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Reserving for climate change

2023 Working Party Update:
Litigation, Wordings and Qualitative Tools

General Insurance Climate Change Reserving Working Party

"To avoid giving false comfort, without causing undue alarm"

September 2023

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In preparing this paper, members of the working party have reviewed an extensive volume of underlying legal and other documents and research papers in order to summarise in a generic fashion what they believe to be the key points to bring to the attention of reserving actuaries. The working party emphasises that this is not a legal or scientific analysis of the arguments, and no conclusions should be drawn from this paper regarding the merits or otherwise of the legal, scientific and moral arguments presented. The paper is intended to provide an overview of the materials reviewed and of areas which, in the opinion of the working party, may be of interest to actuaries. It should be noted however that the topics presented reflect only a small number of the areas which could have been considered in relation to this topic.

While care has been taken to present the information accurately and as understood by members of the working party at the time of preparing this paper, no duty of care is accepted by the authors, nor is any liability for any errors or omissions contained within it. Any party choosing to place reliance on the information contained within this paper does so at their own risk.

Readers should therefore ensure that (i) they should obtain their own legal or other professional advice regarding matters presented in this paper, including, but not limited to, specific questions relating to the legal and regulatory cases presented and their impact on the insurance lines of business discussed; (ii) they are aware of subsequent updates that may affect their interpretation of the matters presented in this paper. While care has been taken to present the information as understood at the time of preparing this paper, recent and future developments may affect the interpretation of the matters presented, potentially materially.

The working party has sought to accurately reference and attribute the sources and images used in preparing this paper. Please contact the authors if you believe that any of the references included is incorrect or omitted.

Abstract

The paper considers three important topics for general insurance reserving actuaries arising from climate change:

- Background to some of the key issues that reserving actuaries need to be aware of when determining how they address climate change in their reserve estimates. The topic is introduced through a number of litigation case studies.
- How reserving actuaries can communicate uncertainty arising in reserve estimates as a result of climate change. This section identifies and proposes some possible solutions to limitations in the current wordings normally used by general insurance reserving actuaries.
- Some qualitative tools that reserving actuaries can use when analysing their portfolios. This includes diagnostic questions for business functions, and heatmap tools for two portfolio types.

Keywords

General insurance; Reserving; Climate change; Litigation; Liability; SAO; Lloyd's; Large loss uncertainty wordings.

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Table of Contents

Table of Figures

1 Overview of this Paper

1.1 Introduction

The Climate Change Working Party was established in 2022 to address the needs of the general insurance actuarial community involved in reserving. Up to this point, there was a relatively common perception that climate change was not really a reserving issue. Assumptions were made that up until a major (climate-induced) natural catastrophe had arisen, this was an area for pricing and catastrophe modelling actuaries whose focus was on the evolving risk; once a material event had happened, the tools were well-established and reserving actuaries knew what they were doing.

The reality is quite different.

For reserving actuaries, climate change is an emerging issue that occurs across portfolios and in unexpected places. Not only does climate change need to be a feature of natural catastrophe and unearned exposure reserving, its impact on any property and casualty portfolio needs careful consideration. Prior earned business is at risk of climate change impacts as well, reaching back from today into the back-book. Climate change-related physical, transitional and liability risks are all of relevance for all reserving actuaries.

Indeed, the challenge of allowing for climate change may well be particularly acute, as many claims arising in connection with climate change lack a clear identifier of this as an underlying cause.

This paper will not tell you everything you want, or perhaps need, to know about climate change. Nor does it seek to convince you that climate change is a real phenomenon or whether it is anthropogenic. It does not seek to advance a position regarding whether and how you might adapt the manner in which you choose to live your life. In fact, no more is required than a recognition that climate change is, and is likely to remain, a current issue of debate and discovery for the working lives of actuaries now and for the foreseeable future.

This paper therefore seeks only to start the discussion around how reserving actuaries can respond and adapt to climate change in their professional capacity. As an emerging generational challenge, it is important that reserving actuaries are equipped to avoid giving false comfort in their estimates. At the same time, they need the tools and information so that they are in a position to draw attention to the issues arising while not causing undue panic and alarm in the face of inevitable uncertainty. In this way, reserving actuaries will be able to participate effectively in the industry response and development of the solutions to the problems posed by climate change.

1.2 Scope and Structure of Paper

This paper is presented in three main sections, together with this introduction and a final section with some concluding comments.

Section 2 provides an overview of ongoing litigation, including two landmark case studies. Through this lens, some of the key aspects of climate change for reserving actuaries are presented. We believe that this provides both an overview of the underlying scientific arguments, and the means through which these ideas are being translated into financial consequences. Through legal compensation mechanisms, costs may emerge that ultimately fall to insurers and reinsurers. At present, the financial outcome of such processes remains highly uncertain.

Section 3 focuses on how the reserving actuary could go about communicating the uncertainty around the potential financial consequences for reserves of climate change. We have started from the established wordings used by reserving actuaries to discuss uncertainty, and suggested some possible solutions that may help to overcome issues identified from our consideration of climate change. The working party expect this section to trigger further discussion and stakeholder consultation given the usage of the established wording and are not suggesting adoption at this time

but do consider the timing for the debate is appropriate given the challenges faced by reserving actuaries.

Section 4 turns to the question of where reserving actuaries should begin when trying to analyse the exposure to climate change within the portfolio. To begin the process of addressing this vast topic, the working party proposes a qualitative assessment methodology. The first is a set of questions that reserving actuaries can ask as part of their information gathering activity. Case studies are then presented for two lines of business: Property Damage/Business Interruption and Directors' & Officers' Liability in the form of heatmaps. These heatmaps have a two-fold purpose: to show where in each portfolio the working party considers the most significant risks for insurers exist, and to provide a framework that reserving actuaries can adopt in considering their portfolios more widely.

Finally, Section 5 sets out some concluding observations, drawing together the key points the working party have made in the paper.

Readers will note that up until Section 4 there is very little discussion of line of business specific material. This has been a conscious and deliberate decision on the part of the working party. The working party are keen to encourage all reserving actuaries to consider the implications of climate change and avoid a situation where this paper might be felt to have less relevance to reserving actuaries with portfolios that have not been addressed directly.

Although for many the natural manifestation of climate-related events is through the physical risks arising from changing and potentially more extreme weather events, for insurers and actuaries, there are two other types of risks to reserves that should be considered. First, there will be unexpected losses emerging as society seeks to adapt to a changing climate. Second, there will be liability implications arising as society attributes accountability for past and current actions deemed to have caused or exacerbated physical losses and risks. As a result, a structured approach to addressing physical, transition and liability risks is important.

1.3 Setting the scene – climate risks taxonomy

This paper adopts a consistent taxonomy to outline the risks from climate change. The UK Financial Stability Board developed a climate change risk taxonomy which is split into the main categories: physical, transitional or liability.

Physical risks are those associated with the changing climate. These are subdivided into categories:

- Acute physical risks – climate related risks that are event-driven e.g. more extreme weather events such as storms, floods, fires or heatwaves which may damage buildings and disrupt the supply of goods and services.
- Chronic physical risks – impact from longer term shifts in climate patterns such as higher global temperatures, rising sea levels, and reduced water availability.

Transition risks are the risks resulting from moving to a "greener" way of life. Factors which influence this include adjusting to climate-related developments in policy and regulation, emergence of disruptive technology or business models, shifting sentiment and societal preferences and evolving evidence, frameworks and legal interpretations[1]. Transition risks are developing rapidly as governments support and subsidize low-carbon industries and regulate and tax high-carbon ones. Further information on the types of sub-risks for transition risks such as policy, legal, technology,

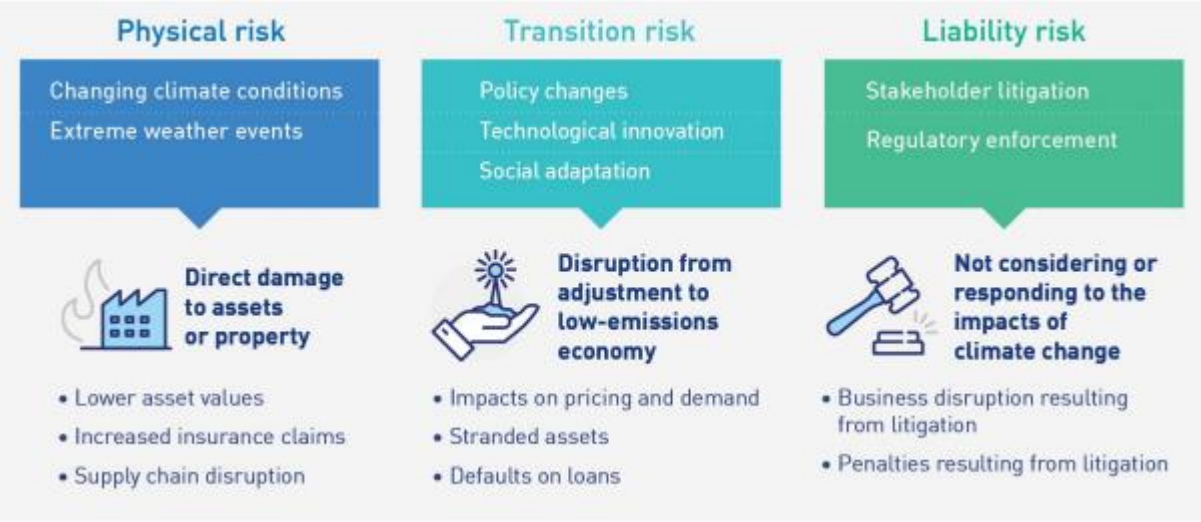
[1] Massey M (2022) Climate Change Enterprise Risk Management: A Practical Guide to Reaching Net Zero Goals United Kingdom Kogan Page Ltd

market sentiment and reputation risks are found in the opinion on climate change risk scenarios issued by the European Occupational Pensions Authority[2].

Liability risks relate to both the increased amount of litigation due to the aforementioned risks, as well as due to increased climate related regulation. They stem from the potential risk of litigation for failing to avoid or minimize adverse impacts of the climate or failing to adapt to climate change. The risk also extends to stakeholders that are seeking compensation from past climate inactivity or misrepresentation.

The risk taxonomy is further explained in Figure 1, below.

Figure 1 Types of climate-related risks[3]



The split of climate risks into their main components forms the taxonomy used in the construction of qualitative tools that reserving actuaries can use when analysing their portfolios as outlined in section 4 of this paper.

1.4 Working party membership

The following individuals were active members and co-chairs (*) of the working party during 2023:

Alex Marcuson*, James Orr*, Keat Ang, Yurie Budhu, Josie Durley, Laura Evans, Konrad Farrugia, Sarah Grimshaw, Nicky Holtzhausen, Pamela Hoto, Martin Massey, Lara Palmer, Steve Patfield, Ian Penfold, Nidhi Rathod, Nikhil Shah, Clifford Smith, Lucy Thomas, Hannah Tonkin, Charlie Winnan

1.5 Acknowledgements

The working party members would like to thank the Institute and Faculty of Actuaries Staff for their help in preparing this paper and to Holly Burdikin of the Bank of England for assisting us with organising our meetings.

We would also like to thank Sharanjit Paddam and Rade Musulin of Finity Consulting for providing us with the motivation to dig below the surface of this topic, Nigel Brook of Clyde and Co LLP for helping us to understand the legal issues and Catherine Barton and Caroline Barlow for reviewing advanced drafts of this paper and providing us with thoughtful suggestions on how to improve it.

[2] https://www.eiopa.europa.eu/system/files/2021-04/opinion-on-climate-change-risk-scenarios-in-orsa.pdf
[3] Australian Prudential Regulatory Authority Prudential Practice Guide CPG Climate Change Financial Risks November 2021 https://www.apra.gov.au/sites/default/files/2021-11/Final%20Prudential%20Practice%20Guide%20CPG%20229%20Climate%20Change%20Financial%20Risks.pdf

2 Climate Change Litigation Case Studies

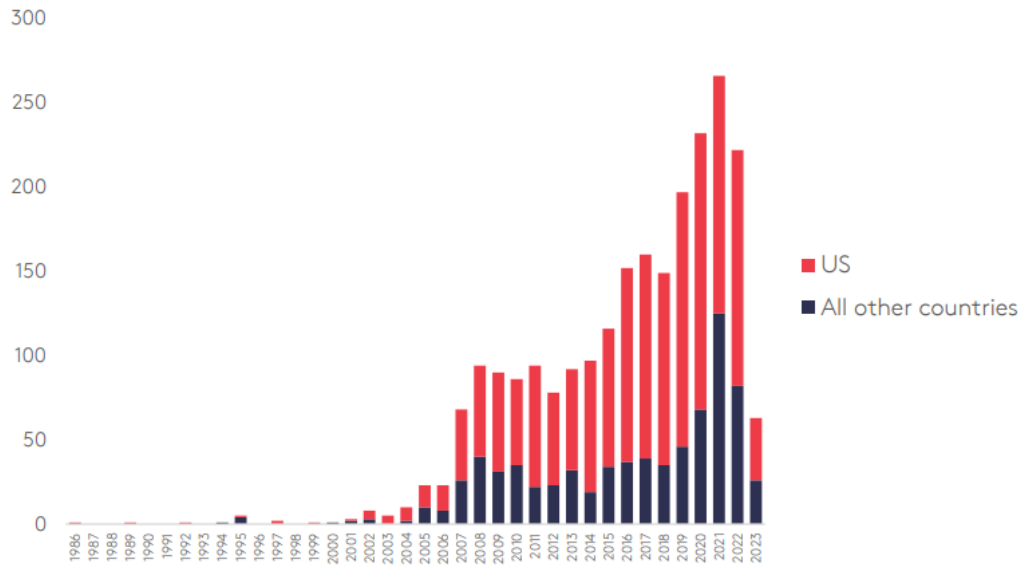
2.1 Introduction

The working party is mindful that there is much discussion of the emerging physical impacts of climate change, whether wildfires, more extreme rainfall patterns, flooding or windstorms, to name just a few. Whilst clearly important, the working party believes that general insurance reserving practitioners are better sighted on developments in physical risks than on climate litigation. The aim in this section is therefore to illustrate the important developments and principles that are emerging in climate litigation, and to provide further reading for those who wish to learn more.

An intended by-product of this approach is that no description of climate litigation is possible without an outline of the financial effects of physical and transition risks. This is because those bearing the brunt of the direct and indirect costs of climate change are seeking to recoup these costs from those that they believe are ultimately responsible.

Figure 2 highlights the increasing amount of climate related litigation. The May 2023 London School of Economics ("LSE") report "Global trends in climate litigation"[4] identifies 2,341 cases worldwide, of which two thirds were filed since 2015.

