [which] is most logically served by an economic approach" (Ibid.: 571). Since we do not live in a Coasian world with zero transaction costs and perfect consumer knowledge, Peñalver explains that fossil fuel companies are in the better position to bear the costs of the damage they create. Though they might simply internalise the cost by raising the price of fossil fuels, that will drive consumers to alternative energy sources, thus reducing overall fossil fuel consumption and emissions. Alongside his economic analysis, Peñalver notes there is an "irreducibly ethical component to tort liability," and that it is our "notions of justice and fairness" that obligate us to compensate those wrongly harmed by others' negligent actions (Ibid.: 574-575).

He concludes with a discussion of the problems of a tort analysis, the first and foremost issue being causation. In the case of more traditional "toxic torts," both general causation and individual causation must be proved. Peñalver refers to the example of asbestos and lung cancer:

> "General causation involves the question of whether the alleged causal factor can cause the type of effect from which the victim suffers (for example, can asbestos in general cause lung cancer?). The issue of individual causation, however, involves the question of whether the alleged causal factor did indeed cause a particular victim's injury (for example, did asbestos exposure cause *this case* of lung cancer?)" (Ibid.: 579).

The second component, more commonly recognised in tort law frameworks as the 'but for' element of causation, is what presents the greatest problem for toxic torts and for potential climate torts (i.e. would the damage incurred by the victim have occurred but for this event?). Any scientific evidence provided by plaintiffs would be inherently probabilistic (e.g. does asbestos exposure generally increase the risk of developing lung cancer), but tort law prefers deterministic proof of causation and would thus require plaintiffs to show a highly substantial increase in the relative risk

(Ibid.: 580-581). Peñalver concludes that, for a victim of the impacts of climate change, deterministic causation on an individual level will be their greatest obstacle.

In 2003, Harvard Law Professor David Grossman followed up with a more comprehensive application of tort principles to climate change, arguing that this route was not as novel or as radical as it appeared, and that particular causes of action (primarily products liability and public nuisance) could prove to be legally viable tort cases. Grossman uses Peñalver's (1998) arguments to justify the appropriateness of its application and acknowledges outright that issues of certainty and causation are the most substantial obstacles in the way of an emerging climate tort lawsuit. Grossman proceeds to explain in detail how plaintiffs could establish standing in products liability and public nuisance cases, and what sort of relief and damages are available for each of those claims (Grossman 2003). However, Grossman's analysis is limited to the jurisdiction of the United States. Fundamental distinctions between British and American tort law leave Grossman helpful only insofar as he is the first to directly funnel climate change through the elements of particular tort lawsuits and examine its feasibility.

Around the same time, Oxford Professor and climate physicist Myles Allen's "Liability for climate change" (2003) proposed that it should be possible to hold emitters liable for damages related to climate change, particularly in the context of extreme weather events. Allen suggested that providing a probabilistic connection between anthropogenic influence on the climate and the frequency or magnitude of an extreme weather event could be enough in a court of law to impose liability (Allen 2003). Such a development in the scientific community could reduce the great uncertainty Peñalver described when determining how a given event and/or its frequency had anything to do with climate change (Peñalver 1998: 568-569).

Allen and Richard Lord QC's "The blame game" (2004) tackled the "who will pay" question. They argue that event attribution studies showing a substantially increased risk (e.g. double) in the context of the role of human influence in a given weather event might be enough to sway English courts to establish causation in a tort.

Scientific evidence of this sort, they argue, should be sufficient and allowed in the courtroom given favourable judicial discretion (Allen and Lord 2004: 552). While the authors acknowledge that regulatory policy may impede and pre-empt potential litigation, they conclude that the possibility remains for climate litigation to develop: “the argument over who pays for the cost of climate change is here to stay” (Ibid.).

In 2007, Nicola Durrant followed Grossman’s lead and applied tort principles to climate change in an Australian context. Where Durrant breaks new ground is by presenting a hypothetical scenario, looking at a large-scale industrial emitter (e.g. a coal mine or a coal-fired electricity plant), and then determining if a duty of care has been established and breached, and if said breach has caused damage to the plaintiff (Durrant 2007). While Durrant’s analysis is also similar and relevant, Australia’s test for a duty of care in negligence cases is slightly different from the United Kingdom’s test (see Section 2.2). Regardless, it is her application of a given scenario through a tort framework that this dissertation emulates.

However, the paper to which the majority of this dissertation refers is Lithuanian Presidential Chief Adviser Giedrė Kaminskaitė-Salters' comprehensive piece on "Constructing a Private Climate Change Lawsuit under English Law" (2010). She provides an in-depth analysis of all potential tortious avenues that plaintiffs could pursue to determine which would be the most likely to successfully materialise in the UK, including negligence, product liability, private nuisance, and public nuisance. She also defines the different forms and elements of causation, explaining both the opportunities and barriers to establishing a link between action and damage. Kaminskaitė-Salters reaches the conclusion that the most attractive causes of action are *negligence* and *public nuisance*, though each comes with its fair share of obstacles. Causation, as others have argued, is still the greatest obstacle in the way of a climate tort in the UK. Kaminskaitė-Salters delineates the paths to a successful climate change case, but she generally dismisses extreme weather events as a litigative opportunity. An equally comprehensive piece by Salzman and Hunter (2007) provides a similar overview in the context of American law, and details the climate cases that have already emerged in the United States (see Section 5.1).

Lord et al. (2012) provide a more updated and globally inclusive piece on climate change liability, and progress the exploration of how attribution science in the case of extreme weather events may ultimately have a place in a climate tort. It provides detailed explanations of the attribution science, the plethora of means with which to impose liability in the context of climate change, and climate liability from the perspectives of various countries (e.g. England, Australia, the United States, Japan, India, Canada, etc.). While the authors are generally pessimistic about how extreme weather events may fare in court, the possibility of such a case emerging in the United Kingdom is not holistically dismissed (Lord et al. 2012: 467-469). Other useful summaries of the recent progress of climate litigation and extreme weather event attribution can be found in David Adam's "Climate change in courts" (2011), Richard Blomquist's "Comparative Climate Change Torts" (2012), and in Mike Hulme's review, "Attributing weather extremes to climate change" (2014).

Lastly, David Hunter (2007) provides an extensive exploration of the ramifications of climate litigation, commenting on its potential to influence international law, institutions, and global agreements to address climate change. Hunter's paper does allude to event attribution as a growing science that will profoundly influence climate litigation in the coming years. His work is discussed in greater detail in Section 5.2, which explores the potential ramifications of a successful climate tort.

2.2 Causes of Action: Negligence and Public Nuisance

As Kaminskaitė-Salters (2010) argues, a negligence or public nuisance cause of action offers the greatest chances of success for a climate tort in the UK. With each, a number of elements must be met before liability can be imposed.

For any defendant(s) to be held liable in negligence, the four requirements must be met as laid out in *Clerk & Lindsell on Torts*:

1. "The existence in law of a duty of care situation, i.e. one in which the law attaches a liability to carelessness. There has to be recognition by law that the

careless infliction of the kind of damage in question on the class of person to which the claimant belongs by the class of person to which the defendant belongs is actionable;
2. Breach of the duty of care by the defendant, i.e. that [s/he] failed to measure up to the standard set by law;
3. A causal connection between the defendant's careless conduct and the damage;
4. The particular kind of damage to the particular claimant is not so unforeseeable as to be too remote" (Jones et al. 2014: Chapter 8, Section 1).

Negligence is not necessarily limited to any specific interest: "a negligent interference with enjoyment of land may give rise to both liability in negligence and nuisance (Ibid., citing *Goldman v. Hargrave* (1967)) or under [Rylands' rule]" (Ibid., citing *Rylands v. Fletcher* (1866)). As such, there is potential for overlap between different causes of action.

First, a duty of care must be established. This principle is defined in the cases of *Donoghue v. Stevenson* (1932) and in *Caparo Industries Plc v. Dickman* (1990), outlining a three-fold test by which the duty is established:

1. The parties must be within sufficient *proximity* of each other;
2. the imposition of the duty of care must be *just, fair, and reasonable;*
3. and damages to the claimant are *foreseeable* (Kaminskaitė-Salters: 87, citing *Donoghue v. Stevenson* (1932) and *Caparo Industries Plc v. Dickman* (1990); *Sutherland Shire Council v. Heyman* (1985)).

Second, the duty of care must have been breached. As outlined in *Blyth v. Birmingham Waterworks Company* (1856), a defendant has breached the duty of care "if his/her conduct falls below the *standard required by the law*, which is that of a *reasonable and prudent person*" (Ibid.: 95, citing *Blyth v. Birmingham Waterworks Company* (1856)). The court thus considers:

- “The objectivity of the reasonableness test;
- the likelihood and seriousness of harm;
- the utility of the conduct; and
- the cost-benefit analysis of avoiding the risk” (Ibid.).

Third, a causal connection must be established between the defendant’s action and the damage dealt to the plaintiff, meaning that the defendant’s conduct actually resulted in said damages. Additionally, “the damage [must not be] as unforeseeable as to be too remote a consequence of the defendant’s wrong-doing” (Ibid.: 100). Due to the substantial number of elements and obstacles involved in establishing causation, these steps are reserved for discussion in Section 4.8.

As opposed to negligence, *public nuisance* consists only of a couple of essential elements: there must be an *actionable wrong* that has a *material effect* on a number of people sufficient enough to constitute a class (Kaminskaitė-Salters: 136, citing Bates et al. 2004). As established in *Gillingham Borough Council v. Medway (Chatham) Doc Co. Ltd* (1992), what matters is the impact of the defendant’s conduct, not necessarily that it is illegal (Kaminskaitė-Salters: 137, citing *Gillingham Borough Council v. Medway (Chatham) Doc Co. Ltd* (1992)), for it to be classified as an actionable wrong. For a nuisance to be considered public, it must “materially [affect] the reasonable comfort and convenience of life of a class of her Majesty’s subjects,” as stated in *Att-Gen v. PYA Quaries Ltd* (1957), which goes on to assert that the responsibility to raise such a case must fall on the community at large, not on an individual (*Att-Gen v. PYA Quaries Ltd* (1957)).

A public nuisance, while it can be actionable by local authorities as a criminal offense, is also actionable as a civil wrong by a private party if it can show that it “suffered particular damage *over and above* the general inconvenience suffered by the public” (Kaminskaitė-Salters: 138). As defined in *Harper v. Haden & Sons* (1933), said damage must be “some *particular, direct and substantial* loss or damage beyond what is suffered by [him/her] in common with...the public affected” (Ibid., citing *Harper v. Haden & Sons* (1933)).

These elements are referred to and discussed in greater detail in Sections 4.5 and 4.7 in the context of the two event attribution studies discussed in Sections 4.4 and 4.6.

This section provided a review of the scholarly literature pertaining to the application of tort liability to anthropogenic climate change. As elaborated upon in Section 4.8, establishing causation will be the greatest obstacle when raising a climate tort, which explains why extreme weather events are not considered in-depth throughout the literature. This dissertation will advance the literature laid out in this section by taking extreme weather events into account and by directly applying the PEA science through tortious frameworks. However, the next section introduces and explains the physical science of PEA and briefly reviews notable attribution studies, showing recent, key advances in the science and addressing the opportunity to apply event attribution as causative evidence in a climate tort.

3. THE PHYSICAL SCIENCE OF PROBABILISTIC EVENT ATTRIBUTION

This section provides a brief description of the science of PEA with reference to relevant, fundamental literature. This overview does not include an in-depth analysis of the science, but instead offers a useful explanation of how the science works, the extent to which it can explain the presence of human influence on a given weather event, and its limitations. It is important to note that PEA sits within a broader field of detection and attribution to climate change, which looks more at trends (e.g. warming temperatures, precipitation patterns) across the globe and over certain continents and regions, rather than at specific climate and weather events. While relevant, those broader attribution studies sit outside of the scope of this dissertation.

3.1 Literature Review

In Allen's "Liability for Climate Change" (2003), he posits that if the occurrence of an extreme weather event could be attributed to human-induced climate change; if the *risk* of the event was altered by anthropogenic GHG emissions, liability for damages might be imposed on emitters in court. Since it is not possible to generally attribute any such event to human action, and because compensation settlements would likely seek to quantify the fraction of the damages due to human influence on the climate, the initial step is to determine the "Fraction of Attributable Risk" (FAR; Allen 2003: 891). This entails a comparison of the probability of the event occurring in the current state of the climate (e.g. with GHG emissions and anthropogenic forcing) to the probability of the same event occurring in a world without climate change (or in some earlier period). First applied in an event attribution study by Stott et al. (2004) regarding the 2003 European heatwave, FAR is defined as

$$FAR = 1 - P_0/P_1$$

where P_0 is the probability of the event occurring without anthropogenic forcing, and P_1 is the probability of the event occurring in the real world, accounting for climate change. It follows that if the FAR is a figure between 0 and 1, risk has increased. If the risk of the event occurring has decreased, the FAR should be less than 0 (Stone

and Allen 2005: 306). An FAR of 0.5, for example, corresponds to a doubling of the risk - only one of every two events occurred naturally (Stott et al. 2004: 612).

In “The end-to-end attribution problem: From emissions to impacts” (2005), Stone and Allen further develop and demonstrate the methodology of PEA. Standard climate change attribution methods “assume a deterministic link between the forcing and the response in question,” but in the case of an extreme weather event, “it is not so clearly applicable to the occurrence of a single local event that could easily have occurred anyway in the absence of the forcing.” The solution to this problem is to examine the *risk* of the event taking place, as opposed to the event itself. Here, the “risk” of anthropogenic influence is the equivalent of the ‘climate’, whereas the occurrence of the event itself is the equivalent of the ‘weather’. Thus, what “we are actually considering [is] the probability of a harm occurring and not the risk itself,” though it is still referred to as risk since it is assumed that the harm is independent of external forcing (Stone and Allen: 304). It follows that the variables used in the calculation of FAR are inherently probabilistic, and are estimated with some uncertainty.

Much of the uncertainty comes from the fact that we have only one real world to observe and no world without climate change. Dynamical models must serve as our substitute for the climate system, comprised of large ensembles of constructed climate simulations intended to emulate several iterations of both climate systems. Stone and Allen explain in detail how these models will account for such uncertainty (Ibid.: 306-313), but ultimately it is with these simulations that we can estimate and visualise how the risk of an event occurring might have changed due to anthropogenic forcing.

Such simulations are most commonly visualised via return time plots. The return time of an event is “the likelihood of the event occurring defined by a particular variable (e.g. temperature, precipitation) exceeding a particular threshold in a certain time period” (Climateprediction.net 2015). Thousands of climate simulations are performed over a given geographical space and time-frame, both of the ‘real world’

and ‘non-human world’, and are plotted logarithmically. Usually, one ‘real world’ model is juxtaposed against several ‘natural world’ models. An example is shown below in Figure 1 of rainfall in the southern UK in the winter of 2013.

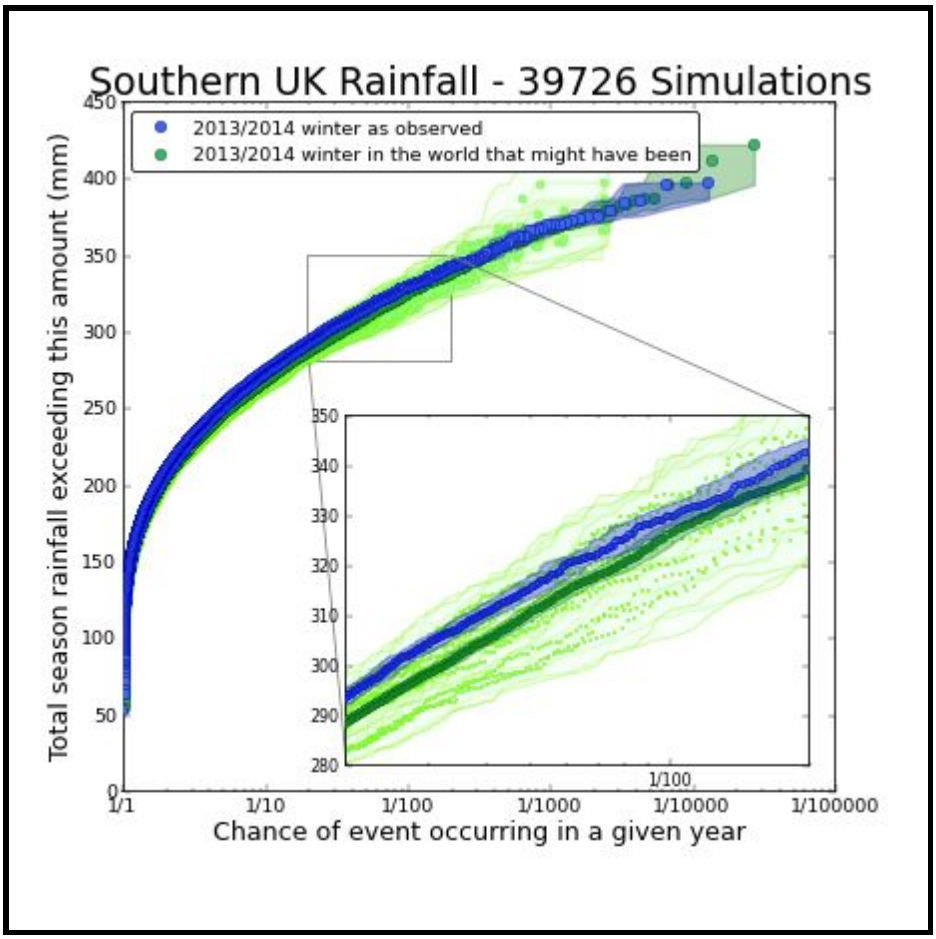

Fig. 1. Return time plot of Southern UK Rainfall in the winter of 2013/2014 (Climateprediction.net 2015)

The x-axis details the chance of the event occurring (e.g. one in every ten years, one in every one hundred years), and the y-axis indicates the level of rainfall exceeding a particular threshold. In this example, an extreme flood occurred if the rainfall passed a threshold of about 350mm. The figure shows that rainfall exceeding that threshold occurs nearly once every thousand years, but has a shorter return time in the ‘real world’ (blue curve) than in the ‘non-human world’ (dark green curve). Some ‘non-human world’ simulations offer even shorter return times, due to the parameters

established in those models. While the results of this plot are not particularly remarkable, it is a useful visualization of a PEA study (see also: Otto et al. 2013).