Figure 2 Total climate change litigation cases up to 31 May 2023[5]



A variety of different types of litigation is identified in the LSE report and from our wider research:

- **Framework cases:** These challenge governments' overall responses. For example, the Urgenda Foundation - a Dutch environmental group - and 900 Dutch citizens have sued the Dutch government, requiring that it do more to prevent climate change.
- **Direct tort/compensation cases:** Two significant cases which highlight distinctive and evolving approaches being adopted by claimants are discussed in detail in this section. The first case *City & County of Honolulu vs Sunoco LP and others* (see section 2.32.3) comprises a direct claim for damages against a large number of "Carbon Majors" and other fossil fuel companies in respect of various alleged past actions. A second case - *Lliuya vs. RWE AG* (see section 2.4) - is a case brought in Germany by a Peruvian farmer and mountain guide in

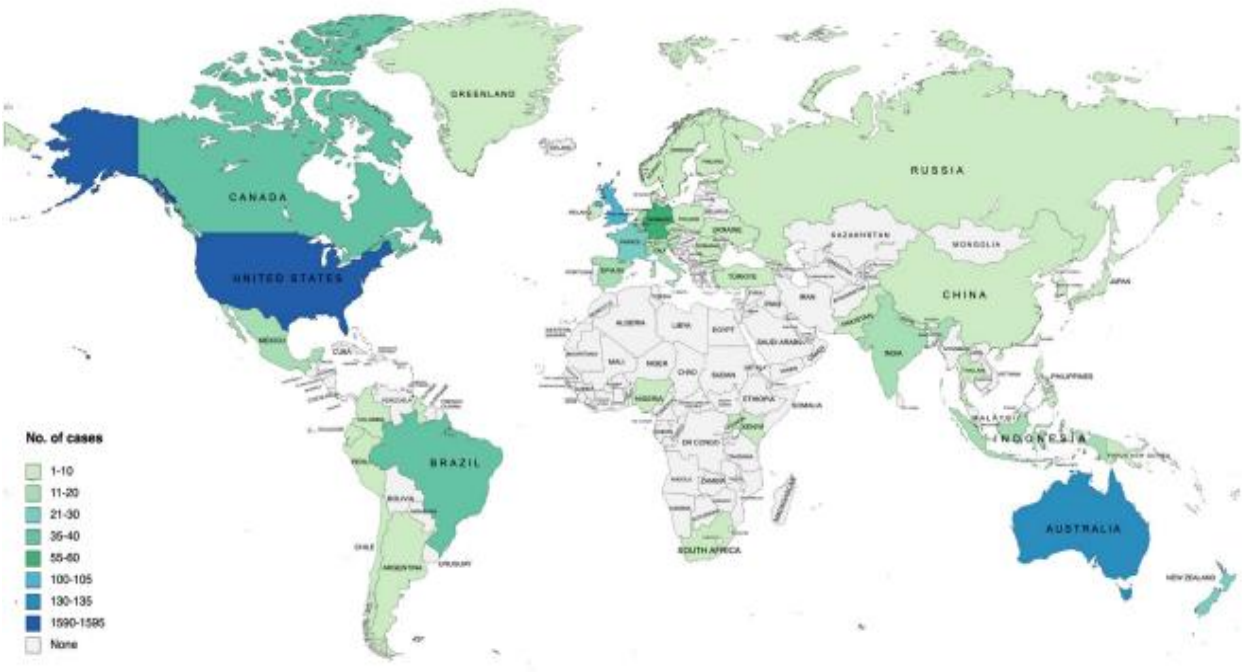
[4] Global trends in climate litigation (LSE 2023) https://www.lse.ac.uk/granthaminstitute/publication/global-trends-in-climate-change-litigation-2023-snapshot
[5] Ibid.

respect of costs incurred to mitigate the consequences of climate change. These cases involve various scientific and legal concepts that have not been tested in the context of climate change. Summaries (see section 2.6) are also given for a small number of other claims before the courts, some being applied more widely than energy industry firms.

- **Strategic cases:** The LSE report identifies a rising number of cases brought with a strategic ambition. These cases have been brought (by claimants, defendants and insurers) to obtain at an early stage a legal ruling on a particular principle, with a view to using such rulings in anticipated future litigation.
- **"Counter claims":** The working party has noted that some litigation and threats of litigation have been brought with a view to reducing the time or cost expended by firms or industry coordination associated with reducing climate emissions. A notable casualty of the threat of anti-competitive action reported during 2023 was the UN-sponsored Net Zero Insurance Alliance ("NZIA") that was seeking to promote a coordinated approach by insurers and reinsurers in their evaluation and reporting of carbon emissions in underwriting activity. We describe this in more detail in section 2.8.
- **"Silent climate claims":** The working party would observe that, owing to the politicised nature of some debate, particularly in the USA, regarding climate change and the legal merits of a focused approach to setting out complaints, many climate change-related tort/compensation cases deliberately avoid making any reference to climate change. By their nature, such claims are hard to identify, however anecdotally there have been professional indemnity/errors & omissions cases brought against architects and engineers for failing to make appropriate climate change allowances in their work.

Figure 3, also taken from the LSE Report[6], shows the geographical distribution of the climate litigation cases as at 31 May 2023. It can be seen that this litigation broadly aligns with the size of the economy and nature of the legal market in each country.

Figure 3 Number of climate litigation cases around the world, per jurisdiction (up to 31 May 2023)[7]



[6] Ibid.
[7] Global trends in climate litigation (LSE 2023) https://www.lse.ac.uk/granthaminstitute/publication/global-trends-in-climate-change-litigation-2023-snapshot https://www.lse.ac.uk/granthaminstitute/publication/global-trends-in-climate-change-litigation-2023-snapshot

2.2 Overview of arguments underpinning climate change litigation

Before looking into the various cases, this paper provides a recap of the key scientific arguments that underpin many of the direct tort claims. Central to the arguments put forward in each case is the principle that responsibility (and hence liability) can be attributed to those who have contributed towards the presence of greenhouse gases ("GHGs") in the atmosphere. Note that the two key cases discussed in this section, *City & County of Honolulu vs. Sonoco LP and others* and *Lliuya vs. RWE AG*, appear to approach the attribution of liability differently. This reflects the differences in the construction of the legal arguments.

As explained in more detail below, the science presented in these cases attributes the presence of GHGs as one of the main drivers of anthropogenic climate change. The argument is then made that the increased adaptation costs, and increased risks and losses resulting from the direct physical impacts as a result of climate change are linked to each defendant's GHG emissions.

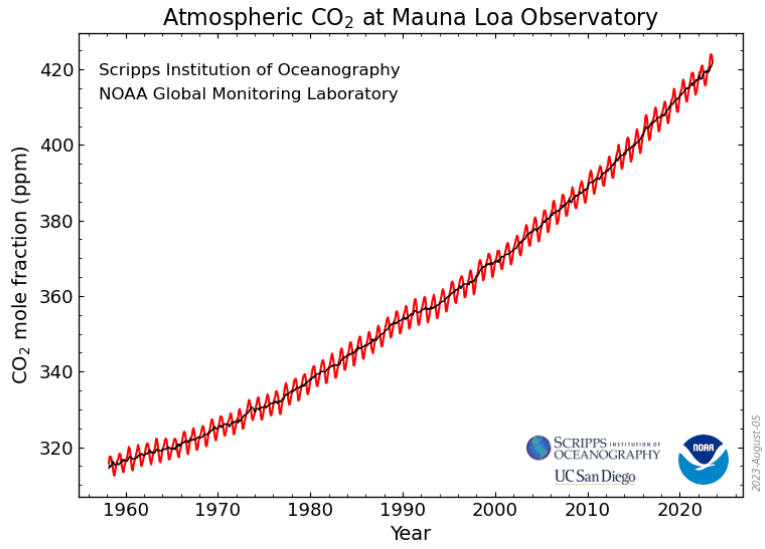
The importance of GHG emissions and atmospheric concentrations for climate change

One of the effects of increased levels of GHGs in the atmosphere is that it increases a process referred to as *Radiative Forcing*[8]. This is the difference between the Earth's overall incoming and outgoing radiation resulting in a substantial increase in energy and heat retention on Earth. It is this additional heating within the atmosphere that is the main driver of global warming.

Concentration of carbon dioxide in the atmosphere

Although there is a range of identified GHGs, the most prominent is carbon dioxide (CO_2), the atmospheric concentration of which has been measured directly and consistently since 1958 at the Mount Loa Observatory on the Big Island of Hawaii[9]. Figure 4 shows the atmospheric parts per million (ppm) of CO_2, as measured under the Scripps CO_2 programme, which was initiated by Charles David Keeling in 1956[10]. As can be seen, the concentration of CO_2 has risen rapidly since 1958 where the chart data begins. This level itself is significantly higher than the pre-industrial (i.e. before 1751) level of some 275 ppm. This graph is commonly referred to as "The Keeling Curve".

Figure 4 Atmospheric CO_2 measured per year at the Mauna Loa Observatory[11]



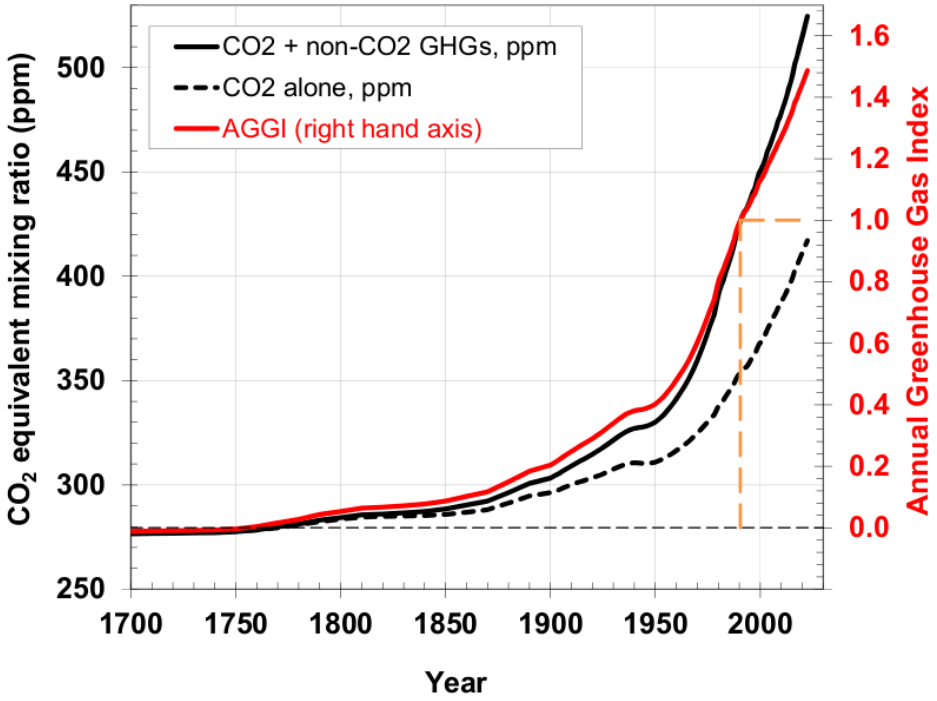
[8] Climate Data Primer (National Oceanic and Atmospheric Administration Climate.gov) https://www.climate.gov/maps-data/climate-data-primer/predicting-climate/climate-forcing
[9] https://gml.noaa.gov/ccgg/trends/mlo.html
[10] https://keelingcurve.ucsd.edu/2013/04/03/the-history-of-the-keeling-curve/
[11] https://gml.noaa.gov/ccgg/trends/mlo.html

In this chart, the red line shows the monthly mean CO_2 measurements, and the black line shows the same data after correction for the average seasonal cycle. This seasonal (annual) cycle that can be observed is the result of photosynthetic activity by plants. Seasonal swings in CO_2 are most pronounced in the Northern Hemisphere, where the seasonal changes in temperature result in very large differences in plant photosynthesis from summer to winter. As plants begin to photosynthesise in the Northern Hemisphere spring and summer, they consume CO_2 from the atmosphere and eventually use it as a carbon source for growth and reproduction. This causes the decrease in CO_2 levels that begins every year in May. Once the Northern winter arrives, plants save energy by decreasing photosynthesis. Without photosynthesis, the dominant process is the exhalation of CO_2 by the total ecosystem, including bacteria, plants, and animals, causing an upswing in CO_2 before the cycle begins again in the Northern Hemisphere spring.

Impact of other greenhouse gases

The main greenhouse gases whose concentrations are rising are carbon dioxide, methane, nitrous oxide, hydrochlorofluorocarbons ("HCFCs"), hydrofluorocarbons ("HFCs") and ozone in the lower atmosphere[12]. In order to represent the overall effect of these GHGs, an aggregated metric has been created, called the Annual Greenhouse Gas Index ("AGGI"), which tracks the increasing amount of heat (radiative forcing) being added to the atmosphere by human-related GHG emissions. It is based on the measurements of GHGs in the atmosphere from sites around the world, so the working party understands that its uncertainty is very low[13]. Figure 5 shows the overall development of the AGGI, in units equivalent to CO_2 ppm since 1700, before the start of the industrial revolution.

Figure 5 Development of Annual Greenhouse Gas Index (AGGI) [14]



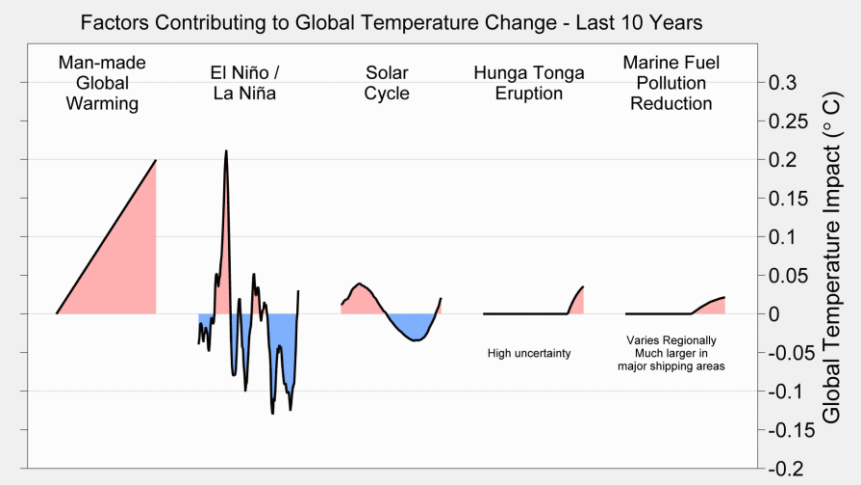
The current level of CO_2 in the atmosphere is some 420 ppm, as represented by the dashed black line above and corresponding to the Keeling Curve shown earlier. However, the effective level in

[12] https://public.wmo.int/en/our-mandate/focus-areas/environment/greenhouse-gases
[13] https://gml.noaa.gov/aggi/
[14] https://gml.noaa.gov/aggi/

CO_2-equivalent terms of GHGs combined is in excess of 520 ppm, as represented by the solid black line above.

Figure 6 shows a stylised representation of the main drivers of global warming over the last ten years puts them into context, including man-made GHGs, the El Nino / La Nina and solar cycles, as well as water vapour (a naturally occurring GHG) from the January 2022 Hunga Tonga (Pacific) subsea eruption and the reduction in sulphur emissions (i.e. cooling particulates) from marine fuel in 2020.

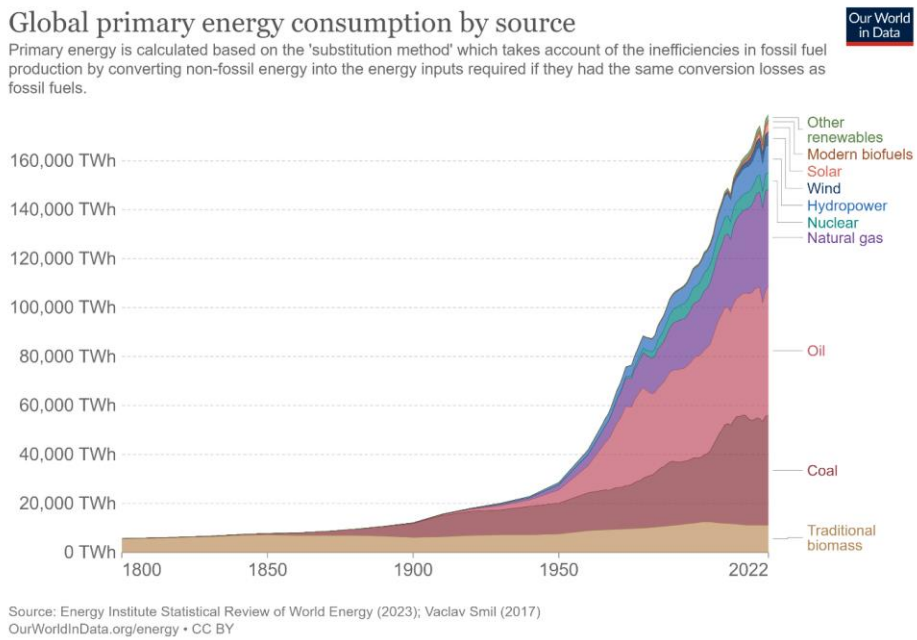
Figure 6 The main drivers of global warming over the last decade[15]



Why have greenhouse gas emissions increased so substantially?

The modern global economy relies on processes that consume energy through the burning of carbon-based fuels, with over 75% coming from the burning of oil, coal and natural gas. Figure 7 shows how rapidly the consumption of these fuels has increased over the last 100 years.

Figure 7 - Global primary energy consumption by source[16]



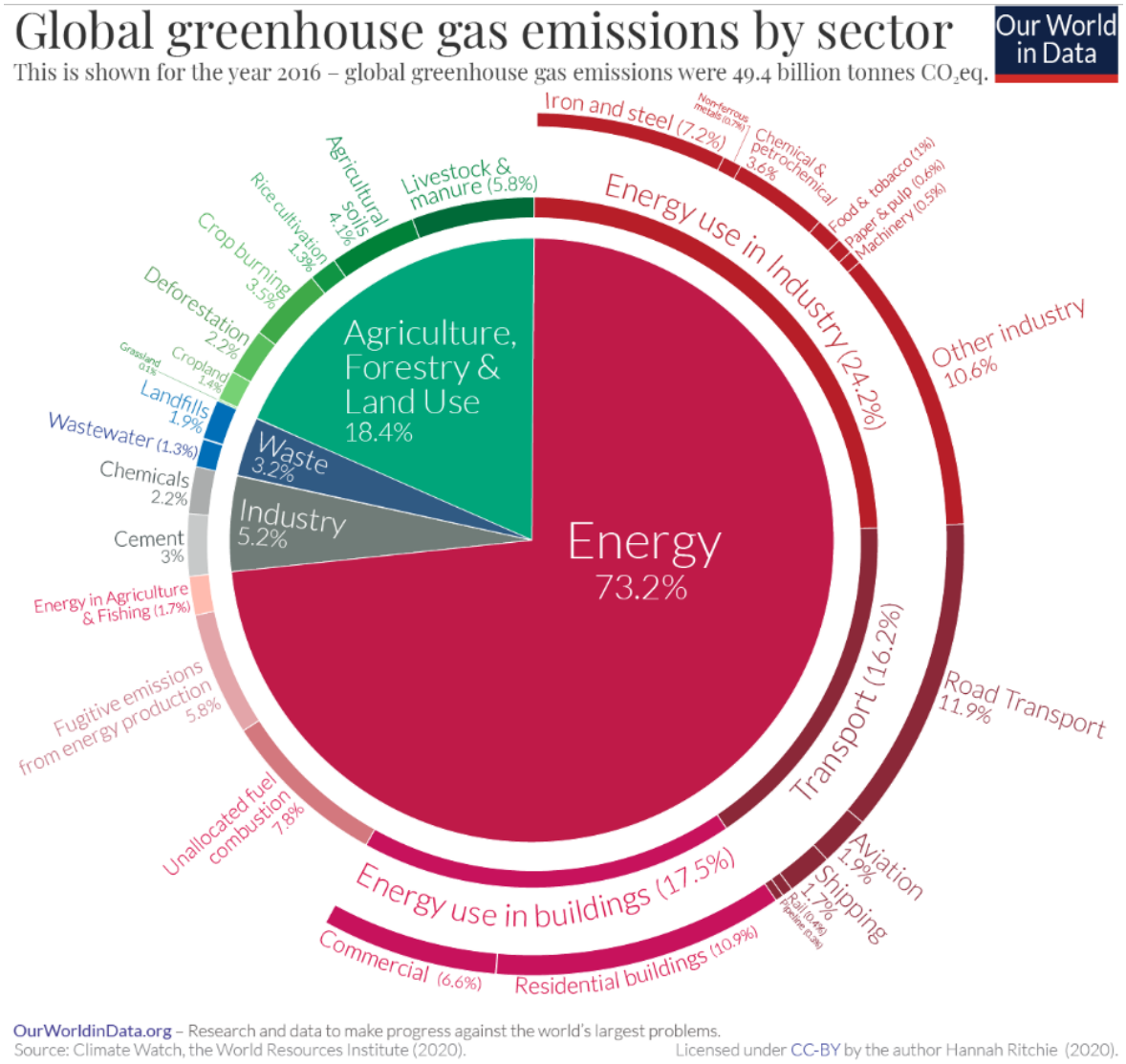
[15] Berkeley Earth - August 2023 Temperature Update https://berkeleyearth.org/august-2023-temperature-update/
[16] https://ourworldindata.org/energy-mix

Aggregate consumption of energy looks set to continue, not least to support the growing global population, economic development and the consequent demand for cheap sources of energy.

Figure 7 shows that some progress is being made in decarbonising the global economy through increasing the use of low-carbon sources, including hydropower, wind, solar, bioenergy, geothermal and wave and tidal energy. Despite this, the continued rapid growth in aggregate demand for energy currently appears to require fossil fuel consumption to increase at least in the short term.

Burning fossil fuels generates carbon dioxide. Figure 8 shows the contribution of energy use to the overall generation of greenhouse gases for 2016.

Figure 8 Global greenhouse gas emissions by sector[17]



What does this mean for current GHG emission rates?

Whilst there has been a gradual increase in the share of low-carbon sources in recent years, this has been accompanied by rapidly rising levels of energy use overall. In addition to emissions from land-use and agriculture, our continuing reliance on fossil fuels for energy is the main driver of current and

[17] https://ourworldindata.org/emissions-by-sector#total-greenhouse-gas-emissions-by-sector

continuing GHG emissions[18] which are at historically high levels, exceeding 50 billion tonnes of CO_2-equivalent annually.

As demonstrated by the Keeling Curve and the AGGI, atmospheric GHG levels have been rising for much of the last 200 years, reflecting the cumulative effect of past emissions. Whilst some excess CO_2 emissions are absorbed quickly, most will remain in the atmosphere for thousands of years[19].

The scientific argument underpinning the legal cases described in this section is that historical GHG emissions are the main contributors to current, higher GHG concentration levels. In the second case of *Lliuya vs. RWE AG*, claimants have argued that responsibility of an entity for climate change can be determined in proportion to their share of historical emissions.

2.3 City & County of Honolulu vs Sunoco LP and others[20]

Overview

The following landmark climate litigation case study has been chosen by the working party as it presents a comprehensive description of the development of the scientific understanding of anthropogenic climate change and the (alleged) role and behaviour of the major fossil fuel companies. It also illustrates current (or certainly recent) thinking on how a legal case could be made to apportion responsibility for and to claim damages relating to climate change.

In March 2020, a complaint was filed in Hawai'i by the City and County of Honolulu against a number of named major corporate members of the fossil fuel industry including BHP, BP, Chevron, Exxon and Shell, plus fossil fuel industry associations such as the American Petroleum Institute (API), the Information Council for the Environment (ICE) and the Global Climate Coalition (GCC).

The complaint claims that the defendants had "…*known for nearly half a century that unrestricted production and use of their fossil fuel products create greenhouse gas pollution that warms the planet and changes our climate…that those impacts could be catastrophic and that only a narrow window existed to take action before the consequences would be irreversible.*" The complaint further states that the defendants had "*engaged in a coordinated, multi-front effort to conceal and deny their own knowledge of those threats, discredit the growing body of publicly available scientific evidence, and persistently create doubt in the minds of customers, consumers, regulators, the media, journalists, teachers, and the public about the reality and consequences of the impacts of their fossil fuel pollution*".

The complaint itself runs to some 119 pages. It presents evidence in support of the above claims, including internal company documents from Exxon in particular, which had an active and well-documented research programme, and which is mentioned most often in the court filing. The working party has focused on the largest section in the document, titled "Factual Background", and has sought to summarise it below, using the eight subsection labels A. to H. and the title headings as presented in the original complaint document. In summarising these sections, the selections made by the working party are subjective and somewhat arbitrary, with the aim of illustrating the nature of the information being presented and the claims being made. As such, they may not necessarily represent all of the key points of legal (or scientific) substance.

Because the summary below is based on the claimant's position, without access to the countervailing arguments by the defendants, it may appear to the reader that the position regarding liability is clear-cut. In reality, the working party anticipate that the case will be closely fought with many complex legal issues to be addressed by the court, including avenues for appeal.

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[18] https://ourworldindata.org/greenhouse-gas-emissions
[19] https://www.epa.gov/climate-indicators/greenhouse-gases
[20] https://climatecasechart.com/wp-content/uploads/case-documents/2020/20200309_docket-1CCV-20-0000380_complaint.pdf

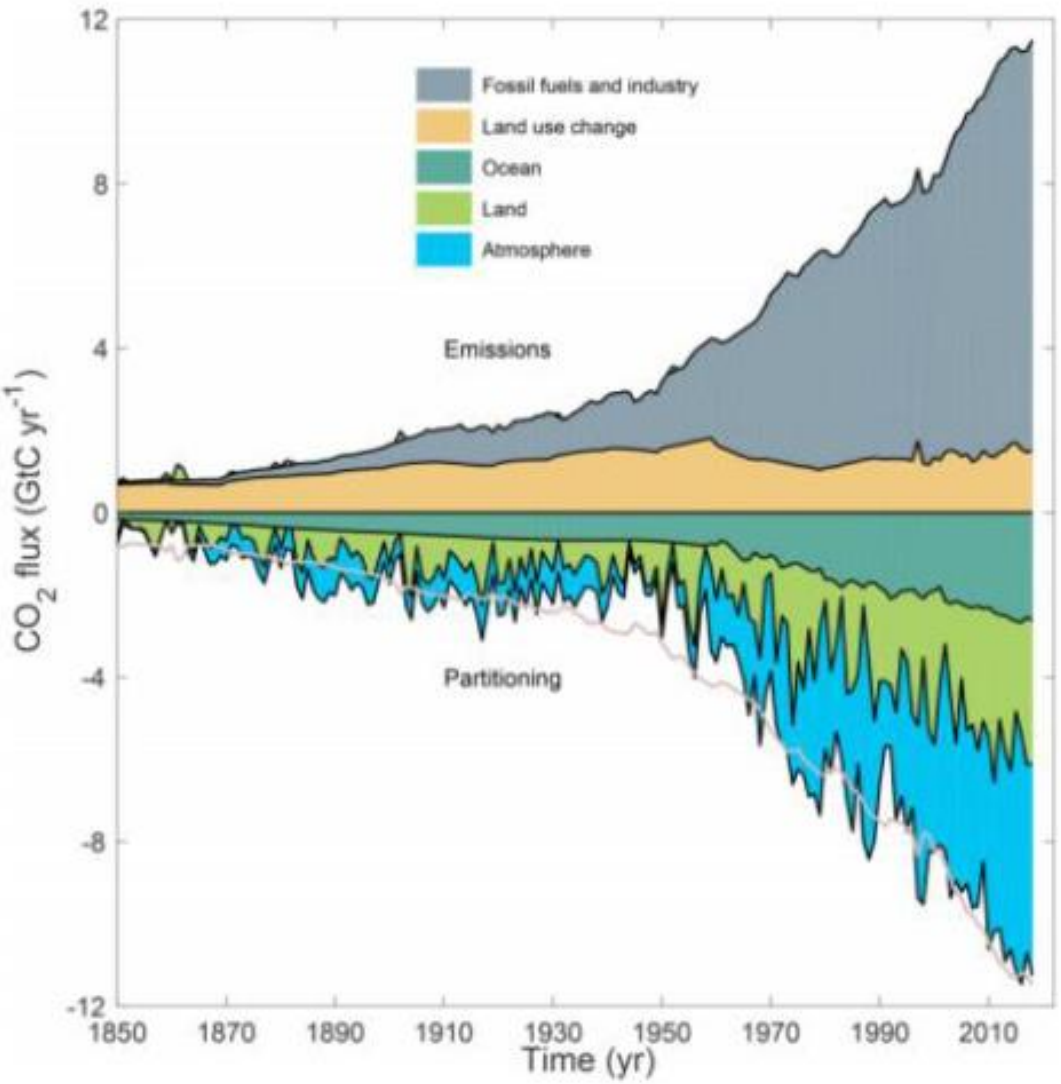
Section Summary - Factual Background

A. Climate Disruption—Cause and Effects

The document states that human-caused warming of the Earth is unequivocal and that, as a result, the atmosphere and oceans are warming, sea level is rising, snow and ice cover is diminishing, oceans are acidifying, and hydrologic systems (i.e. where water resides, in what form, where it moves to and how) have been altered. It further states that the mechanism by which human activity causes global warming is well-established and is overwhelmingly caused by anthropogenic greenhouse gases, which are largely by-products of humans combusting fossil fuels.

Subsection A. includes Figure 9, which shows the flow (or "flux") of CO_2 with emissions from various sources, including fossil fuels, and where these are absorbed, including into the oceans, land and (crucially) the atmosphere, which is driving the greenhouse effect. The graph also illustrates the "Great Acceleration" in fossil fuel use since the 1950s.

Figure 9 Annual anthropogenic CO_2 emissions and partitioning in the environment 1850-2018[21]



[21] City & County of Honolulu vs Sunoco LP and others, page 32 and attributed to P. Frumhoff et al. The Climate Responsibilities of Industrial Carbon Producers, 132 CLIMATIC CHANGE 157, 164 (2015), https://link.springer.com/article/10.1007/s10584-015-1472-5 although chart does not appear in underlying source.

Subsection A. lists some of the environmental and physical consequences of the disruption to the Earth's energy balance, including flooding and inundation of land and infrastructure, increased erosion, higher wave run-up and tides, increased frequency and severity of storm surges, saltwater intrusion, and other impacts of higher sea levels. It also mentions longer periods of drought interspersed with fewer and more severe periods of precipitation, and associated impacts on the quantity and quality of water resources available to both human and ecological systems. It claims that the consequences of the defendants' conduct and their exacerbation of the climate crisis are already impacting the city (of Honolulu) and will continue to increase in severity.

B. Attribution

Here, the court filing states that use of the defendants' fossil fuel products will have released a substantial percentage of anthropogenic greenhouse gases between 1965 and the present day, and that these are quantifiable individually and in the aggregate. The filing also claims that the (higher) level of these emissions reflects the conduct and actions of the defendants in concealing the hazards of fossil fuel products and their campaign against regulation.

C. Defendants Went to Great Lengths to Understand, and Either Knew or Should Have Known About the Dangers Associated with Their Fossil Fuel Products

Subsection C. sets out a timeline for research into atmospheric CO_2, its potential and observable impact on global warming, beginning in the 1950s and running up to the 1990s. Some key milestones are highlighted below.

1954 - Geochemist Harrison Brown and his colleagues at the California Institute of Technology wrote to the API, informing the trade association that preliminary measurements of natural archives of carbon in tree rings indicated that fossil fuels had caused atmospheric carbon dioxide levels to increase by about 5% since 1840.

1959 - The API organized a centennial celebration of the American oil industry with a keynote speech by nuclear physicist Edward Teller, who warned the industry that "a temperature rise corresponding to a 10 per cent increase in carbon dioxide will be sufficient to melt the icecap and submerge…all the coastal cities."

1965 - President Lyndon B. Johnson's Science Advisory Committee's Environmental Pollution Panel reported that a 25% increase in carbon dioxide concentrations could occur by the year 2000, that such an increase could cause significant global warming, that melting of the Antarctic ice cap and rapid sea level rise could result, and that fossil fuels were the clearest source of the pollution. LBJ gave a subsequent special message[22] to Congress that "This generation has altered the composition of the atmosphere on a global scale through…a steady increase in carbon dioxide from the burning of fossil fuels."