More broadly, Allen et al. explain PEA in a 2007 piece in the *University of Pennsylvania Law Review*. The authors argue that there ought to be an objective approach with which to quantify the role of anthropogenic forcing on climate in cases of "actual harm" (e.g. following extreme weather events) that can be agreed upon by both scientific experts and legal practitioners. The authors review the state of detection and attribution methods at the time and address critical questions and obstacles that would likely emerge in a legal case (Allen et al. 2007). The basic idea is that we need to be asking the right questions. Considering the uncertainty that accompanies the determination of the real impacts of particular drivers on the climate system (e.g. GHG emissions), the question should be how the climate system would be different if a particular driver were absent assuming all others evolved and behaved as observed (Ibid.: 1363). Applied in the context of a legal case:

> "If a plaintiff were to argue that she had been dispossessed because an increase in heat-wave risk had rendered her village uninhabitable, she would have to explain why she was there in the first place… The issue is thus not absolute climate, but the climate relative to that which a plaintiff might reasonably have been expected to experience when she invested in the region" (Ibid.: 1364).

It is this principle, named "ceteris paribus," that underpins the probabilistic and risk-oriented nature of PEA, and that, as Allen et al. argue, needs to be considered in prospective legal cases of climate-related harm.

Section 3.2 Notable PEA Studies

With that said, a number of PEA studies have been published, the first regarding the European heatwave of 2003 by Stott et al. (2004). At the time, the summer of 2003 over Europe had been the hottest summer since the 16th century and was

responsible for large numbers of heat-related deaths across the continent. The authors concluded that past anthropogenic forcing was responsible for nearly 75% of the increased risk of such a heatwave (i.e. FAR = 0.75). The findings were consistent with those reported by Luterbacher et al. (2004) and Schär et al. (2004), who used statistical methods as opposed to the FAR method (Hulme 2014: 504).

The reach of these PEA studies is broad, ranging from the 2000 floods in England and Wales (Pall et al. 2011), heavy summer rains in Pakistan in 2010 (Christidis et al. 2013), drought in East Africa in Spring 2012 (Funk et al. 2013), heavy rains in southwest Japan in July 2012 (Imada et al. 2013), and the heatwave in Australia during Summer 2013 (Lewis and Karoly 2013). Many more have been compiled and released in various Bulletins of the American Meteorological Society (Herring et al. 2014; Peterson et al. 2013; Peterson et al. 2012).

Not all attribution studies look simply at probability. Some instead explore how the magnitude of a given event might have shifted due to human influence on the climate. As such, sometimes seemingly contradictory results are produced by multiple studies of the same extreme weather event. This occurred with two studies looking at the heatwave over western Russia in the summer of 2010. Dole et al. (2011) concluded, following the use of the FAR method, that the heatwave was largely due to natural atmospheric variability, as opposed to anthropogenic forcing. However, Rahmstorf and Coumou (2011) concluded using statistical methods that there was only a 20% chance that the heat record would have occurred naturally without the influence of GHG emissions. Seeking to understand and reconcile these divergent findings, Otto et al. (2012) used an FAR methodology with large ensemble simulations, concluding that neither study was essentially wrong. Instead, the two studies were answering different questions. Dole et al. addressed the attributable *magnitude* of the extreme heat, whereas Rahmstorf and Coumou explored the *probability* of its occurrence. As such, it is critical for attribution studies to be precise when introducing the questions they seek to answer (Hulme 2014).

Section 3.3 The Future and Citizen Science

Stott et al. (2013) have since provided a more comprehensive overview of the state of PEA, touching on many of the past studies performed and the future challenges faced by the science. Amongst other limitations, the science of PEA is limited in geographical scope due to the dearth of comprehensive regional data in some parts of the world. Additionally, our understanding of the climate system entails much greater confidence in studies exploring issues of temperature (e.g. heatwaves, droughts) versus events looking at precipitation or more seasonal events (e.g. flooding, hurricanes and typhoons, etc.). However, there is confidence that such limitations can be overcome, especially with the assistance of citizen science (Allen 1999). For example, Climateprediction.net is a volunteer-based computing and climate modelling project based at the University of Oxford, using the computers of volunteers around the world to explore how climate change is affecting the world now and in the future. More specifically, the weather@home project (see Massey et al. 2014) is a group of regional climate modelling experiments within climateprediction.net used to perform attribution studies of extreme weather events.

Although PEA is a fairly new science, it offers the best available means with which we can attribute an extreme weather event to human influence. It is expected that over the coming years that more detailed and accurate climate observations on regional and global scales will emerge and reduce the uncertainty that accompanies event attribution studies. Section 4 explores how this science, as it stands, would fare when legally tested through elements of tort law. In doing so, this dissertation will advance the field and more closely explore the legal application of PEA than has the literature outlined in Section 3.

4. EXPLORING POTENTIAL CASES

To determine how one might raise a successful climate tort in the United Kingdom, we must take the following steps: First, Sections 4.1-4.3 discuss who could potentially raise a case and who the prospective defendants could be, as well as what types of damages and loss could be claimed and remedies sought. Secondly, Sections 4.4-4.7 explain in detail the context and outcomes of the following two attribution studies: the 2003 European heatwave and the 2000 floods in England and Wales. Each attribution study will then be taken step-by-step through 'negligence' and 'public nuisance' causes of action. Existing case law and relevant literature are included to better understand the legal contexts and circumstances under which these cases might be brought and tested. Section 4.8 is devoted to the opportunities and barriers claimants would face when tasked with establishing causation. Section 4.9 concludes this analysis with an explanation of what the "best-case" scenario would be and why.

4.1 Prospective Claimants

To raise a case, a claimant must first have standing. In English law, "all persons are entitled to sue and are liable to be sued in tort actions," (Kaminskaitė-Salters 2010: 60, citing Dugdale et al. 2006: 257) but "*in order to claim relief, the claimant must have some private legal right or legal interest recognised by law which has been violated by the defendant*" (Ibid., citing Geddes 1992: 30). Under certain circumstances, especially in the case of public nuisance, a private claimant would only be able to bring an action if they have "suffered damage over and beyond the general public" (Ibid.). Another important item to consider is that no one could claim damage to the environment, as English law does not grant protection of the environment as a public right. Only in the case that such environmental degradation impacted a person's health or property could one raise a claim. However, even so, the English courts' test for *locus standi*, or standing, are not as strict as they are in the United States, where multiple climate torts have been raised. Therefore, the UK potentially enables a wider range of litigants to raise a case (Kaminskaitė-Salters 2010: 62).

Amongst the potential claimants are:

- Central government and local authorities/municipalities, who could potentially allege damage or disruption to public land, property, and services;
- Quasi-public bodies (e.g. the Crown Estate, English Heritage, National Trust) and non-governmental organizations (NGOs), the former of which could have their property threatened by climate change and the latter of which would need to allege damage to its own land (private nuisance) or raise a public nuisance (but prove it suffered damage over and above the general public);
- Private businesses and individuals; and
- Foreign claimants, which could raise a case under the rules of the Brussels Regulation (in which "persons domiciled in an [European Union] Member State shall, whatever their nationality, be sued in the Courts of that state") and under the Civil Jurisdiction and Judgments Order (CJJO) of 2001 (in which "an individual is domiciled in the UK if [they are a] 'resident' in the UK, or if [they have] a 'substantial connection with the UK'." The former states that in case of tort, "a person may be sued in the 'Courts for the place where the harmful event occurred or may occur'" (Kaminskaitė-Salters: 63-66; citing European Council, 2001 and The Civil Jurisdiction and Judgments Order, 2001).

4.2 Prospective Defendants

According to Kaminskaitė-Salters, "the potential *range of defendants* who could be subjected to a tort-based climate change claim is *potentially inexhaustible*," as everyone who engages in any way with the global economy contributes to the emission of GHGs and thus climate change (Kaminskaitė-Salters: 70). However, the most likely defendants will be those who "have helped *cause* or...*materially contributed to*, global warming," which would not apply to individual consumers as their emissions would be negligible (Ibid., citing Smith and Shearman 2006: 17). David Grossman (2003) also notes that consumers do not necessarily have meaningful alternatives to using fossil fuels and products that rely on them (Grossman: 28), and as such cases against them would likely be dismissed.