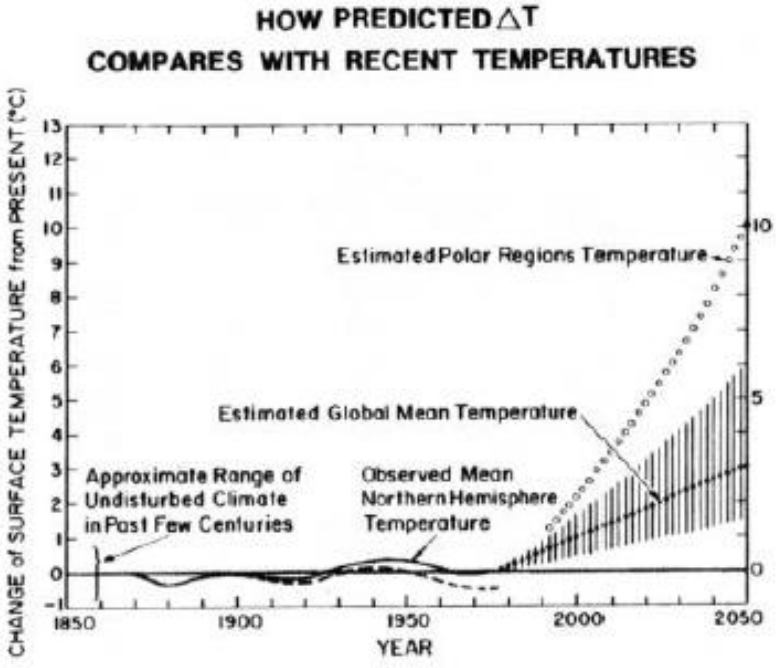
1969 - The Stanford Research Institute (SRI) delivered a report on air pollution to the API, projecting that atmospheric CO_2 concentrations would reach 370 ppm by 2000 - almost exactly what it turned out to be (369 ppm). The report explicitly connected the rise in CO_2 levels to the combustion of fossil fuels, finding it "unlikely that the observed rise in atmospheric CO_2 has been due to changes in the biosphere."

1978 - James Black of Exxon's Products Research Division reported that "current scientific opinion overwhelmingly favours attributing atmospheric carbon dioxide increase to fossil fuel consumption," and that doubling atmospheric carbon dioxide, according to the best climate model available, would

[22] A 50th Anniversary Few Remember: LBJ's Warning on Carbon Dioxide | JFP Mobile | Jackson, Mississippi (jacksonfreepress.com)

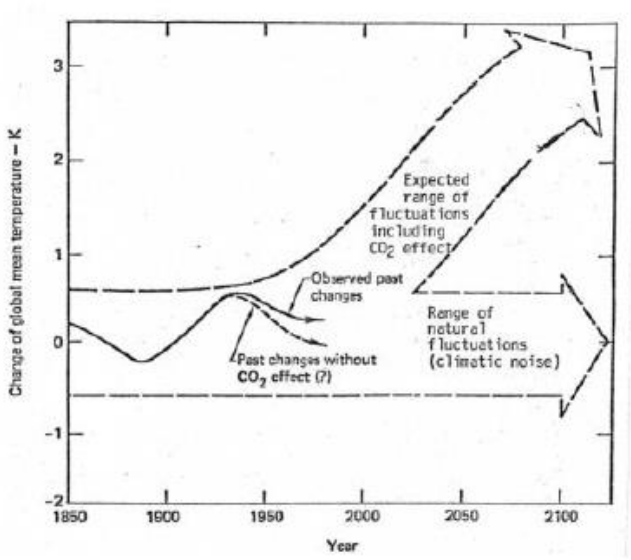
"produce a mean temperature increase of about 2°C to 3°C over most of the earth," with double to triple as much warming at the poles, as illustrated in this Figure 10.

Figure 10 Future global warming - 1977 prediction from internal Exxon document[23]



1980 - Exxon's Henry Shaw distributed a memorandum on the "CO_2 Greenhouse Effect." The memo included Figure 11, which illustrates global warming anticipated by Exxon, as well as the company's understanding that significant global warming would occur before exceeding the range of natural variability and being detected.

Figure 11 Exxon forecast impact of emissions on global temperatures[24]

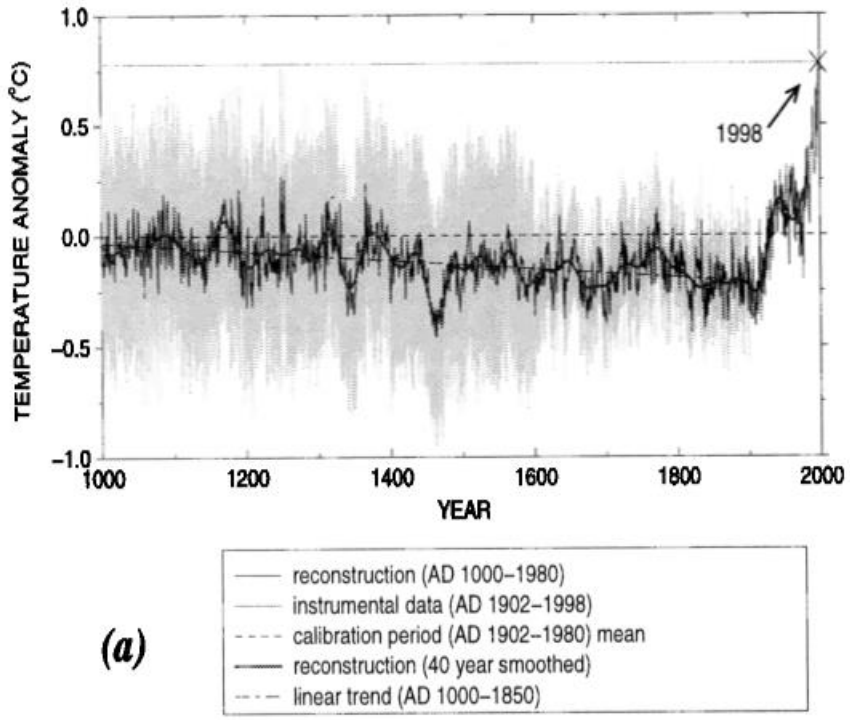


[23] City & County of Honolulu vs Sunoco LP and others, page 40 - Memo from J.F. Black to F.G. Turpin, The Greenhouse Effect, Exxon Research and Engineering Company (June 6, 1978), http://www.climatefiles.com/exxonmobil/1978-exxon-memo-on-greenhouse-effect-for-exxon-corporation-management-committee page 26.

[24] Internal briefing on CO_2 "Greenhouse" Effect (Exxon, 1982); Source: Inside Climate News https://insideclimatenews.org/wp-content/uploads/2015/09/1982-Exxon-Primer-on-CO2-Greenhouse-Effect.pdf

The "CO_2 Greenhouse Effect" memo included the prediction that levels of global warming would become significant by the turn of the century (in 2000) and observably higher than natural levels of variation. In 1999, evidence of a clear climate change signal was provided in the "Hockey Stick" graph (shown in Figure 12) published in the Geophysical Research Letters journal[25]. The published paper stated that "*20th century warming counters a millennial-scale cooling trend which is consistent with long-term astronomical forcing*".

Figure 12 The "Hockey Stick" graph[26]



1988 - The Shell Greenhouse Effect Working Group issued a confidential internal report, "The Greenhouse Effect," which acknowledged global warming's anthropogenic nature: "Man-made carbon dioxide released into and accumulated in the atmosphere is believed to warm the earth through the so-called greenhouse effect." The authors also noted the burning of fossil fuels as a primary driver of CO_2 build-up and warned that warming could "create significant changes in sea level, ocean currents, precipitation patterns, regional temperature and weather." They further pointed to the potential for "direct operational consequences" of sea level rise on "offshore installations, coastal facilities and operations (e.g. platforms, harbors, refineries, depots)."

D. Defendants Did Not Disclose Known Harms Associated with the Extraction, Promotion, and Consumption of Their Fossil Fuel Products, and Instead Affirmatively Acted to Obscure Those Harms and Engaged in a Concerted Campaign to Evade Regulation.

Subsection D. of the complaint sets out how key events during the period 1988–1992 appear to have prompted the defendants to change their tactics from general research and internal discussion on climate change to a public campaign aimed at evading regulation of their fossil fuel products and/or emissions. Those key events included:

[25] Northern hemisphere temperatures during the past millennium: Inferences, uncertainties, and limitations (wiley.com)
[26] Ibid.

a. In June 1988, NASA scientist James Hansen's presentation to the US Congress which confirmed that human activities were contributing to global warming, gaining significant news coverage and publicity, including coverage on the front page of the New York Times.

b. In July 1988, Senator Robert Stafford and four bipartisan co-sponsors introduced "The Global Environmental Protection Act," to regulate CO_2 and other greenhouse gases, followed by four more bipartisan bills to significantly reduce CO_2 pollution over the following ten weeks. U.S. presidential candidate George H.W. Bush also pledged that his presidency would "combat the greenhouse effect with the White House effect."

c. In December 1988, the United Nations formed the Intergovernmental Panel on Climate Change (IPCC), a scientific panel dedicated to providing the world's governments with an objective, scientific analysis of climate change and its environmental, political, and economic impacts.

d. In 1990, the IPCC published its First Assessment Report on anthropogenic climate change, in which it concluded that:

   (1) "there is a natural greenhouse effect which already keeps the Earth warmer than it would otherwise be," and

   (2) "that emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxide. These increases will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface. The main greenhouse gas, water vapour, will increase in response to global warming and further enhance it."

e. The United Nations began preparing for the 1992 Earth Summit in Rio de Janeiro, Brazil. The Summit resulted in the United Nations Framework Convention on Climate Change (UNFCCC), an international environmental treaty providing protocols for future negotiations aimed at "stabiliz[ing] greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

Subsection D. then describes alleged actions taken by the defendants and associated trade bodies (the API, ICE and GCC) with the aim of evading the introduction of regulations. The working party would encourage readers to refer to the original court filing to learn more.

E. In Contrast to Their Public Statements, Defendants' Internal Actions Demonstrate Their Awareness of and Intent to Profit from the Unabated Use of Fossil Fuel Products

Subsection E. lists a number of design and investment decisions taken by the defendants that take account of anthropogenic climate change, including: raising offshore oil platforms to protect against sea level rise; reinforcing offshore oil platforms to withstand increased wave strength and storm severity; and developing and patenting designs for equipment intended to extract crude oil and/or natural gas in areas previously unreachable because of the presence of polar ice sheets.

F. Defendants' Actions Have Exacerbated the Costs of Adapting to and Mitigating the Adverse Impacts of the Climate Crisis

Subsection F. discusses the impact of delays in addressing climate change, statements made by the defendants which acknowledge the costs of inaction on anthropogenic climate change (e.g. a speech made by John Browne of BP), investments made by defendants in technologies to reduce emissions (e.g. investment in new engine technologies by Exxon), public statements about moving to net zero emissions by Shell and BP's "Beyond Petroleum" slogan.

Subsection F. then goes on to describe how defendants could have taken other practical, cost-effective steps to reduce the use of their fossil fuel products. These included sharing scientific evidence, more open communication of risks and impacts with shareholders, banks, insurers, the public and regulators. The complaint also states that defendants could have refrained from their actions to undermine regulations, supported and encouraged policies to avoid dangerous climate change, made sustained investments in renewable energy sources and taken more account of shareholders resolutions to change policies and business practices regarding climate change.

G. Defendants Continue to Mislead About the Impact of Their Fossil Fuel Products on Climate Change Through Greenwashing Campaigns and Other Misleading Advertisements.

This subsection is critical of defendants' current practices in relation to advertising, claims that their products are "green" or "clean", failing to inform consumers about the effects of their fossil fuel products in causing climate change. The complaint also alleges “greenwashing” campaigns playing to consumers’ concerns about climate change and promoting the impression that defendants are substantially diversified energy companies making meaningful investments in low carbon energy compatible with avoiding catastrophic climate change. In contrast, between 2010 and 2018, a recent study[27] identified that BP spent 2.3% of total capital spending on low carbon energy sources, Shell spent 1.2%, and Chevron and Exxon 0.2% each.

The subsection ends by drawing comparison between the identified need to reduce greenhouse gas emissions to address climate change and the stated growth ambitions of the firms themselves, which point to higher levels of future greenhouse gas emissions.

H. Defendants Caused the City’s Injuries.

This final subsection of the Factual Background section sets out a number of present-day impacts that it claims the City and County of Honolulu has suffered as a result of climate change linked to the actions of the defendants. These include the impact of sea level rise to date and predicted in the future, the impacts on shorelines and existing infrastructure, including for drinking water, which is being affected by the decline in rainfall over the last thirty years and a shift to less frequent and more intense rainstorms interspersed with longer and more frequent droughts, as well as the effects of saltwater inundation, corrosion and coastal erosion.

Subsection H. also mentions the impact on natural resources and habitats for wildlife, ocean acidification from the take-up of CO_2, and public health impacts from extreme heat, pests and vector-borne illnesses. Infrastructure is also vulnerable to flooding, including "rain bomb" events, contributing to the heightened costs of increasing resilience and mitigating risks to the City's assets and to its citizens.

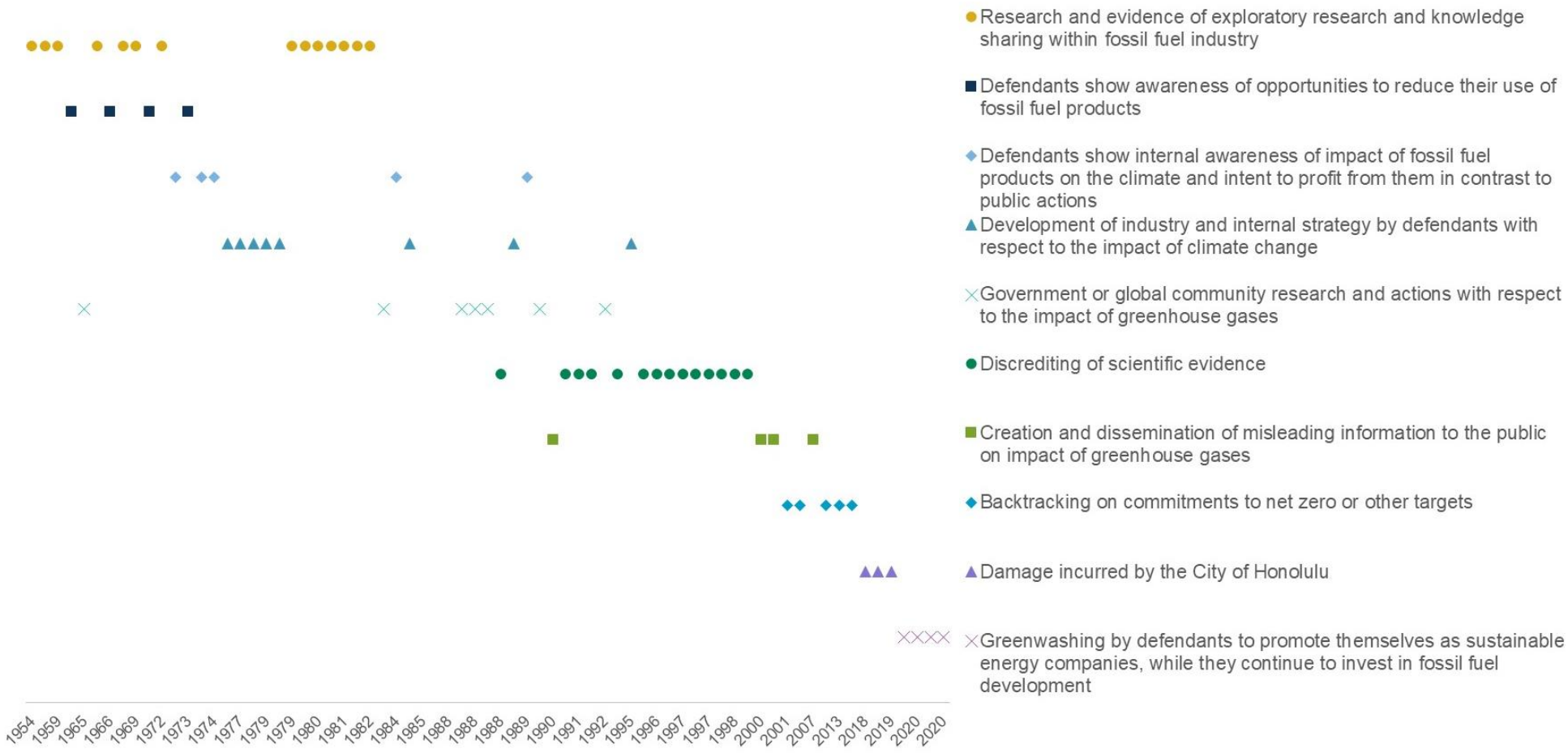
Section Summary – Causes of Action

The end of the complaint document sets out the basis for its claims, including public and private nuisance, strict liability failure to warn, negligent failure to warn and trespass. It then details the award elements being sought including compensatory and punitive damages, equitable relief, disgorgement of profits and costs of bringing the suit. The working party is mindful that these are legal terms, most likely specific to the jurisdiction, and it encourages interested readers to seek their own advice if they wish to understand more about this case.