As such, amongst the most likely potential defendants are:

- "*Entities that burn fossil fuels on a large scale*… includ[ing] companies supplying electricity; district heating companies; aircraft operators and shipping companies";
- Fossil fuel suppliers, consisting "predominantly of [coal,] oil[,] and gas exploration and production companies, as well as [coal and] oil refineries"; and
- "*Entities that manufacture products reliant on fossil fuels*…[which] would include car, aircraft, and ship manufacturers" (Kaminskaitė-Salters: 70-71).

Considering that the emissions of a single defendant may still not be substantial percentage-wise, it would be viable for multiple defendants to be grouped in the same action in order to make a better case for their material contribution to the impacts of climate change (Ibid.: 72-73).

4.3 Losses Alleged and Remedies Sought

Claimants will allege certain types of damage and any resulting loss in a climate tort case, the most likely of which will be death and bodily injury, damage to land, buildings and goods (Ibid.: 76). In the case of extreme weather events, it is foreseeable that each of these would be a plausible loss to allege and for which to seek remedies. It follows that plaintiffs will seek *damages* or *injunctions* as remedies, depending on the scenario. Following an extreme weather event, damages would be the most likely remedy sought. As Kaminskaitė-Salters explains:

> "Damages may be the appropriate remedy in situations where the harm caused by global warming has already occurred. In the UK, this would include claims by victims of the recent flooding events; those who suffered health problems in the [heatwaves] of 2003 and 2006; central government and local authorities/municipalities and insurers who have incurred losses as a result of both the floods and the heat-waves; and other similar claims" (Ibid.: 77).

These would generally be compensatory damages, not punitive damages. This means that while the victim will be returned to the position that s/he were in had the tort not taken place, the courts "will not, as a general rule, award additional damages in order to have a 'dissuasive' effect on the tortfeasor" so that the victim does not necessarily benefit from the tort being committed (Ibid., citing Allen 2000: 16). The courts, however, might be reluctant to issue damages out of fear that the floodgates would open for such claims. As such, injunctive relief is another plausible remedy, which could take the form of a prohibitory injunction (prevents a tort from being continued or repeated), a *quia timet ('because he fears')* injunction (issued when a tort is highly likely or imminent to occur), or a mandatory injunction (requires defendant to do as the court specifies; Kaminskaitė-Salters: 78-80).

4.4 Case #1: The 2003 European Heatwave

Having reviewed some of the essential components of raising a case, I turn to the first attribution study. In August of 2003, Europe was struck by a record-breaking heatwave. According to the UK Meteorological Office, more than 20,000 people died as several European countries experienced their highest temperatures on record. Nearly 15,000 people died in France alone, with a number of heat-related deaths in the UK (2,000+), Portugal (2,100+), Italy (3,100+), Holland, (1,500+), and Germany (300+). The Office for National Statistics reported 2,139 excess deaths (i.e. "calculated as observed deaths minus expected mortality (average of deaths in the same years 1998 to 2002)"), in England and Wales as a result of the heatwave (Johnson et al. 2005). Multiple countries experienced forest fires, declining reservoirs and river flows, and various economic sectors were affected. For example, the heatwave might have cost European farming up to about 13.1 billion euros. Weather charts reveal a large area of high pressure over most of Western Europe. High-pressure systems circulate air clockwise (in the northern hemisphere), which brings hot and dry tropical air towards the UK. The highest temperature was recorded in Brogdale in Kent on 10 August 2003 at 38.5°C (101.3°F), a record that currently stands (Met Office 2015).

Stott et al. (2004) performed an event attribution study on the heatwave, focusing on Western Europe. While their established geographical boundaries exclude much of northern Europe, the outcomes are still loosely applicable to the UK. The study sought to determine the long-term changes in the climate system due to anthropogenic and natural drivers in decadal-mean European summer (June-Aug) temperatures, and then estimate how the risk of the mean summer temperatures exceeding a particular threshold has changed due to anthropogenic forcing in the climate. The study concluded that it is *very likely* (e.g. a confidence level of >90%) that past anthropogenic forcing was responsible for a significant portion of the observed warming (Stott et al. 2004: 611). The authors offered a best estimate that "human influence [was] to blame for 75% of the increased risk of such a heatwave" (Ibid.: 612), or an anthropogenic FAR of 0.75 (see below, Fig. 2.), and claimed that "the likelihood of such events is projected to increase 100-fold over the next four decades, [making it] difficult to avoid... that potentially dangerous anthropogenic interference in the climate system is already underway" (Ibid.: 613).

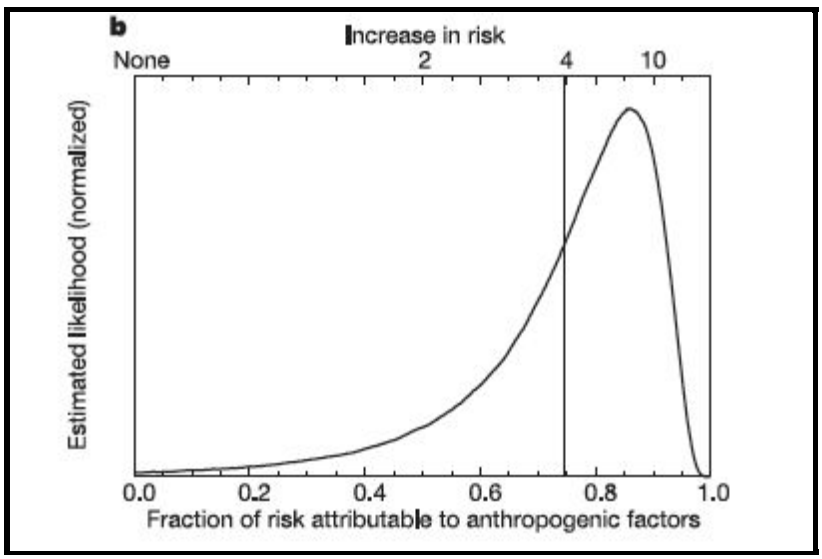

Fig. 2. Fraction of Attributable Risk of 2003 European Heatwave.
[Vertical line indicates "best estimate"](Stott et al. 2004: 612)

4.5 The Heatwave: Negligence versus Public Nuisance

How might the outcomes of Stott et al.'s attribution study fare when seeking to make a negligence- or nuisance-based claim? In the case of the former, as outlined in Section 2.2, a claimant would need to establish that the defendant(s) owed a duty of care, that it had been breached, that there is a causal connection between the defendant's' negligent action and plaintiff's damages (addressed in Section 4.8), and that the damage was not so unforeseeable as to be too remote.

In the case of the UK heatwave, a claim could be raised as the population sustained substantial damages, including death. In regards to establishing the duty of care, no case has emerged anywhere imposing duty on emitters. That discussion largely remains theoretical and as such the establishment of duty would rely heavily on judicial discretion (Kaminskaitė-Salters 2010: 88; Salzman and Hunter 2007: 99; Dugdale et al. 2006: 392; Durrant 2007: 406).

If a duty of care could be established, the next obstacle is to determine that a breach has occurred. The courts must be objective when deciding the standard of care to which a defendant must be held to, which depends largely on the type of activity the defendant is engaged in as opposed to the category to which they belong (Ibid.: 96, citing *Wilsher v. Essex Area Health Authority* (1987) and *Nettleship v. Weston* (1971)). It is possible that the courts may hold fossil fuel suppliers and emitters to a standard at which they are expected to seek ways to reduce their climate impact, and as such only if they were at the forefront of the industry's effort to reduce emissions might they be able to refute a breach of duty of care (Ibid.: 97). In assessing the likelihood and the seriousness of the harm, the court could cite the heatwave's attribution study. Seeing as the study confirms that the risk of anthropogenic influence more than doubled and concludes that the likelihood and magnitude of heatwaves occurring will increase over the next several decades with nearly 90% certainty, the study could be critical in establishing a breach.

The timing of the case has substantial bearing on determining the utility of the defendant's conduct and performing a cost-benefit analysis of the action in question.

A case in the mid-2000s might work against a plaintiff, as likely defendants could argue that less-carbon intensive ways were not available at a reasonable cost, meaning that the defendant's conduct (e.g. emitting fossil fuels, supplying fossil fuels for dependant products, etc.) would be of high utility and would be of great cost to eliminate - thus not implying a breach. However, in 2015, as renewable technologies have emerged as viable alternatives on the market, judicial discretion could potentially lean the other way. Determining that a breach has occurred, in this case, is highly circumstantial but will become more likely as advancements are made in alternative technologies and energy sources.

Since causation will be addressed in Section 4.8 due to the magnitude of its importance, the next element is foreseeability. In this case, considering the mounting scientific evidence showing the impacts and harms of climate change, it is fair to say that courts would establish that said damage was foreseeable and not too remote (Kaminskaitė-Salters: 95). However, this would likely depend on whether a causative connection between a defendant's GHG emissions and the damages following a similar heat event are established.