Figure 13 sets out in a schematic a timeline prepared by the working party showing when certain alleged activities took place.

[27] Anjli Raval & Leslie Hook, Oil and gas advertising spree signals industry’s dilemma, FINANCIAL TIMES (Mar. 6, 2019), https://www.ft.com/content/5ab7edb2-3366-11e9-bd3a-8b2a211d90d5 (accessed Feb. 21, 2020).

Figure 13 Honolulu case timeline



2.4 Lliuya vs. RWE AG[28]

Climate attribution

While climate change itself and its impacts have resulted from actions taken by multiple parties over many years, in climate litigation, a specific defendant and the role of that defendant must be identified. This is a necessarily complex issue, and one which climate attribution science will be key to resolving. It should be noted that "climate attribution" can refer not only to the analysis of the extent to which extreme weather events are attributable to climate change but also to the analysis of the extent to which different sectors/entities have contributed to climate change. In the remainder of this section, unless otherwise specified, references to attribution refer to the latter.

A 2021 paper[29] highlighted a number of issues driving the complexity of attribution science and the use of attribution evidence in litigation. A key issue is that in assessing the impact of emissions on the climate or the change in likelihood of a given extreme event, the modelling requires judgement, the science is evolving, and the output is often probabilistic. The output of the scientific analysis may not then align with legal standards for defining proof of causation[30]. Furthermore, the translation from emissions to contribution is not necessarily straightforward e.g. in the event of failure of an ecosystem, only emissions up to the point of failure would be relevant whereas more gradual changes may be linked to overall emissions[31] so the consideration of responsibility would need to consider contributions at different points in time.

Beyond the technical aspects of the analysis, jurisdictional issues are likely to be significant when considering claims which ultimately relate to establishing a causal link between the actions of a defendant and the impacts of climate change. Thresholds for determining causal links vary significantly across regions - from a link being "more probable than not" to a link being certain[32].

For insurers, the most natural comparison is likely to be to asbestos claims which share similar characteristics to potential climate change claims in terms of both the extended delay between an activity and its impact and the difficulty of identifying the specific source of a given impact. However, whereas the list of employers/manufacturers potentially liable to contribute to an asbestos claim should be finite and identifiable, identifying all the contributors to climate change is significantly less straightforward. Progress is however being made in this area, for example with the Climate Accountability Institute's Carbon Majors Database, which quantifies the extent to which leading coal, gas and oil companies have contributed to overall emissions. This is discussed further in Section 2.5.

The case brought by Saúl Luciano Lliuya against German energy company RWE, discussed below provides an example of a current case relating to attribution of responsibility. This is an ongoing case but the claim itself provides a view of how such claims may be constructed and the arguments which may be raised.

Case study: Lliuya v. RWE AG

Saúl Luciano Lliuya is a resident of Huaraz, a city in the Peruvian Andes located under glacial Lake Palcacocha. Melting of the glacier has led to an increase in the water level of the lake as well as the risk of parts of the glacier breaking off and falling into the lake, both of which increase the risk of flooding of the city below. According to the claim, Peru's National Institute for Civil Defence ("INDECI") has published a map of Huaraz indicating flood risk across the city, with Mr Lliuya's

[28] Statement of claim, 23 November 2015, Section 7, as translated by Germanwatch e.V. https://rwe.climatecase.org/en/legal
[29] Stuart-Smith, R.F. et al. (2021). Attribution science and litigation: facilitating effective legal arguments and strategies to manage climate change damages. Summary report for FILE Foundation. (https://www.smithschool.ox.ac.uk/sites/default/files/2022-03/attribution-science-and-litigation.pdf)
[30] Ibid.
[31] Ibid.
[32] Ibid.

property located in a "red" zone indicating that an inundation of three meters would persist after an initial flood drains[33]. As such, Mr Lliuya argues that his property is significantly impaired by the risk of flooding[34] and further that this risk is "at least partially attributable to anthropogenic climate change and further aggravated by it every day" [35].

In November 2015, Mr Lliuya filed a claim against RWE, a German energy company, in the regional court in Essen, Germany. The case is brought under Section 1004 of the German Civil Code which states that a property owner can require another party to remove an interference with their property[36]. The case seeks "to determine that the respondent [RWE] is liable, proportional to its level of impairment (share of global greenhouse gas emissions), to cover the expenses for appropriate safety precautions in favour of the claimant's property from a glacial lake outburst flood from Lake Palcacocha"[37].

Based on the working party's review of the claim, there are three key steps in the argument:

- **Increased flood risk due to climate change:** The claim argues that the glacial retreat in the Andes (and subsequent flood risk for Mr Lliuya's property) can be attributed to climate change. The claim cites studies which indicate a significant increase in the water level of the lake and the risk arising for the city of Huaraz as well as an IPCC report stating with a "very high" degree of confidence that the glacial retreat in the Andes can be attributed to climate change[38].
- **Relationship between emissions and climate change:** The claim points to both German legislation and RWE's own statements as implying acknowledgment of a link. The German Greenhouse Gas Emission Allowance Trading Act (TEHG) allows trading of greenhouse gas emission licenses with a stated aim "to contribute, by means of a cost-efficient reduction of greenhouse gasses, to worldwide climate protection"[39]. Similarly RWE has an aim of producing carbon neutral power by 2050 which the claim states as an indication that RWE acknowledges a causal relationship between emissions from power generation and global climate change.
- **Contribution of RWE to global emissions:** The 2014 Carbon Majors report identifies RWE as contributing 0.47% of global emissions from 1854 to 2010[40]. The claim then argues that, if RWE is responsible for 0.47% of global emissions, it should also be obliged to cover this share of the costs of mitigating the flooding risk i.e. €17k of the estimated €3.5m cost of drainage of the lake to reduce its current volume and regulate future outflow[41].

The case is ongoing in the German courts, with the most recent development being the visit of experts to Huaraz in the summer of 2022 to consider two evidentiary questions[42]:

- Is there a serious threat to Saúl Luciano Lliuya's property due to flood/mudslide from Lake Palcacocha?
- Is it the case that RWE's power plants increase greenhouse gases which in turn lead to increases in global temperatures and that this accelerates the melting of the glacier? If so, is

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[33] Statement of claim, 23 November 2015, Section 7, as translated by Germanwatch e.V. https://rwe.climatecase.org/en/legal

[34] Ibid.

[35] Ibid.

[36] https://www.gesetze-im-internet.de/englisch_bgb/englisch_bgb.html

[37] Statement of claim, 23 November 2015, as translated by Germanwatch e.V. https://rwe.climatecase.org/en/legal

[38] IPCC, 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Figure 27-8

[39] Statement of claim, 23 November 2015, Section 7.1, as translated by Germanwatch e.V. https://rwe.climatecase.org/en/legal

[40] Heede, R. Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854-2010. *Climatic Change* 122, 229-241 (2014). https://doi.org/10.1007/s10584-013-0986-y - Supplementary Table 3

[41] Statement of claim, 23 November 2015, Section 9, as translated by Germanwatch e.V. https://rwe.climatecase.org/en/legal

[42] Indicative Court Order and Order for the Hearing of Evidence, November 2017, Section 4.III, as translated by Germanwatch e.V. https://rwe.climatecase.org/en/legal

RWE's contribution to this "measurable and calculable" and is that contribution 0.47% of the total?

The latter of these then seeks input on the fundamental question of whether it is in fact possible to assess the contribution of an entity to the impacts of climate change and, if it is, how that contribution can be measured. While the experts are yet to report, it is unclear what the next steps in this case will be. The answers to these questions will however be significant in determining future developments in climate litigation, at least under German law. In the meantime, the case can provide insight into how such claims may be structured and so offer one potential approach for insurers to perform an initial assessment of potential historical exposures, for example, through assessment of coverage provided to entities listed in the latest Carbon Majors Database in the first instance.

It is worth highlighting the striking features of this claim:

- The geographical distance between the claimant and the defendant.
- The choice of Germany as the location of the action. It would appear that this was a deliberate choice on the part of the claimants to choose a legal environment that would most support the claim being made.
- The small size of the amount claimed. The cost to RWE of settling this claim, with less than 0.5% of global emissions, is minimal with the damages sought said to be in the tens of thousands of Euros.
- The very deliberate, formulaic and finite size of damages being sought by the claimants. In contrast to claims seeking substantial sums of compensation, this claim is seeking a limited sum as a contribution to known estimated costs.

It would appear that this claim has been brought in a very measured fashion in order to establish certain points of legal principle. While there is no direct read across from a German Court ruling to rulings in other, more litigious locations, it is possible that the strategy being adopted is to obtain a clear ruling in respect of certain matters of law that can then be presented as points of reference elsewhere. Time will tell as to how effective this claimant strategy proves to be.

2.5 Overview of attribution responsibility and carbon major database

The most comprehensive source for tracing the origins of anthropogenic CO_2 and methane to the world's largest extant producers of carbon fuels and cement is the "Carbon Majors" Database, which was established in 2013 by Richard Heede of the Climate Accountability Institute ("CAI")[43]. This database was used as the source of the 0.47% share of emissions attributed to RWE in the *Lliuya v RWE AG* case. The earliest production records date from 1854, although the working party understands that there is an aim to measure emissions since the dawn of the industrial revolution (1751). Figure 14 shows the top part of a selected table from this study, setting out the calculated shares attributed to the largest global producers. The entry for RWE can be seen on row 28.

[43] The Carbon Majors Database: CDP Carbon Majors Report 2017

Figure 14 Cumulative emissions attributed to carbon major fossil fuel and cement producers, 1854-2010[44]

Supplementary Table 3. Cumulative emissions attributed to carbon major fossil fuel & cement producers, 1854-2010

	Entity	Production (fuels & cement) $GtCO_2$	Flaring, own fuel, vented CO_2 $GtCO_2$	Fugitive methane $GtCO_2e$	Total emissions $GtCO_2e$	Percent of global 1751-2010
1.	Former Soviet Union,* (oil, gas, coal)	116.88	2.31	10.53	**129.72**	**8.94%**
2.	China (coal & cement)	115.11	0.00	8.98	**124.09**	**8.56%**
3.	ChevronTexaco, USA	46.28	1.48	3.34	**51.10**	**3.52%**
4.	ExxonMobil, USA	41.60	1.54	3.53	**46.67**	**3.21%**
5.	Saudi Aramco, Saudi Arabia	42.82	1.03	2.18	**46.03**	**3.17%**
6.	BP, UK	32.51	1.02	2.31	**35.84**	**2.47%**
7.	Gazprom, Russian Federation	25.09	2.13	4.92	**32.14**	**2.22%**
8.	Royal Dutch Shell, The Netherlands	27.57	0.99	2.19	**30.75**	**2.12%**
9.	National Iranian Oil Company	26.71	0.76	1.62	**29.08**	**2.01%**
10.	Poland (coal)	24.66	0.00	2.09	**26.75**	**1.84%**
11.	Pemex, Mexico	18.14	0.59	1.29	**20.03**	**1.38%**
12.	British Coal Corp., UK *	17.74	0.00	1.50	**19.25**	**1.33%**
13.	ConocoPhillips, USA	14.70	0.67	1.50	**16.87**	**1.16%**
14.	Petroleos de Venezuela	14.77	0.44	0.95	**16.16**	**1.11%**
15.	Coal India	14.28	0.00	1.21	**15.49**	**1.07%**
16.	Peabody Energy, USA	11.46	0.00	0.97	**12.43**	**0.86%**
17.	Total, France	10.79	0.35	0.77	**11.91**	**0.82%**
18.	Russian Federation (coal)	10.36	0.00	0.88	**11.24**	**0.78%**
19.	PetroChina, China	9.67	0.28	0.61	**10.56**	**0.73%**
20.	Kuwait Petroleum Corp.	9.80	0.23	0.48	**10.50**	**0.72%**
21.	Abu Dhabi NOC, UAE	8.84	0.26	0.57	**9.67**	**0.67%**
22.	Sonatrach, Algeria	7.96	0.40	0.91	**9.26**	**0.64%**
23.	Consol Energy, Inc., USA	8.38	0.00	0.71	**9.10**	**0.63%**
24.	BHP Billiton, Australia	6.97	0.06	0.58	**7.61**	**0.52%**
25.	Czechoslovakia, (coal) *	6.77	0.00	0.57	**7.35**	**0.51%**
26.	Anglo American, UK	6.68	0.00	0.57	**7.24**	**0.50%**
27.	Iraq National Oil Company	6.70	0.14	0.29	**7.14**	**0.49%**
28.	RWE, Germany	6.31	0.00	0.54	**6.84**	**0.47%**
29.	Pertamina, Indonesia	6.16	0.21	0.46	**6.83**	**0.47%**
30.	Libya National Oil Corp.	6.22	0.15	0.32	**6.69**	**0.46%**
31.	Nigerian National Petroleum	6.06	0.15	0.33	**6.54**	**0.45%**
32.	Petrobras, Brazil	5.49	0.16	0.34	**5.99**	**0.41%**
33.	ENI, Italy	5.20	0.24	0.54	**5.97**	**0.41%**
34.	Rio Tinto, UK	5.50	0.00	0.47	**5.96**	**0.41%**
35.	Arch Coal, USA	5.43	0.00	0.46	**5.89**	**0.41%**
36.	Petronas, Malaysia	4.56	0.22	0.50	**5.27**	**0.36%**

In discussing the "Conservatisms, caveats, and uncertainties" in his analysis, Richard Heede states that the production data and attributed emissions are "generally conservative", by which the working party understands that the figures being stated err towards underreporting "fossil fuel and cement production compared to the actual history of production by nearly all of the carbon major entities." On this basis, the working party understands that the 0.47% share of emissions figure used for the Lliuya v. RWE AG case is likely lower than the actual share of historical emission for the firm.