Kaminskaitė-Salters best summarises the obstacles faced in meeting this cause of action. Namely, as it pertains to establishing a duty of care, it is difficult to assert a connection between a defendant's actions and a plaintiff's damages because of the global nature of climate change and inability to trace emissions to a particular party. Additionally, extending the duty of care to any victims of climate change, especially following an extreme weather event, risks opening the floodgates. Defences could also be made that the utility of the conduct leading to the emissions would outweigh the costs of any potential damages from emissions (Kaminskaitė-Salters: 102).

What about a public nuisance? It appears that proving an actionable wrong (see Section 2.2) might not necessarily be the most substantial obstacle in raising such a case, but much like in the case of negligence, causation would have to be established. However, if a private party were to indeed raise a public nuisance case following a heatwave, the greatest obstacle would be to show that the party in

question suffered particular damage over and above the general public. This would not be completely insurmountable in the case of the 2003 heatwave. The courts would likely deem death as a 'particular' kind of damage when compared to the other negative health effects associated with such heatwaves (e.g. a heatstroke), which improves the viability of this case in court, considering that over 2,000 people died in the UK due to the heatwave.

4.6 Case #2: 2000 Flooding in England and Wales

The second case is an attribution study by Pardeep Pall et al. (2011), which examines how anthropogenic GHG emissions might have contributed to flood risk in England and Wales in the autumn (Oct-Nov) of 2000. The floods were the result of the wettest autumn recorded since 1766. Nearly 10,000 properties were damaged throughout the UK as a result, and insurance losses were estimated to have amounted to £1.3 billion.

A multi-step PEA test was performed (see Fig. 3 below), with the conclusion that it was "very likely that global anthropogenic emissions substantially increased the risk of flood occurrence" (Pall et al. 2011: 382). The results more specifically indicated that it was *very likely* (in nine out of ten cases) that the FAR was above 0.2 (risk increased by more than 20%), and *likely* (in two out of three cases) that the FAR was above 0.9 (risk increased by more than 90%) (Ibid.: 384).

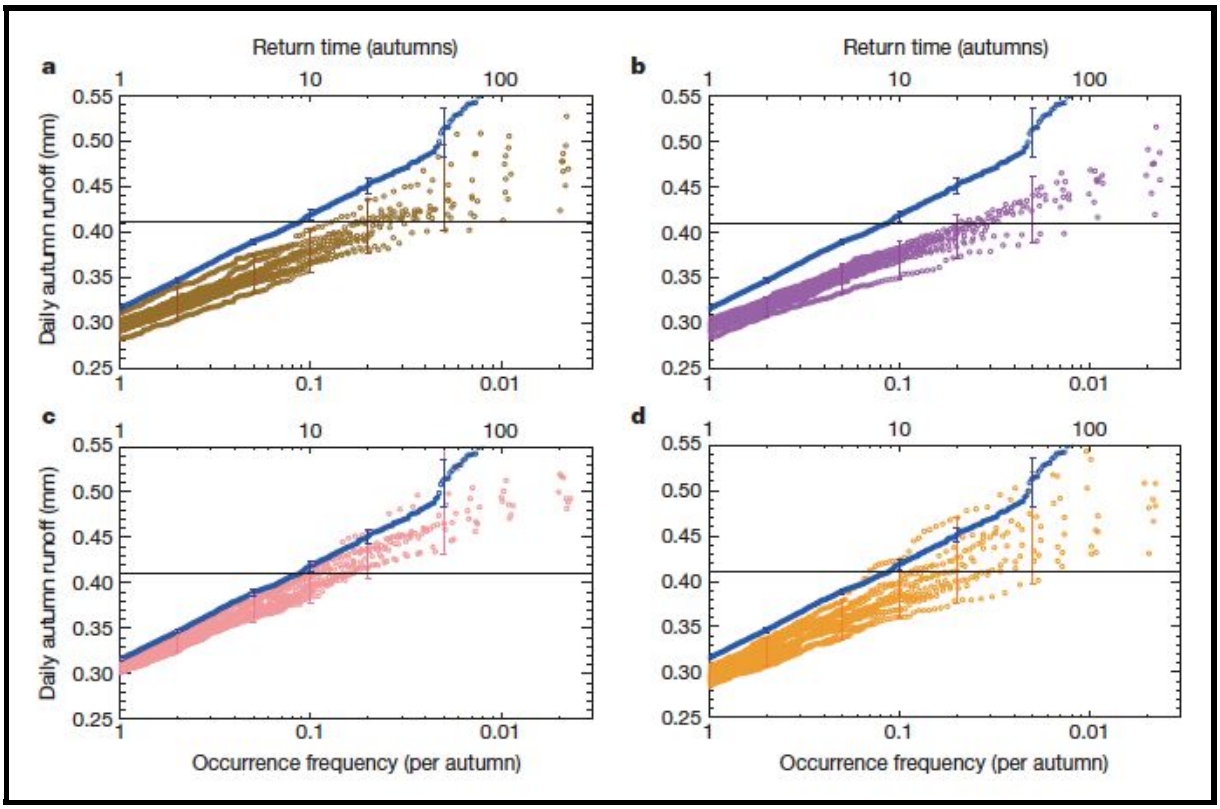

Fig. 3. Return time plots of UK Floods. Blue curve represents real-world simulation; brown, orange, pink and orange curves represent different non-human world simulations (Pall et al. 2011: 384).

4.7 The Floods: Negligence versus Public Nuisance

Having delineated and explained the elements of negligence and public nuisance previously, this section will specifically address the elements in question for each cause of action when examining the 2000 flooding attribution study.

In regards to negligence, it appears that the most progress could be made in assessing the seriousness and likelihood of the harm when trying to establish that the duty of care owed by a defendant was breached. In the case of the floods, there is clear probabilistic evidence that the risk of the floods occurring substantially increased due to climate change, as well as their expected magnitude. However, it is hard to say if courts will look specifically at the FAR of 0.2, which was deemed *very likely*, or if they will accept the FAR of 0.9, which was deemed only *likely*. The court

will probably adopt the more confident figure, so it is likely that the FAR of 0.2 will be adopted in this instance, a notably weaker risk figure.

As for public nuisance, presenting particular damage would be paramount. In this case, no deaths were reported, unlike in the heatwave. The most likely damage experienced by any particular claimant would be to their property, and therefore it would not be 'particular'. However, economic losses due to lost tourism, for example, may be deemed 'particular' damage in this instance.

Having applied Stott et al.'s attribution study of the 2003 heatwave (2004) and Pall et al.'s study of the 2000 UK floods (2011) through the various elements in public nuisance and negligence causes of action, all that is left to examine is how causation might be established in either of these cases.

4.8 The Critical Component: Causation

Causation can be more broadly be defined as:

> "Establishing a causal relationship between a certain legally relevant behaviour and a loss or injury. In this framework, the legal evidence is inextricably linked to scientific findings and the ability of the [C]ourts and tribunals to rely on such scientific evidence" (Verheyen 2005: 249).

However, there is a difference between *scientific* causation and *legal* causation:

> "As R. Verheyen stresses, science focuses on the discovery of all the possible causes of a particular event and therefore treats causation as the sum of the conditions which are jointly sufficient to produce the event in question; legal causation, on the other hand, needs to attribute liability to a particular entity and is, therefore, inevitably 'a social construct' which 'often does not concern questions of fact'" (Kaminskaitė-Salters 2010: 153).

Case law has struggled to establish causation in cases with scientific uncertainty. In the case of *McTear v. Imperial Tobacco Limited* (2005), the court concluded that even "epidemiological evidence of a statistical association between smoking and lung cancer…" did not determine a causal connection between the two, "even if judged to be statistically significant" (Kaminskaitė-Salters: 153-154, citing *McTear v. Imperial Tobacco Limited* (2005)). As such, "*scientific and statistical evidence is an important - but by no means conclusive or sole - basis of establishing legal causation*" (Ibid.: 154). The case went so far as to say that applying statistical probability to specific causation would be a "fallacy," (*McTear v. Imperial Tobacco Limited*, citing *Hotson v. East Berkshire Area HA* (1987) and *Gregg v. Scott* (2005)).

According to *Clerk & Lindsell on Torts*, there are essentially two steps to establishing causation in such cases. The first is to demonstrate "that the event which allegedly gave rise to the claimant's damage can ever cause that type of harm," and the second is for the claimant to "prove that [his/her] particular damage was caused in this way" (Jones et al.: Chapter 2, Section 2, Sub-section c).

To first show a *factual* link between the negligence and the damage, the 'but for' test is required, as established in *Rich v. Pierpont* (1862): "would the damage of which the claimant complains have occurred 'but for' the negligence (or other wrong-doing) of the defendant?" (Kaminskaitė-Salters: 155, citing *Rich v. Pierpont* (1862)). The Court would need to differentiate between *general* and *specific* causation. In regards to the former, a causal link would need to be established between anthropogenic emissions and climate change, as well as between anthropogenic climate change and regional environmental effects. With the latter, the plaintiff would have to show that climate change caused the specific event at hand (i.e., the 2003 heatwave or the 2000 autumn floods) and that the emissions of the defendant were responsible for that event (Ibid.: 155-156).

It is fair to assume that general causation would be established considering mounting scientific evidence, more general attribution studies, and existing legislation. As such, a claimant would be primarily concerned with establishing

specific causation: did climate change cause the 2003 heatwave, or the autumn 2000 floods, and could one determine if a particular defendant's emissions were responsible for either of those events? However, one then faces a *dual causation problem*, as Kaminskaitė-Salters describes it:

- "Firstly, how does one prove that the specific event (e.g. flooding, subsidence, or hurricane) was caused by climate change when in fact it may have been a weather event in no way linked to climate change?"
- "Secondly, how does one ascribe liability for the damage in question to a particular defendant, when 'climate change damage is undoubtedly caused by multiple activities and no single one has caused the entire damage?'" (Ibid.: 159, citing Faure and Nollkaemper 2007: 160).

She also notes that even if such conclusions were attainable, a claimant is faced with a "multitude of emitters" and "historical emissions" due to the time lag between an emission and its dissipation/impact (Ibid.). Seemingly, any such case seems doomed in the case of an extreme weather event, since it cannot be said with complete certainty that a particular event is solely the result of climate change.

The case of *Fairchild v. Glenhaven Funeral Services Ltd* (2002) presents a potentially more flexible application of the causation principle. This could breathe life into a tort case surrounding an extreme weather event. The case, which had to do with mesothelioma due to asbestos exposure, presented this question to the courts:

> "Can a single employer, or multiple employers, be held liable in a situation where it is clear that *one of them* was responsible for the disease, but not where it is to possible to say *which one*?" (Kaminskaitė-Salters: 166, citing *Fairchild v. Glenhaven Funeral Services Ltd* (2002)).

The courts held that the circumstances in this case merited a relaxation of the traditional 'but for' test, and that "all the defendants should be held jointly and severally liable for the damage caused" and that a "*breach of duty by the defendants*

had materially increased the risk, which should be treated as the equivalent of materially contributing to the disease" (Ibid.: 165). To see if the case could serve as the basis to impose liability in a climate tort, Kaminskaitė-Salters tests the application of the principles laid out in *Fairchild* to climate change. She concludes that it is uncertain whether climate change holistically could fit the parameters of the case, unless the Courts "are prepared to relax the rules by extending the application of *Fairchild* to circumstances where there are alternative causes to the relevant damage (be they tortious or innocent in nature)" (Ibid.: 171).

Additionally, it would be nearly impossible to even meet the requirements for material contribution laid out in *Fairchild*. Kaminskaitė-Salters shows that even the cumulative carbon emissions from the FTSE index of 100 companies only accounted for 1.6% of the global total in 2003/04 (Ibid.: 172).

However, certain cases following *Fairchild* could serve as precedent for probabilistic evidence to play a role in establishing causation. The 2007 case of *Novartis Grimsby Ltd v. Cookson* concluded, as it pertained to carcinogens in the workplace and an employee's bladder cancer, that if occupational exposure more than doubled the risk of cancer, then logically it would make sense that the exposure caused the disease (Jones et al. 2014: Chapter 2, sub-section c, sub-section iii; citing *Novartis Grimsby Ltd v. Cookson* (2007)). The same test was applied and accepted *Jones v. Secretary of State for Energy and Climate Change* (2012), which held that certain evidence did establish a causative link between carcinogenic fume exposure and lung cancer and other respiratory diseases (Ibid., citing *Jones v. Secretary of State for Energy and Climate Change* (2012)).

Fairchild also did not answer whether the case can be applied in instances where multiple tortfeasors all add to the risk of damage caused by the same agent. *Barker v. Corus* (2006) answered this question, stating that *Fairchild* can apply in a situation "provided that the increased risk can be attributed to the same causal mechanism" (Jones et al. 2014: Chapter 2, sub-section 5; citing *Barker v. Corus* (2006)). In the case of extreme weather events, this would be *extremely* helpful in holding multiple

defendants liable, as the emissions produced from the burning of fossil fuels all contributed to the increased risk of occurrence.

It is possible then that a loose application of the “doubles the risk” principle, as well as the causation principles outlined in *Fairchild*, could enable the use of probabilistic evidence in establishing causation following an extreme weather event. However, whether judicial discretion will push for such an open application of these principles remains uncertain. After all, the cases above pertain to medical conditions related to material exposure in the workplace: a fairly different scenario than lost life or property following a flood or a heatwave.

Either way, only after a causal link is established must the claimant prove *legal causation*, meaning that the defendant ought to be held legally accountable for the damage suffered by the claimant (Ibid.: 178, citing Miller and Goldberg 2004: 302). This presents even more obstacles and potential arguments for defendants, as the court would then consider:

- “Acts of nature;
- intervening acts of third parties;
- intervening acts of the claimant himself/herself (including contributory negligence); and
- remoteness of damage” (Ibid.: 179).

Only the first two factors are of concern in this case, as potential intervening acts of the claimant would likely not be ruled substantial enough to dismiss legal liability on behalf of the defendant, and as the occurrence of extreme weather events due to climate change will likely become more foreseeable instead of more remote (Ibid.: 184). The first factor, that the tort committed could have simply been an act of nature, is already inherently implied in any application of the event attribution science. Such studies are probabilistic *because* any given event, whether it is a heatwave or a flood, could have occurred anyway.

However, even if the 'but for' test is initially satisfied, the defendant could assert and show that a third party's action (or lack thereof) breaks the chain of causation and thus exempts the defendant from legal liability. To do so, two of the three following conditions must be satisfied:

- The intervention was not foreseeable;
- the intervention was independent; and/or
- the defendant could not have done anything to withhold the harm (Ibid.: 180, citing Miller and Goldberg: 306-306).

For emitters, it would be relatively easy to satisfy two of these conditions based on the current state of climate science. While they might not be able to escape the argument of unforeseeable intervention (i.e. they are probably aware of such breaks in the chain, emissions-wise), one party could easily argue that emissions of other parties occurred independently of their own and that they were helpless to prevent the damage from occurring. However, this could be circumvented if emitters were held proportionately liable, instead of jointly or severally liable (e.g. they would pay for damages proportionate to the emissions they are responsible for; Ibid.: 181).

Barker addressed the issue of proportionate liability. In that case multiple employers could not be held liable, as some were no longer in a position to provide compensation (i.e. had become insolvent). The court concluded that proportionate liability, which would require tortfeasors to compensate proportionately based on their particular probability of causing the harm, was fairer in this instance (*Barker v. Corus* (2006)). Outrage from workers, trade unions, and Parliament alike produced the Compensation Act of 2006 to essentially reverse the *Barker* decision (Great Britain 2006). However, as the reversal only applies to mesothelioma cases, proportionate liability could still be applied in a climate tort.

Conclusively, causation remains the greatest obstacle to raising a climate tort. There is certainly relevant case precedent, but it is also ambivalent and ambiguous for prospective claimants in a climate tort. On the one hand, some cases have left the

door open for probabilistic evidence to, at the very least, be considered and used to impose liability on tortfeasors. On the other hand, the court has shown its reluctance to embrace such evidence and establish causation. Additionally, the court's commentary on how an individual's choices can impose barriers to holding a defendant liable is concerning. Could the courts ascertain that an individual might have chosen poorly to stay out too long in the middle of a heatwave, or even that someone could have selected to live elsewhere, away from areas prone to damaging flood events?

Such uncertainty is in and of itself a barrier to even raising a case in the first place, but the door is certainly not closed. With that said, having examined two distinct attribution studies and causes of action, the next section concludes what the best-case scenario would be to raise a climate tort in the United Kingdom.

4.9 The Best-Case Scenario

This section concludes that a public nuisance case emerging from the 2003 heatwave (or a similar event) is likely to be the best-case scenario for event attribution to forward a climate tort through the courts in the United Kingdom.

Why a public nuisance?

- It offers the best opportunity for several claimants to pursue a case. Considering the widespread impact of the 2003 heatwave, much of the public could step forward and constitute a class.
- If raised by local authorities, it could also be filed as a criminal wrong and provide greater incentives to emitters to change their practices. Negligence is purely a civil wrong, which does not necessarily require unlawful action.
- If raised by private claimants, they could foreseeably claim particular damage over and above the general public in the case of an extreme weather event.

Why the 2003 heatwave?

- Proving particular damage in the case of the heatwave is substantially easier, as it resulted in many deaths. The floods only rendered economic and property losses.
- The results of Stott et al.'s (2004) attribution study leaves less room for uncertainty and presents a greater FAR than in Pall et al.'s (2011) study and could be potentially more convincing to the courts. It also addresses the "doubles the risk" test outlined in existing case precedent.
- Flooding in some areas is a seasonal occurrence, and precipitation-related events are generally more difficult to attribute to climate change than temperature-related events (Stott et al. 2013)

As such, litigants in the United Kingdom would have the greater chance of success in raising a *public nuisance* in the aftermath of a *heatwave*, as opposed to a flood.