The working party would reflect that there do not yet appear to be any competitors for or alternatives to the Carbon Major Database as a source for attributing shares of historical emissions. Despite the imperfections of analysis described above, and the potential arguments that might arise against using an imperfect measure, the working party notes that the courts have in the past been prepared to use imperfect measures as a basis for awards in legal cases. For example, the well-established framework for the calculation of PPOs ("Periodical Payment Orders") in the UK[45] relies upon an ASHE[46] (Annual Survey of Hours and Earnings) "index" to define increases in structured settlements in serious bodily injury cases. The ASHE survey was never designed for this purpose and is not strictly an "index".

[44] Tracing anthropogenic CO_2 and methane emissions to fossil fuel and cement producers, 1854-2010 - Supplementary Materials (Richard Heede, November 2013) https://climateaccountability.org/pdf/Heede%20SupplementaryMaterials%20Nov13.pdf

[45] https://www.actuaries.org.uk/system/files/field/document/B3%20PPOs_0.pdf

[46] Annual Survey of Hours and Earnings (ASHE) - Office for National Statistics (ons.gov.uk)

2.6 Other litigation including greenwashing, climate-washing and D&O claims

Greenwashing, or indeed the efforts by firms to present themselves in a favourable public light through association, is not a new concept. As the public has become increasingly aware of climate change and has demanded action by governments and wider society, many firms have sought to promote their standing as good corporate citizens through publicising the climate actions. This has involved sustainability commitments, climate pledges and advertising their clean energy investments.

Inevitably such activity increases the likelihood that some of these statements prove to be at best wishful thinking and at worst patently untrue. Similarly, the demand for ambitious commitments and pledges will result in a proportion being unfulfilled. Some of these cases have led to litigation from shareholders and other stakeholders, challenging the veracity of corporate statements or holding organisations to account for making good on their commitments. Litigation also arises from shareholders and other stakeholders who oppose such pledges and commitments whether on political/economic grounds or on the basis that such pledges and activity are not in the best interest of shareholders.

The term greenwashing has the potential itself to be somewhat nebulous. One definition of greenwashing identified by the working party is: “Greenwashing means to promote unsubstantiated or misleading claims regarding an actor’s environmental performance. Greenwashing can also describe the selective disclosure of positive environmental or social impacts of a company’s business practices, without complete disclosure of negative impacts.”[47]

In recent years, greenwashing as a term has evolved to be used interchangeably with the term ‘climate-washing’. This reflects the increasing number of complaints that have also been brought on climate change grounds. Climate washing has been defined by the Geneva Association as cases that “raise issues of law or facts regarding the science of climate change and climate change mitigation and adaptation efforts”[48].

The Grantham Institute has highlighted “climate-washing” to be an emerging trend noting that the last few years “have seen an explosion of ‘climate washing’ cases” [49]. They identify that 81 climate-washing cases against companies have been filed between 2015 and 2022, of which 53 arose in 2021 and 2022. This appears to show a substantial increase in the frequency of such cases in more recent years[50]. Whilst governments remain the main targets, the number of cases filed against corporates has increased, and the range of sectors targeted has become more diverse, moving to include food, agriculture, transport and finance as well as the core cases against oil and gas companies[51].

Increasing awareness means that initiatives by regulatory bodies of all forms are in turn leading to increasing identification of potential cases which may be supporting the increasing trend. For example, the International Consumer Protection Enforcement Network (“ICPEN”) hosts an annual sweep of websites, which gives consumer authorities across the world the opportunity to target fraudulent, deceptive or unfair conduct online. In 2021 this sweep was focused on misleading environmental claims and noted that: “As part of the international sweep, ICPEN members analysed almost 500 websites promoting products and services across a range of sectors, including clothes,

[47] CSSN Research report 2022: Climate-washing litigation: Legal liability for misleading climate communications
[48] The Geneva Association. 2021. Climate Change Litigation - Insights into the evolving global landscape. Authors: Maryam Gol Naraghi, Joana Setzer, Nigel Brooke, Wynne Lawrence and Lucia Williams
[49] Global trends in climate change litigation: 2023 snapshot
[50] Global trends in climate change litigation: 2023 snapshot
[51] Scenario Analysis Working Group: Climate Litigation Risk Chapter

cosmetics and food. Members found that 4 in 10 of these websites appeared to be using tactics that could be considered misleading and therefore potentially break consumer law."[52]

Often complaints regarding misleading climate claims are dealt with by watchdogs, rather than taken to court. Such processes tend to be faster and less expensive. In 2021 the UK Advertising Standards Agency ("ASA") conducted a series of enquiries into environmental advertising claims and practices in a drive to support global efforts to reduce carbon emissions and battle the climate crisis[53]. This increased focus may be further supporting the increased volume of climate litigation.

The Grantham report notes that "Laws and standards, such as the now updated Organisation for Economic Co-operation and Development (OECD) Guidelines, EU Directive on Green Claims, and initiatives by regulatory bodies, are becoming more common. This could lead to further litigation and help to discourage climate-washing behaviour." [54]

Below are some summaries of climate washing litigation cases that seek to typify the emerging trends observed. Although litigation cases brought against companies are those most likely to directly affect insurers, one example is a case brought against a decision made by a governmental body which may affect corporate investments. As can be seen from the variety of this sample of case summaries, the range of climate litigation cases and the trends driving them are much broader than it has been possible to include here. Four types of cases have been shown here:

- Disinformation spread by high-emitting companies about the impacts of their products.
- Inadequate predicted future impacts of current investment decisions.
- High emitting sectors being subject to litigation all along the value chain.
- Misleading advertisements overstating the environmental benefits of a product.

Further examples are available in both the cited papers and extensively in the Sabin Center for Climate Change Law climate change litigation database[55].

Disinformation spread by high-emitting companies about the impacts of their products:

Municipalities of Puerto Rico v. Exxon Mobil Corp:[56] In this case, filed in November 2022, the municipalities of Puerto Rico are suggesting that given Exxon, plus ten other oil and coal defendants, are responsible for 40.01% of all global industrial greenhouse gas emissions from 1965 to 2017, they are correspondingly responsible for the impact this has had on climate change, specifically the increased intensity of the 2017 Atlantic Hurricane Season.

The plaintiffs contended that the defendants were liable because "they knowingly caused and contributed to the worsening of the climate change by producing, promoting, refining, marketing, and selling fossil fuel products… that have caused and continue to cause the devastating effects of climate change, while concealing and misrepresenting the dangers associated with the use of fossil fuel-based products, including the increased frequency of more dangerous storms."

In addition to more intense storms, the municipalities alleged other physical climate change impacts, including coral reef degradation and "an unprecedented, massive bloom of sargassum" as well as social, educational, and economic losses, including increased emigration from the municipalities and damages to the agricultural industry.

[52] Global sweep finds 40% of firms' green claims could be misleading - GOV.UK (www.gov.uk)
[53] The adverts banned for misleading climate claims - BBC Future
[54] Global trends in climate change litigation: 2023 snapshot
[55] Climate Change Litigation Databases - Sabin Center for Climate Change Law (climatecasechart.com)
[56] http://climatecasechart.com/case/municipalities-of-puerto-rico-v-exxon-mobil-corp/

Inadequate predicted future impacts of current investment decisions:

ClientEarth v. Shell Board of Directors:[57] ClientEarth have said that this is the first ever case of its kind seeking to hold corporate directors personally liable. This case alleges Shell's 11 directors have breached their legal duties under the Companies Act by failing to adopt and implement an energy transition strategy that aligns with the Paris Agreement. Shell claims that its "Energy Transition Strategy," which includes a net zero emissions plan with a 2050 target, is consistent with the 1.5°C temperature goal of the Paris Agreement. ClientEarth, based on a third-party assessment done by Climate Action 100+, claims that the strategy excludes short to medium-term targets to cut the level of scope 3 emissions despite these accounting for more than 90% of the company's overall emissions.

The group's net emissions are calculated to fall by just 5% by 2030, which does not comply with the Dutch Court's 2021 order to reduce emissions by 45% in group-wide emissions by the end of this decade. ClientEarth alleges that the Board's failure to fully comply with the Dutch Court's judgment is also a breach of its legal duties. While the initial case was rejected by the UK High Court in May 2023, an oral hearing is pending. The case raises questions about decision-makers' role in determining our planetary future and the need to adapt to the reality of climate change.

High emitting sectors being subject to litigation all along the value chain:

Sierra Club Canada Foundation et al. v. 7 Minister of Environment and Climate Change Canada et al:[58] This case is challenging whether the Minister of Environment and Climate Change Canada's decision to approve the Bay du Nord Development Project was within his jurisdiction under the Canadian Environmental Assessment Act and was reasonable. The Project proposed was to develop in the Flemish Pass offshore Newfoundland, with expected reserves of 300 million barrels of oil. In approving the Project, the Minister took into account the environmental assessment report for the Project, prepared by the Impact Assessment Agency of Canada.

The Minister determined that the Project was not likely to cause significant adverse environmental effects. The applicants submit that the environmental assessment report did not satisfy the requirements under the Act or the guidelines for the assessment of the Project. Among other things, the applicants allege that the report did not acknowledge all of the GHG emissions associated with the Project, including downstream GHG emissions which could account for 90% of the Project's total emissions, and the effects related to additional production for the Project.

Therefore, the applicants submit that the report failed to consider all of the Project effects and was therefore deficient. As a result, the Minister lacked jurisdiction to make the decision as he relied on a report that did not meet the requirements under the Act.

Misleading advertisements overstating the environmental benefits of a product:

Whilst the above three cases relate directly to the fossil fuel industry, there is also close scrutiny and challenge of claims being made in other sectors, which can also be found in the Sabin Center for Climate Change Law climate change litigation database[59]:

FossielVrij NL v. KLM:[60] On May 24, 2022, campaigners for FossielVrij NL issued a letter of summons to Dutch aviation company KLM at a shareholder meeting of AirFrance-KLM. The letter states that KLM will be sued in violation of European consumer law if it does not cease misleading advertisement claims under its 'Fly Responsibly' campaign to the effect that CO_2 compensation measures and alternative fuels can make flying sustainable. The Fly Responsibly ads present the airline as "creating a more sustainable future" and on track to reduce its emissions to net zero by 2050.

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[57] https://climatecasechart.com/non-us-case/clientearth-v-shells-board-of-directors/

[58] http://climatecasechart.com/non-us-case/sierra-club-canada-foundation-et-al-v-minister-of-environment-and-climate-change-canada-et-al/

[59] Climate Change Litigation Databases - Sabin Center for Climate Change Law (climatecasechart.com)

[60] https://climatecasechart.com/non-us-case/fossielvrij-nl-v-klm/

Environmental organisations FossielVrij NL, Reclame FossielVrij and ClientEarth claim that there is no such thing as 'flying responsibly' at present, and that KLM seeks company growth and increased flight sales, whilst it should be reducing emissions by reducing the number of flights 'to keep a just, liveable world within reach'. Specifically, the organizations claim that customers are offered the option to buy carbon offset - labelled 'CO2ZERO' - by funding reforestation projects or KLM's purchase of biofuels, but that such labels are misleading and that such products do not make a meaningful contribution to reducing KLMs footprint. Moreover, KLM's marketing undermines the urgent action needed to minimise climate catastrophe.

DWS Greenwashing:[61] The consumer protection association of the federal state of Baden-Württemberg filed a lawsuit against Germany's largest investment fund company DWS, a subsidiary of Deutsche Bank, on suspicion of misleading advertising and greenwashing. Before the Regional Court in Frankfurt, the complaint challenged statements that investments would help counteract climate change through targeted advertising and contribute towards achieving climate goals, without providing details or evidence. In advance of the court hearing, DWS issued a cease-and-desist declaration, undertaking to refrain from the advertising in question.

2.7 Climate attribution revisited and how insurance can help with financing the transition?

One inference that can be made from the *Lliuya vs. RWE AG* case and the use of the "Carbon Majors" Database[62] is the potentially vast sums that litigants might seek to recover from those identified in the database. Many of the corporate defendants are likely to have been substantial and sophisticated buyers of insurance over many years. The consequences for the insurance industry have the potential to be extremely severe.

However, an alternative way of looking at this is to ask what role the insurance industry can play in helping to finance the transition, through risk price signalling, risk management technical expertise and the modelling and analysis skills needed to support the inter-generational financial transfers likely to be required.

First, a reality check: the global insurance industry, its total assets and premium inflows, is too small for it alone to fund the transition to a low-carbon climate-resilient global economy.

Let's try to size the insurance industry. The International Association of Insurance Supervisors (IAIS) has estimated that, for the 90% of global written premiums included in its 2022 Global Insurance Market Report[63], the global insurance industry had some $44 trillion in assets and $38 trillion in liabilities. Only a proportion of the resulting excess of assets over liabilities, some $6 trillion, would be available to meet the costs of climate change, even if the insurance industry was to provide some degree of funding of the transition.

In contrast, estimates for the cost of transition to Net Zero by the middle of this century range from over $100 trillion[64] to some $275 trillion[65], in comparison to a current global GDP figure of around $100 trillion[66]. Granted, these capital expenditure figures are not purely an additional cost: they include the cost of replacing aging assets, with more efficient and lower carbon alternatives, and the cost of new assets to support new activity associated with continued economic growth.

Past examples of large systemwide liabilities that have been faced by the insurance industry include asbestos where the total cost in the USA, where the greatest losses have been incurred, has been estimated at some $100 billion[67]. Based on these comparisons, the working party would observe that

[61] https://climatecasechart.com/non-us-case/dws-greenwashing/
[62] The Carbon Majors Database: CDP Carbon Majors Report 2017
[63] https://www.iaisweb.org/uploads/2022/12/GIMAR-2022.pdf
[64] https://www.irena.org/publications/2021/Jun/World-Energy-Transitions-Outlook 'Energy transition investment will have to increase by 30% over planned investment to a total of USD 131 trillion between now and 2050…'
[65] https://www.mckinsey.com/capabilities/sustainability/our-insights/six-characteristics-define-the-net-zero-transition 'In all, our analysis suggests that the Net Zero 2050 scenario would require spending on physical assets of about $275 trillion between 2021 and 2050 (about 7.5 percent of GDP over the period) in the areas we analysed.'
[66] https://www.statista.com/statistics/268750/global-gross-domestic-product-gdp/
[67] https://www3.ambest.com/ambv/bestnews/articlecontent.aspx?refnum=281133 'Our estimated net ultimate asbestos loss of $100 billion [in the US] remains the same.'

the potential price tag for climate change is many orders of magnitude greater than the largest losses to date, further illustrating the infeasibility of the insurance sector shouldering any material share of funding the vast majority of the transition.

Nevertheless, across the wide range of emerging and anticipated changes arising from climate change, it is possible to see many areas where insurance has a key role to play:

Physical Impacts

Pre-loss: Insurance naturally provides a pricing signal for physical risks from climate-related trends and events. Where insurance is unaffordable, or risks are uninsurable, this can point to an unsustainable set of circumstances, where a more radical response may be needed such as relocating an investment. Accurate insurance pricing can also provide incentives to invest in risk mitigation (more commonly described as 'adaptation') measures to reduce vulnerability and improve resilience. Over time, insurance as a risk pricing signal can steer capital investment to more economically sustainable purposes.

Post-loss: Where insurance is affordable, insurance can provide indemnity protection and 'Build Back Better' initiatives can also help build resilience. In catastrophe-prone regions, the coordination of insurance responses can also aid economic recovery in affected regions, and guide decisions as to whether reconstruction or relocation is the optimal policy response.

Transition Impacts

The transition to a low-carbon, climate resilient global economy will drive new investments, new technologies and new economic sectors.

New investments and development: Large new investment projects, including wind and solar farms, will involve construction risks where insurance can protect against losses before these come onstream. Once commissioned, insurance can protect those assets during their operational life. Insurance will have a role to play in enabling designers, manufacturers and installers to play their role within the supply chain.