5. DISCUSSION

Section 5.1 first examines climate cases that have taken place outside of the United Kingdom, particularly in the United States, the Netherlands, and more recently in Belgium. These cases display the progress that has been made with climate litigation around the world, as well as the legal avenues others have taken to address the damages rendered by climate change. While not predicated on extreme weather events, they do also showcase legal obstacles that claimants will face when pursuing litigation. In particular, the section highlights *pre-emption* as a substantial barrier that stifled success in the U.S. and could do the same in the UK.

Subsequently, the potential ramifications of a successful climate tort in the UK are discussed in Section 5.2. These range from the passage of more aggressive climate legislation to action on behalf of investors in fossil fuel companies to change industry practice. It also includes simple back-of-the-envelope (BOE) calculations that reveal the potentially crippling financial impacts of a successful climate case on the world's largest fossil fuel companies. This discussion will also address how successful climate litigation in the UK could spur progress within climate science, international climate policy (e.g. via the UNFCCC), adaptation strategies, and climate cases in other countries.

5.1 International Climate Litigation and the Issue of Pre-emption

Climate litigation has surfaced in other parts of the world. Lord et al. (2012) highlight the numerous litigious avenues that exist in various countries, but this section narrows the focus to the United States, the Netherlands, and Belgium for a few reasons. First, the U.S., much like the UK, uses the common law method, and as such the application of tort principles are virtually identical. The cases raised in the States have been on the basis of public nuisance, and are consequently useful for comparison. These American cases are also used here to introduce pre-emption as an obstacle claimants would likely face in the UK. Second, the world's first successful climate case took place in the Netherlands, and is of great interest. Last, Belgium's "Climate Case" draws direct inspiration from the Netherlands' success and

displays how climate litigation in some countries can, and does, instigate cases in others.

As of 2012, four major cases have been filed in the United States against various parties on the basis that their GHG emissions constitute a public nuisance, all of which were ultimately dismissed. In *California v. General Motors Corp.* (2007), the state sued a group of car companies for monetary damages resulting from GHG emissions, however, that case was dismissed (Lord et al. 2012: 581, citing *California v. General Motors Corp.* (2007)). *Comer v. Murphy Oil* (2011) sought to remedy damages from fossil fuel and chemical companies on the basis that their emissions were responsible for intensifying Hurricane Katrina, but the case went nowhere and failed in the Fifth Circuit Court of Appeals (Ibid.: 581-582, citing *Comer v. Murphy Oil* (2011)). *Native Village of Kivalina v. ExxonMobil Corp*. (2009) was a case raised by native Alaskan villagers against the energy industry for having contributed to climate change via emissions after major floods ravaged their village, but this case was too dismissed on the grounds that regulating emitters was the business of the legislative, not the judiciary (Ibid.: 582, citing *Native Village of Kivalina v. ExxonMobil Corp*. (2009)).

However, the fourth case, *American Electric Power v. Connecticut* (2011), broke new ground despite its dismissal. Consolidated from two cases, claimants sought an injunction by the court on power plants on the basis that their emissions constituted a common law nuisance. Unlike the former three cases, *AEP* made its way to the U.S. Supreme Court after the Second Circuit Court of Appeals ruled in favor of the plaintiffs. However, the Court reversed the decision unanimously for one sole reason. It looked to *Massachusetts v. Environmental Protection Agency* (2007), a successful public climate change case in which the Court held that states had standing to raise cases protecting their citizens from the harms of climate change, and that the EPA was indeed responsible for regulating vehicle/tailpipe GHG emissions by way of the Clean Air Act. The case thus displaced the federal common law of nuisance, and therefore the responsibility to regulate or limit emissions does not sit with the courts in this instance. The Court, however, did not explicitly state

that the Clean Air Act pre-empts all state public nuisance litigation regarding climate change (Ibid.: 582-584, citing *American Electric Power v. Connecticut* (2011)).

The four American cases display many of the issues that prospective UK claimants will face in pursuing climate litigation, but pre-emption comes to the forefront in all of them. This presents a major obstacle for climate torts in the UK, as the courts could decide that pre-existing climate change legislation, such as the Climate Change Act of 2008, pre-empts the courts imposing liability against GHG emitters. Similarly, the courts may generally decide that it is up to Parliament to tackle the issue of climate change instead of the judiciary. In each scenario, litigation could be barred as a viable option for victims of the harms of climate change.

Unlike the United States, the Netherlands managed to raise a climate case and win in early 2015. Urgenda, a sustainable non-profit organization, successfully sued the Dutch government with 900 co-plaintiffs, asserting that the country's existing climate policy failed to adequately address the dangerous impacts of climate change. The Netherlands, they argued, was not doing its part to help keep global temperatures beneath the 2°C threshold established at COP 15 in Copenhagen. At that time, Dutch policy would only reduce emissions by 16% (below 1990 levels), and the plaintiffs argued that emissions would need to be reduced by 25%. The District Court of Hague ruled in favor of the plaintiffs, thus mandating the Dutch government to take more aggressive policy measures to meet the 25% target. This would be the first time any court in the world has mandated a government to reduce GHG emissions. Undoubtedly, the Dutch government will appeal the decision, but at the very least, this case supports the idea that pre-existing legislation can be deemed insufficient and merit judicial action.

The Dutch case has since inspired litigative action in Belgium. In December 2014, Belgium launched the *Klimaatzaak* (Dutch for "Climate Case") campaign, and has enlisted over 9,000 citizens as co-plaintiffs. The campaign calls for a 40% cut to GHG emissions (from 1990 levels) by the 2020. The case, expected to be heard near the end of 2016, has garnered substantial momentum following Urgenda's

success in the Netherlands (Climate Case, 2015), and is proof that successful climate litigation may come with a domino effect and inspire climate action in other countries.

5.2 Potential Ramifications of a Successful Climate Tort

Having viewed examples from other countries, the question now is what the consequences of a successful climate tort in the UK would be. Immediately such a case would alter the English judicial landscape and open the door to similar cases. However, a successful climate tort will have more far-reaching impacts, prompting action on behalf of policymakers, investors, and large industrial fossil fuel emitters.

Taking into account the high costs of litigation and concern with opening the floodgates, one successful case could spur action on behalf of Parliament. It is possible that legislation may be enacted imposing more aggressive emissions reductions, expediting the transition to renewable energy production, and increasing financial relief to victims of extreme weather events. Granted, the UK's Climate Change Act of 2008 is already one of the world's most aggressive pieces of climate policy, mandating an 80% reduction in GHG emissions (compared to 1990 levels) by 2050 (Great Britain, 2008). However, if the UK government drafted additional legislation in the wake of a successful case (much like it did following asbestos cases addressed in Section 4.8), it could pre-empt the courts from taking additional action in future cases and reduce the substantial administrative costs that normally accompany such cases.

The judicial and legal landscape could change in other ways as well. As a successful case requires relaxed thresholds to establishing causation and a duty of care to GHG emitters, the result could change the way that probabilistic scientific evidence, whether it is epidemiological, climatological, or otherwise, is considered in the courts. It could also potentially restore and affirm the use of proportionate liability in such cases.

Additionally, considering the high stakes of a case (e.g. high administrative and damage-related costs), the industrial and corporate landscape could shift dramatically to reduce emissions and avoid liability. Earlier this year, Howard Covington and Raj Thamotheram published two papers as part of making a singular case for “forceful stewardship” (Covington and Thamotheram 2015a; 2015b). The authors asserted that the ramifications of a global temperature increase of 2°C or more would cause “severe” economic damage and places the value of a diversified equity investment portfolio at risk. Compared to a scenario without warming, they conclude “the value at risk in 2030 may be equivalent to [at worst] a permanent reduction of between 5% and 20% in portfolio value” (2015a: 1). To reduce the risk, the authors assert that long-term investors must do whatever possible to bring about a rapid energy transition from fossil fuels to renewable technologies and consider the nature of their investments in fossil fuel companies. It is this approach and call for action that the authors term as “forceful stewardship.”

The authors make their case to investors, but the nature of their claim is proactive: investors must act if they are to mitigate the financial risks associated with a dramatically changing climate, and they must use their stake in large emitters to incentivise a change in energy technology and consumption. However, a legal decision holding large-scale emitters liable, whether it be in the context of an extreme weather event or otherwise, will have substantially large financial implications for investors in liable companies. Even before a verdict is issued, investors will likely take action if a fossil fuel company they have invested in is at risk of being held liable in court. Some investors may engage in “forceful stewardship” and vote for resolutions that alter the business strategies of fossil fuel emitters (2015b: 1), but others may simply choose to withdraw their dividends or their capital investments altogether if the emitters in which they are invested do not act.