New technologies: The massive expansion in sustainable energy, from wind and solar in particular, has been accompanied by a rapid increase in the scale and sophistication of turbines, solar farms, how these link to the grid and how energy is traded and prices. There is also a greater focus on energy efficiency. The mass roll-out of new technologies, including electric vehicles, heat pumps, insulation and digitalisation of the grid, create risks and opportunities for insurers. Other energy technologies are also emerging, including (green) hydrogen, biofuels for aviation and marine transport, as well as green ammonia. All of these innovations generate new financial risks where insurance has a role to play and where there will be less data upon which to base our actuarial models.

Liability Impacts

As discussed in more detail previously, public, professional and management/director liability insurance products are key parts of the modern economy, enabling individuals and firms to carry out their jobs secure from the risk of ruin in the event of errors or misfortune. The ability of these products to price the changing cost of continuing certain economic activities in the face of an evolving litigation landscape will be a critical task for the industry.

Equally, where certain key economic activities are no longer insurable owing to the threat of future litigation, the insurance industry will have a key role in helping society to design mechanisms and financial structures that navigate these challenges in a cost-efficient manner.

2.8 Antitrust threat and collective action

The Net Zero Insurance Alliance (NZIA) was established at the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow in 2021, with each member committing to '*…transitioning all operational and attributable greenhouse gas (GHG) emissions from its insurance and reinsurance underwriting portfolios to net-zero emissions by 2050 consistent with a maximum temperature rise of 1.5°C above pre-industrial levels by 2100 in order to contribute to the implementation of the COP21*

Paris Agreement'. How to achieve this was left to each company's discretion but was to be based on the latest available scientific knowledge, including the findings of the IPCC.

Subsequently, in May 2023, a letter[68] was sent to members of the NZIA, care of the United Nations Environment Programme (UNEP) Financial Initiative, signed by 23 Republican State Attorneys General. The letter raised a number of legal concerns relating to antitrust regulations and requested documents and information relating to communications within the NZIA[69] on commitments made to the NZIA, including how those commitments would be met. Previous to this letter, three members (Munich Re, Zurich and Hannover Re) had already left the NZIA, with Munich Re's CEO Joachim Wenning saying that[70] '*In our view, the opportunities to pursue decarbonization goals in a collective approach among insurers worldwide without exposing ourselves to material antitrust risks are so limited that it is more effective to pursue our climate ambition to reduce global warming individually*'.

Following the publication of the Attorneys General's letter, a further seven insurers, including Swiss Re and Lloyd's, left before the end of May. This left the NZIA significantly depleted, and questions being asked about the effectiveness of insurers' response to climate change. The working party's view is that, whilst this has been a significant development in the evolution of the insurance sector's role in responding to climate change, the immediate financial risks faced by reserving actuaries will be little affected. However, in the longer term, the evolving political landscape and its influence on future investment in coal, oil and gas may well delay the energy transition and further increase levels of future global warming.

In the working party's opinion, there are still many aspects of climate change that can be explored collaboratively, whilst steering clear from areas of political debate. These include research and education to understand the changing risk landscape, tracking developments in climate litigation, supporting the development of new opinion and uncertainty wordings, the development of new analytical approaches, and the ongoing assessment and modelling of physical risks. Whilst climate science is clear on the situation, the causes and consequences of global warming, we believe that the political landscape is less straightforward, and a wider set of considerations need to come into play in how insurers operate in different jurisdictions.

This development highlights that there remains a broad spectrum of views on climate change and how society should respond, with no clear pollical consensus. As a result, the working party believes that the future will be characterised by gradual developments in approaches coupled with bursts of change as climate effects and social attitude tipping points arise.

2.9 Conclusions

It can be seen from the various elements of climate litigation that have been taking place that there are many complex legal and scientific issues in play, and it will be some time before these are resolved to any degree.

The working parties' analysis has shown not only that the potential sums of money involved are vast, but that a sophisticated variety of legal strategies are being deployed by claimants in their approach to seeking compensation.

With such high sums of money involved, it appears possible that the consequences for some insurers may be catastrophic, and that some insurers may have unknown exposures within their reserves to substantial claims costs. However at this stage, there are so many moving parts, that reaching any conclusions with confidence appears premature.

How then should the reserving actuary respond, and communicate these uncertainties in an effective manner? This is the focus of the next section of the paper.

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[68] https://attorneygeneral.utah.gov/wp-content/uploads/2023/05/2023-05-15-NZIA-Letter.pdf

[69] The letter (ibid) further requests documents and information where insurers are also members of the Net Zero Asset Owners Alliance (NZAOA)

[70] https://www.businessinsurance.com/article/20230331/NEWS06/912356540/Munich-Re-pulls-out-of-UN-climate-group,-citing-antitrust-concerns,-Joachim-Wenn

3 Communicating Climate Change Reserve Uncertainty

3.1 Executive Summary

This section of the paper aims, through the lens of Climate Change exposures, to inform the actuary on how to communicate to various stakeholders (including auditors and regulators) material sources of uncertainty within the reserves.

The Working Party recognises that there is an existing framework and guidance in place, used principally within the Lloyd's and London Market, for describing uncertainty within the reserves. This section of the paper therefore starts with a review of this existing framework and highlights some limitations of it, including some that have arisen from a perceived shift in the reserve risk landscape within the insurance industry and how actuaries report on it. Some evolutionary changes have been suggested that seek to overcome these limitations and accommodate the changing risk environment.

Although large loss wordings tend to be a particular focus for general insurance actuaries working in Lloyd's and the London Market, they are informative for wider general insurance reserving communication and their scope should not be considered as limited.

There are two practical challenges associated with the existing large loss wordings guidance and practice. These challenges arise because:

- The definition of what constitutes a Climate Change loss is unclear.
- The information available to the reserving actuary regarding exposure to Climate Change losses can be limited and hence a constraint in making an opinion statement.

These reserving challenges are not necessarily unique to Climate Change but are distinct from those that arise from describing uncertainties associated with specific loss events, or groups of casualty losses, in that the risk is systemic and evolving along a long time-dimension.

This section of the paper recommends some potential modifications to the existing wording guidance to address and overcome challenges arising in situations where:

- There is uncertainty arising from Climate Change where the reserves, or possibly the explicitly identified reserves, held are not material.
- The actuary has grounds to believe that there could be a material element of uncertainty in the reserves, but does not have sufficient information to provide a definitive opinion on whether this is the case.

In each case, the Working Party felt that there were gaps in the existing guidance that could be remediated by the proposed enhancements. For the first situation, the Working Party has proposed a set of four specimen wordings that mirror the existing large loss wordings, but cater for situations where the reserves, or possibly the explicitly identified reserves, do not include a material element arising from Climate Change.

Similarly, the Working Party has proposed a specimen wording for the second situation. Alongside this, they have suggested a framework that reserving actuaries might use to provide further disclosures to users of their work. It is intended that reserving actuaries can use some of the qualitative tools presented in section 4 of this paper to populate these disclosures.

In carrying out this study, the Working Party identified a further difficulty arising from the absence of documented research and published documentation regarding the approaches adopted by reserving actuaries when selecting wordings to be used. In carrying out this study, the Working Party has therefore sought to document its understanding of current practice regarding large loss wordings.

3.2 Introduction and Historical Context

Existing Guidance

After the US terrorist attacks in 2001 the WTC Working Party was formed by the Institute and Faculty of Actuaries' (the "IFoA") General Insurance Board. The WTC (World Trade Centre 9/11 terrorism event) Working Party produced a paper which accompanied the then applicable professional standards issued by the IFoA - advisory notes GN20 and GN33. Amongst other things the paper addressed wordings which actuaries could elect to use in opinions and reports to describe the uncertainty around estimates for the WTC loss. The paper (the "*First Large Loss Advisory Note*")[71] was updated in November 2002[72] and the wordings expanded to reflect emerging market practice.

In 2004 and 2005, the level of hurricane activity and the scale of the losses again raised the issue of wordings to describe the uncertainty associated with particular large losses. A General Insurance Research Organising (GIRO) Working Party was formed to revisit the issue of large loss wordings and, subsequently, a paper (the "*Second Large Loss Advisory Note*")[73] was prepared that updated the First Large Loss Advisory Note. The intention at the time was that such wordings would be applicable for future large losses also.

Alongside the four wordings suggested in the Second Large Loss Advisory Note, a consensus developed around the usage of the wordings by actuaries. The wordings are not formulaic, but they provided a framework within which a degree of quantitative consistency might be achieved in how the wordings were to be firstly interpreted for a given situation and secondly applied. The literature surrounding the approaches that actuaries might adopt appears, however, to be very limited[74].

The wordings represented a significant intellectual development in actuarial practice, providing a common framework through which reserving actuaries could highlight the most material elements of uncertainty arising from their work. They also provided a means through which actuaries could support auditors in decisions regarding whether they needed to qualify the audit opinion relating to a set of accounts.

Conclusions arising from the Climate Change Reserving Working Party 2022

In 2022 the IFoA established this Working Party[75] to consider how general insurance actuaries should approach the challenges associated with reserving for Climate Change. A key finding[76] from this work was that Climate Change increased the uncertainty in reserves for some, but not all, insurance portfolios and that there is the potential for this increase in uncertainty to be material. This led to two key questions:

- How could and should actuaries appraise this uncertainty?
- How should they communicate their findings?

However, the Working Party also identified two specific challenges relating to reserving for Climate Change:

[71] Note and Working Party Paper on the US Terrorist Attacks of 11 September 2001. Institute of Actuaries General Insurance Board, Gibson L. et al. (December 2001, revised December 2002) https://www.actuaries.org.uk/system/files/documents/pdf/wtcwppaper.pdf
[72] Ibid.
[73] Wordings for Actuarial Opinions and Reserving Reports - Large Losses. Gibson L. et al. (n.d. thought to be late 2005). https://assets.lloyds.com/assets/pdf-lloyds-reserving-guidance-large-loss-wording-advisory-note/1/Large-Loss-Wording-Advisory-Note.pdf
[74] Hurricane Katrina: Gibson, Collins, Shepley, Archer-Lock. GIRO convention 18-21 October 2005.
[75] https://actuaries.org.uk/media/ttmbq5lf/climate-change-reserving-working-party-terms-of-reference.pdf
[76] Boiling the Ocean? Climate Change Reserving Working Party (2023) GIRO Conference. Marcuson T.A.G et al.

- That the definition of Climate Change liabilities was not clearly defined. Aside from evolving scientific understanding and social attitudes, practitioners had noted that many claims potentially caused or amplified by Climate Change would not be flagged as such.
- That actuaries, facing an inevitable shortage of information, need to have a means of navigating the opposing threats of providing undue assurance and causing unnecessary alarm.

Recent Developments in Professional Standards

In 2023, following a period of consultation, the set of professional standards issued by the UK Financial Reporting Council, were updated and amended. In particular, TAS 100 included a new specific obligation such that "Practitioners carrying out technical actuarial work must identify and consider all relevant material factors and relevant material risks that may affect or have the potential to influence their technical actuarial work and which the practitioner might reasonably be expected to know about at the time of carrying out the work." [77]

In its Application section, TAS 100 v2.0 includes a specific reference to Climate Change as to one of the risks that actuaries might wish to consider, alongside other risks such as technological, economic or legislative change.

As a result of this development in professional standards, the Working Party believes it will be helpful for their proposals to be compatible with a framework for determining how, where and when to highlight priority risks, and which risks can justifiably be excluded from comment. This is to mitigate the risk of a scenario arising where actuarial communications become obscured by extended passages of excluded matters.

Approach adopted in developing proposals

There is therefore an apparent need for a documented framework that reserving actuaries can adopt when considering and communicating the uncertainties presented by Climate Change. In response, the Working Party has sought to develop some suggested approaches for consideration by the wider actuarial community. In doing so, the following criteria have been adopted in developing the proposals:

(a) They should address the issues identified above.

(b) As far as possible, proposals should be an evolution of the existing large loss framework and not a radical overhaul. The existing framework has stood the test of time over the last twenty years and there is limited anecdotal evidence to suggest material shortcomings.

(c) The proposals should be developed in such a manner that they can equally apply to other similar situations faced by reserving actuaries. Although this would be a wider topic than this paper, which addresses climate change, the Working Party did not feel that it would be helpful to develop wording proposals that spoke only to Climate Change. For example, the current (2022-2023) uncertain inflationary outlook appears to share some of the characteristics presented by reserving for Climate Change. Similarly, there may be a wider set of environmental or sustainability uncertainties that emerge in due course of which Climate Change is just one example.

The Working Party's understanding of how actuaries apply the existing framework is set out in a flowchart in Figure 22 in Appendix 1.

[77] Technical Actuarial Standard 100: General Actuarial Standards Version 2.0 (March 2003), FRC. https://www.frc.org.uk/getattachment/67478854-f362-419b-9317-ae27063f824b/TAS-100-General-Actuarial-Standards-Version-2-0_-March_2023.pdf page 4.

Exclusionary Wordings

The authors note at this point that under the Generally accepted accounting principles (GAAP) it is well-established in non-life actuarial practice to exclude extreme tail risks from best estimates, for example the recurrence of the major, unanticipated losses akin to those arising from US asbestos and pollution claims that emerged during the 1980s. It is however self-evident that such exclusions cannot and should not be used lightly. The exclusion of material risks, whether by means of a wide-ranging exclusion or an extended list of specific risks, can clearly undermine the value of the reserving work performed. The question of when exclusions might reasonably be adopted for remote scenarios is discussed later in this section. Note that the correct treatment under Solvency II regarding allowance for extreme events differs from GAAP. This is highlighted in section 3.3.

Summary

This paper therefore seeks to suggest ways in which the Large Loss Wording Advisory Note might be extended to overcome some of the present challenges identified. Although the Working Party's focus in its preparation has been reserving for Climate Change, it is anticipated that it will have wider application and proposals have been drafted accordingly.

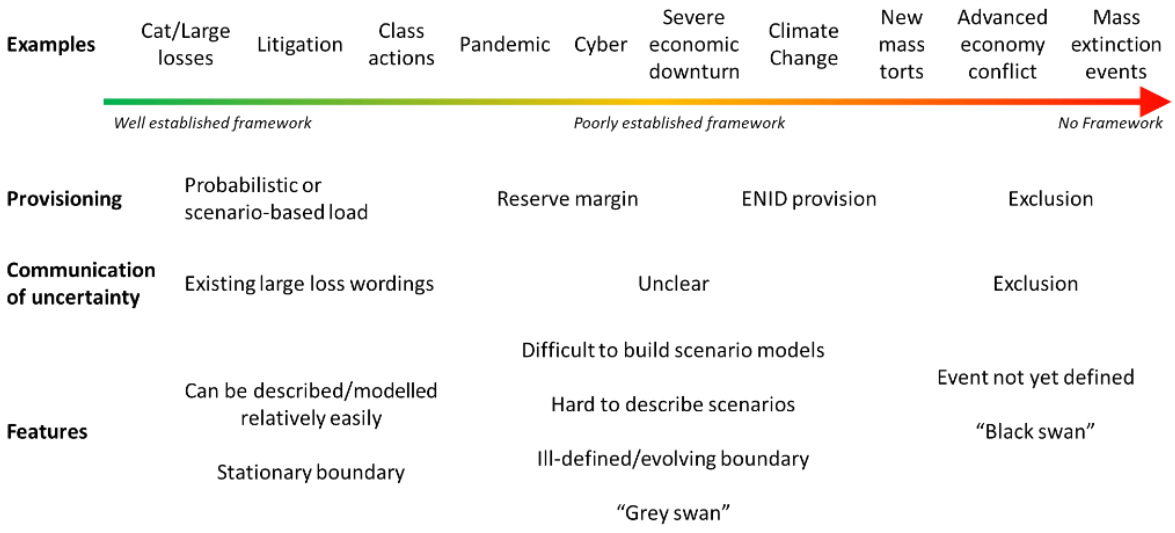
3.3 Motivation

Figure 14 provides a graphical way in which the continuum of reserve uncertainties might be considered, along with some of the characteristics of features falling into these zones, some examples of the types of risk that might be suitable for such treatment and the established approach to describing them.