If a case is successfully levied against any of the world’s largest fossil fuel companies, it could substantially impact the financials of those companies. For example, if a court agreed to place an injunction on the explorative activities of any of these companies, it would starve them of years of revenue, amounting to trillions

of pounds in the long-term. To calculate potential lost revenue, one only needs to perform BOE calculations, converting from Gigatons of CO_2 ($GtCO_2$) to U.S. dollars (with a hypothetical cost per barrel of oil of $50 USD), which would look like this:

$$x\ GtCO2 * (1\ Gt\ Oil / 3.17\ Gt\ Oil) * (1000\ Mt / 1\ Gt) * (1000\ Kt / 1\ Mt)$$
$$* (1000\ tons / 1\ Kt) * (7.3\ barrels / 1\ ton) * 50\ USD / 1\ barrel) = \$\ y$$

Taking the available CO_2 left in the reserves of three of the world's largest fossil fuel companies (listed below; Fossil Free Indexes LLC 2015), the monetary value of their reserves are shown below as of late 2014:

Company	Oil Reserves ($GtCO_2$)	Reserve Value (USD)
Gazprom	6.749	$777 billion
ExxonMobil	4.307	$495 billion
BP	4.214	$485 billion

These are fairly simple BOE calculations, and they assume a particular cost of oil without accounting for future value and inflation. Note that, for simplicity, gas reserves and coal companies are excluded, however these calculations still serve as a useful visualization of potential loss. These values would escalate quickly if gas and coal reserves were included. It is also important to note that $50/barrel is a very low price, but is not too far from current market value. Global CO_2 in listed private reserves (including coal, oil, and gas) currently amounts to 762 $GtCO_2$ and could double to 1541 $GtCO_2$ if all prospective reserves are developed (Carbon Tracker Initiative 2013: 22). With that said, the calculations above already suggest that a substantial amount of revenue will be lost if any injunctions were placed on even a single company to extract from their reserves. Substantial financial ramifications for these companies and the global economy would ensue.

David Hunter (2007) addresses some of the additional ramifications of climate litigation, without a particular case necessarily having to be successful. Hunter

argues that litigation's focus on victims and the impacts they face will require continued expansion of research and analysis on the local and regional impacts of climate change (Hunter 2007: 5). He refers to U.S. climate cases that were filed with the intent to improve climate impact assessments and their usage (Ibid.: 6). In this sense, any climate litigation will continue to push the boundaries of scientific research on climate change. Hunter even refers to event attribution as a growing science that will come to shape climate litigation strategies (Ibid.: 7).

Hunter further argues that climate litigation could "increase the political will for stronger international climate change policy" and that it "should not be seen in isolation from the negotiations under the UNFCCC and the Kyoto Protocol" (Ibid.: 9). He references a lawsuit raised in Canada, asking that the courts declare the country in noncompliance with the UNFCCC and the Protocol. Climate conferences, such as that in Copenhagen and the upcoming one in Paris, are prime spaces for climate advocates and claimants to share and develop litigation strategies, as well as to create partnerships that will assist in crafting litigation. Such efforts, Hunter argues, can and will shape the sorts of conversations that take place at these climate conferences and may contribute to producing globally binding agreements to act on climate change.

More importantly, climate litigation (especially if successful) could have further impacts on the UNFCCC. According to Hunter:

> "The focus on remedies that is inherent to climate litigation may influence future debates at the UNFCCC over adaptation. Certainly, the portrayal of specific harm to victims *today*, as opposed to general impacts tomorrow, is likely to force climate negotiators and the UNFCCC secretariat to focus on adaptation and compensation sooner than it otherwise would. This could increase funding available under the regime to respond to the needs of victims. In the most extreme scenarios, the threat of civil liability could conceivably lead industry and others to promote a liability regime under the

> UNFCCC that would both clarify the rules of liability and essentially cap private sector liability" (Ibid.: 11).

Hunter comments on other potential implications, including the development and strengthening of international law and institutions by being incorporated into litigation cases, but these are not relevant to tort cases in particular. Ultimately, Hunter concludes that climate litigation will promulgate as more cases are filed, which will have much broader impacts. Indeed, while successful climate lawsuits in other countries could mobilise cases in the United Kingdom, a successful climate tort in the UK might motivate other such cases around the world and provoke policy changes on a global level.

With that said, many of the ramifications suggested here are speculative, but that does not preclude the possibility that climate litigation in the UK and beyond could have profound global impacts that challenge and reframe the ways used to communicate, address, and mitigate the impacts of climate change. There is no doubt that a successful climate tort in the UK could change the way that climate change is addressed, and extend the capacity to citizens of the UK and elsewhere to try and effect change on their own.

6. CONCLUSION

Mounting evidence leaves no doubt that the impacts of climate change will bring harm to individuals and communities around the globe. However, even the most ambitious climate legislation might not yet address these harms. The idea that one or many could litigate against large-scale fossil fuel emitters on the basis that their GHG emissions are responsible for harmful climate change is not a new one, and has indeed manifested in multiple countries. In the case of extreme weather events, it could not be determined whether or not climate change had any bearing on the frequency or magnitude of their occurrence. But as the nascent science of PEA developed, it now presents a unique opportunity for victims of extreme weather events to seek compensatory damages from fossil fuel emitters on the basis that climate change increased the risk of such events occurring.

This dissertation sought to determine the best climate context and tortious approach to raising a case that could be successful in the courts, specifically within the UK, as to date no such climate cases have emerged in that jurisdiction. This took the form of a comparison between the attribution studies of two past weather events, namely a heatwave and a flood, and seeking whether a negligence-based or nuisance-based cause of action would have greater chances of success.

This dissertation concluded that the attribution study of the 2003 heatwave would likely be most successful and that the cause of action with the best chances of success would be public nuisance. The greatest obstacle has been, and will continue to be, establishing factual and legal causation, as event attribution of this sort is inherently probabilistic, not deterministic. Furthermore, it would require judicial discretion to relax existing standards in order to establish a link between GHG emissions and the damages brought by an extreme weather event. The remainder of the dissertation explored how other climate torts have fared in the United States and what the potential ramifications of a successful UK climate tort might be, with the conclusion that a successful case could have profound impacts on international climate efforts in the realms of science, law, and policy.

As such, this work filled gaps in both PEA and climate litigation literature by proposing the best-case scenario for the two to come together. It also forwarded the two fields by considering more recent, substantial developments in the case law that vastly improve the prospects of raising a successful climate tort in the UK, as well as important legal, political, and economic ramifications that could result from such a case.

If the UK, and even other countries such as the U.S., are to see successful climate torts in the future, there will have to be progress in a number of areas. First, test cases will have to be raised in the UK and, if predicated on extreme weather events, will have to carry convincing attribution studies in hand. Having high confidence (i.e. 90% or greater) that the risk of an event occurring *at least* doubled will have to be the baseline. Figures with less confidence and smaller risk will give judges more discretion with which to dismiss such cases. These events will sadly have to render serious damages, likely in the way of substantial harm or death. This precludes a number of opportunities otherwise available to a claimant and certainly which claimants could raise a case, but these are the circumstances if any climate tort is to have any chance of success.

Second, climate scientists, with the help of global citizen science (Massey et al. 2014), will have to continue addressing major climatic events as they come, and thus improve the base of PEA studies. The greater body of attribution literature generally comments on particular trends (e.g. increasing temperatures, changes in precipitation patterns and frequency, rising sea levels, etc.). These trends do and must continue to guide where PEA studies are focused. Additionally, as many regions of the world do not have the observed data and resources necessary to craft reliable regional climate models, the effort must continue to expand climatological and meteorological databases around the world to more closely examine and assess extreme weather events. Experts in this area will also have to develop the appropriate means with which to communicate this science in legal arenas if PEA is to hold weight in future climate cases.

Lastly, prospective claimants will have to make the case that existing climate change legislation is not enough and does not pre-empt the courts from taking action. The Netherlands serves as a model for potential plaintiffs, and as climate litigation in Belgium and other countries continues to mobilise, momentum and pressure will build and could compel the court in the UK to take action.

External factors will undoubtedly play into the prospects of a climate tort. The upcoming climate conference in France, COP 21, may ultimately produce a globally binding climate agreement that would require more aggressive climate action on the part of all involved countries. This may render climate litigation obsolete within the UK and beyond. Additionally, as climate litigation materialises, the UNFCCC's mechanisms to address loss and damages may shift as well to encompass a greater number of victims, including those of extreme weather events, within their ambit, eliminating the need for individuals to take litigative action for themselves.

Despite the obstacles faced and the challenges ahead, tort litigation has great potential to address the impacts of climate change and bring about change on any level. As David Hunter (2007) asserts, it is not necessarily imperative that such a case succeeds. It is more significant that cases are filed in the first place, and that they are recognised in the greater community. If global leaders fail yet again to produce another binding, global agreement this year in Paris, the responsibility will fall into the hands of the victims of climate change to seek their own remedies and incentivise change in policy and industry practice.

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