Figure 15 highlights that:

- The Large Loss Advisory Note works well for situations to the left-hand side. Here suitable scenarios can be built, and a probabilistic or scenario-based approach can be adopted to establish reserves and evaluate the associated uncertainty.
- To the right-hand side of the diagram are the extreme events that, under GAAP, it is normal practice to exclude. While these scenarios are theoretically possible, they remain too remote and ill-defined to seek to include explicitly in reserves.

Figure 15 Framework to articulate differing sources of reserve uncertainty[78]



[78] On the top line of examples "litigation" can clearly stretch from known case law and practice through to grey/black swan litigation outcomes, climate change is exposed to the latter. In this schematic diagram, the former is intended.

Practice varies amongst reserving actuaries as to whether under GAAP some implicit allowance is, or indeed should be, included within best estimates for the possibility of such adverse events. In any event, allowance for such elements would likely be dwarfed by other sources of parameter uncertainty in reserving models. Many firms may choose to include an additional allowance in reserves over and above the actuarial best estimate to allow for uncertainty, including from such remote events.

Under Solvency II, the requirement to hold mean reserves catering for the full range of outcomes normally results in the inclusion of an additional "ENID Reserve"[79], however the approach to measuring such elements and the resultant size varies between portfolios and actuaries.

The authors note that any allowance included here for uncertain outcomes relates to the impact of these extreme scenarios on the mean or best estimate of the future payments. While it is to be expected that climate change will affect the shape of the overall reserving distribution, the key question is the extent to which this affects the uncertainty in the estimation of the mean reserves.

There has in recent years, been an emerging class of uncertainties that have been addressed by reserving actuaries using the Large Loss Advisory Note framework. It is not clear, however, that reserving issues of this nature were in mind when the Large Loss Advisory Note was prepared. These are the examples shown in the middle of Figure 14.

For most of the examples that have arisen to date, the Large Loss Advisory Note appears to have worked well. This is because in each case:

- Significant losses had started to emerge for some (re)insurers, and it was therefore possible to define the issue and build scenario-based models to quantify potential outcomes.
- Material associated reserves were already being established by insurers.[80]

The Working Party believes that for Climate Change the issue is different and certain limitations of the Large Loss Advisory Note framework are apparent. While these are described in greater detail in the next section, the practical challenges faced by reserving actuaries may be summarised in the following two questions:

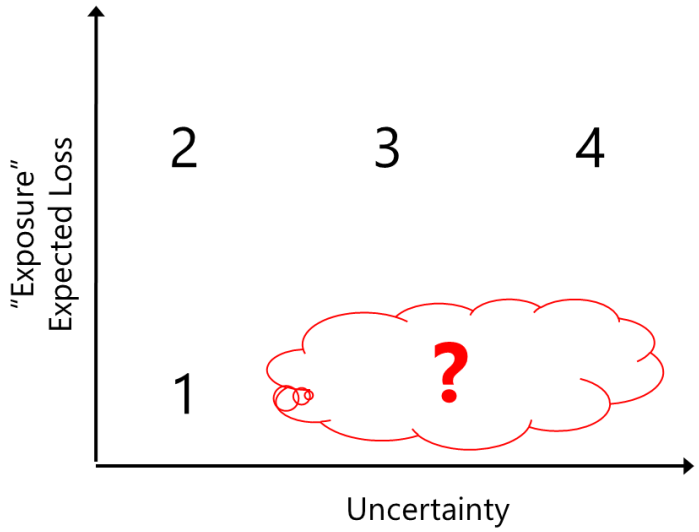
- What is the appropriate wording for the reserving actuary to use when Climate Change reserves do not make up a material share, or perhaps do not make up an *explicit* material share, of reserves?
- What is the appropriate wording for the reserving actuary to use when they believe that the potential reserve risk arising from Climate Change may be material, but do not have meaningful information with which to test this hypothesis?

Figure 16 provides a graphical representation of the first challenge. The numbers highlight the combination of size and uncertainty of reserves that give rise to each existing type of wording. An example decision tree methodology for this analysis is included in Figure 22 in Appendix 1.

[79] The acronym ENID stands for *Events Not In Data*. See for example Solvency II Technical Provisions for General Insurers, (2013) Dreksler S. et all, Section 6, page 45.

[80] This is often not the case for certain aspects of Climate Change, where it may be politically difficult for firms to establish explicit reserves. See for example, references to this in Section 2.7 and Section 2.9.

Figure 16 Existing wordings do not cater for high uncertainty issues where no (explicit) material reserve established



One notable feature of this is the extent to which the term *Exposure* (used in the current large loss wordings) is interpreted as being measured by the size of reserves held. Although the term could be interpreted by another measure, for example, the potential size of loss arising, this introduces new difficulties, for example that the source of uncertainty is treated consistently with the remainder of the reserves.

The second challenge is best considered by example by comparing the reserve uncertainty associated with Climate Change for the following two portfolios:

- Portfolio A is a new start-up insurer writing domestic personal lines business.
- Portfolio B is long-standing insurer that is known to have underwritten a significant share of energy liability business for many years around the world. Some of this business is believed to have been written on an occurrence basis. Owing to the passage of time, comprehensive data on policy wordings and limits is not readily available.

For Portfolio A, it may be relatively simple for the actuary to include a comment to the effect that the reserves are believed to have only limited exposure to Climate Change.

By contrast, it may be unclear at the time whether or not a comment should be included for Portfolio B, and if made, what should be said. While it is clear that the possibility of exposures may be familiar to informed stakeholders, it is unclear whether silence on the matter sufficiently discharges the actuary's professional obligations.

3.4 Problem Definition

Before setting out a suggested approach to overcome the challenges described above, the Working Party believe it is important to generalise the questions, and to identify the present features of Climate Change that give rise to them. Through this, we hope that the suggested changes can be used in a more general fashion for other sources of reserve uncertainty that may arise in future.

When seeking to describe the uncertainty in reserves arising from Climate Change, two specific challenges present themselves:

- *Defining the Boundary* of Climate Change losses.
- Overcoming *Information Limitations* associated with Climate Change exposures.

Defining the Boundary

The actuary needs to determine which losses should be included for consideration when describing the uncertainties in reserves within the category of Climate Change. Noting the boundary is not necessarily binary with components of loss arising from several causal factors. There are two parts to this:

- *The attribution of loss costs to Climate Change:* While Climate Change may be a necessary element to a given loss, it may not be the sole cause. A particular challenge identified in respect of Climate Change is its capability to amplify the size of loss events, resulting in greater loss frequency and severity effects to be observed. For example one study[81] has estimated that Hurricane Sandy economic losses were $8bn, or c. 15%, higher as a result of climate change than would otherwise have been the case (sea level rise driven by anthropogenic climate change).

- *The moving nature of the target:* As time passes, ongoing economic activity (see Figure 5) may mean that historical reserves experience a widening of exposures from both live policies and future underwriting.

    - In marked contrast to this, major loss events such as the US terrorist attacks in 2001 and Hurricane Katrina in 2005, were both sufficiently clearly defined loss events under both aspects: attribution to (i) the cause of loss and (ii) a fixed point in time.
    - During 2022 and 2023, and following sharp increases in the rates of inflation observed across reserving portfolios, actuaries faced similar difficulties in defining the boundary. For example:
        - How much was already implicitly included in reserve estimates for inflation?
        - At what point might understanding of uncertainty caused by inflation be considered to be generally understood by recipients of actuarial advice, and therefore no longer meriting the same degree of emphasis by the actuary?
    - Changes made to future underwriting may have implications for the actuary's understanding of how the back-book, now in reserves, was itself approached in terms of risk selection, terms and conditions and rating.

For many large losses, it will be relatively straightforward to define a single event, or group of events to which an additional wording relates.

However, when analysing a specific source of uncertainty such as Climate Change, the source of loss may be less well defined. This could be because:

- The causality may not be fully understood or generally accepted. The extent to which the size of a particular loss event can be attributed to Climate Change is an emerging science (attribution science). Even as this field matures, it is reasonable to assume that there will be a reasonable range of opinions on such findings.
- There may be other factors that interact, amplify or confound the impact of the particular source of uncertainty being considered. For example, the impact of economic factors, including inflation, will materially affect, and be affected by, the way in which society responds to Climate Change.
- There may be parallel sources of uncertainty that accumulate or correlate with the specific source of uncertainty but where the aggregation is not clear cut. Decisions as to which insured losses are sufficiently similar to combine under a common cause may materially affect the results of such aggregation.
- The source of uncertainty itself may be changing in its extent and its impact over time. Some examples of this: A landmark court case may supersede an existing legal interpretation of wordings and exposures. Scientific developments may attribute particular losses to Climate

[81] https://www.nature.com/articles/s41467-021-22838-1; Strauss B. H. et al. Nature.

Change or even actions of insured parties. Increased environmental changes may increase the financial motivation of investment into greater understanding of climate science.

In the Working Party's opinion, the actuary will need to consider and communicate clearly:

- The boundaries applied to defining the source of uncertainty; and
- The potential impact on their results of adopting wider or narrower alternative definitions.

Furthermore, the actuary will need to take considerable care in determining in which situations it is appropriate to set boundaries in respect of Climate Change. A broad definition may be helpful in communicating the manner in which Climate Change may affect multiple lines of business at the same time. Conversely, an approach which considers specific sources of risk individually may be more helpful in identifying the most material uncertainties in a portfolio.

The Working Party does not believe that there is presently a unique approach that will be appropriate to adopt here in all cases. Reserving actuaries will therefore need to refine their approach given the make-up and features of the portfolio that they are addressing.

Information Limitations

The actuary needs to have a means of considering and communicating uncertainty when they have relatively limited information available with which to form such an assessment. This includes making statements regarding the limited information that, for understandable reasons, they have available.

A particular challenge arising from reserving for Climate Change comes from the potential lack of information available to the actuary in carrying out their work. This reflects a combination of:

- Internal factors: The fact that in certain situations the actuary believes that the portfolio in question might have exposure to an issue. At the time of performing the analysis however, they do not have, and there is no realistic prospect of gaining within the required timescale, access to the information required to confirm this belief and/or quantify such exposure.
- External factors: The evolving frontier of scientific understanding, including the many areas where there are a wide range of legitimate opinions regarding the financial impact of Climate Change on insurance portfolios[82].

It is important to clarify here that the situations envisaged by the Working Party are not those where the actuary could build a model of a scenario or outcome (although the choice of parameters may be uncertain) nor those where the actuary may be uncertain which model or group of models to apply. Rather, it addresses the situation where there is, at the time, no bounded model that can be applied to the situation and around which meaningful quantitative statements can be made.

The Working Party notes that, potentially, statements made by the actuary that highlight shortfalls in the information available to them may act as prompts for additional disclosures by firms regarding current information regarding the issue and the steps being taken to overcome critical gaps identified.

It is important to emphasise that the situation described in the preceding paragraphs (i.e. regarding a reserving issue that has been identified but is incompletely understood) should be contrasted with one where a more general exclusionary wording is legitimately used by actuaries. The latter approach highlights that reserve estimates do not include allowance for the emergence of future losses that

[82] Note that in order to facilitate the broadest application and take-up of its work, the Working Party has sought as far as possible to adopt a neutral position regarding the wider aspects of Climate Change and have focussed on the financial risk consequences.

might arise in respect of new types or classes of claims, but upon which there are no grounds to expect them to arise.[83]

Section 3.7 provides further expansion on information maturity and its influence on reserving opinions.

3.5 Proposed solutions where no material (explicit) reserves

The Large Loss Advisory Note sets out four specimen wordings that indicate, in increasingly strong terms, the degree of uncertainty presented by a given large loss. They are (using **bold**, ***italic*** and **underline** formats to draw attention to key components) explained below:

1. I am satisfied that the company/syndicate **has no material exposure** to the Large Loss.
2. The company/syndicate **has material exposure** to the Large Loss. However, ***this exposure does not lead to a material increase in the uncertainty*** of the company/syndicate's total reserves [in an adverse direction].
3. The company/syndicate **has material exposure** to the Large Loss. This ***increases the uncertainty*** of the company/syndicate's total reserves, but **does not increase that uncertainty** [in an adverse direction] **significantly beyond the normal range of uncertainty** for insurance liabilities at this stage of development.
4. The company/syndicate **has material exposure** to the Large Loss. The ultimate amounts of these claims are subject to a great deal of uncertainty which, combined with their total size, ***increases the level of uncertainty*** for the total reserves of the company/syndicate **significantly beyond the normal range of uncertainty** for insurance liabilities at this stage of development.

As indicated by the highlighted parts of the text, there are up to three operative elements that are used to distinguish between the cases, categorised by the following three questions:

(a) Is the exposure material? (**bold text**)

(b) Does the exposure materially increase the uncertainty? (***bold italic text***)

(c) Is this material increase in uncertainty significantly beyond the normal range of uncertainty? (**bold underlined text**)

As described above in section 3.3, this framework comes unstuck when the answer to large loss wording 1 is no.

In fact, we believe that it may additionally present the actuary with difficulties where the estimates may already include some implicit allowance for the exposure. As a result, it may prove difficult for the actuary to determine whether the additional exposure that has been introduced is material. In the Working Party's opinion, this may currently be more likely to be the case when an actuary is considering the reserves held for Climate Change losses.

Although it might be argued that it is for the actuary to make a choice regarding the proportion of reserves that are implicitly or explicitly associated with Climate Change and proceed accordingly, in the Working Party's opinion this may not provide an ideal approach. This is because it requires the actuary to make an unnecessary judgement that could result in a material source of uncertainty not being highlighted.

[83] For example, the standard wording for Statements of Actuarial Opinion under the Lloyd's Valuation of Liabilities Rules (e.g. 2022YE Lloyd's Valuation of Liabilities Rules, Corporation of Lloyd's, https://assets.lloyds.com/media/d2a7adb4-9309-4242-a89d-ba96e0201b56/2022YE-Lloyd's-Valuation-of-Liabilities-Rules.pdf page 21) includes following wording: "In particular, although I have made what I believe to be a reasonable allowance for the risk of adverse development, I have not anticipated the emergence of major new types or classes of claims."

Taken further, a third scenario might arise where the actuary does not believe that their best estimate reserve includes a material share relating to Climate Change. However, the management or directors of the insurer have elected to include an additional reserve loading that results in the total share of reserves associated with Climate Change being material. A slavish, formulaic application of the tests (a) to (c) above could then result in the illogical outcome of an opinion on the booked reserves attracting a higher uncertainty level wording than an opinion on the actuary's reserve best estimate reserve.

Before setting out the Working Party's proposed solution to this problem, there are two brief observations to be made:

- When answering questions (b) and (c) the closing words of the additional wordings 3 and 4 indicate that the "normal range of uncertainty" is to be considered in the context of what is normal "at this stage of development". Our understanding is that this is to enable the actuary to recognise the inherently greater levels of uncertainty to be expected for immature portfolios of business, particularly in certain classes of business.
- The existing wordings are expressed in terms of a *Large Loss*. If they are to be used more widely, we believe that it would be more helpful to replace the words "Large Loss" with "**Uncertainty Source**" in any specimen wordings.

Table 1 sets out the Working Party's additional specimen wordings that an actuary might elect to use to communicate the degree of uncertainty where there is a material degree of uncertainty from a given source regardless of the materiality of the share of reserves attributable to this source. These have been presented alongside the corresponding established wordings contained in the Large Loss Advisory Note. In each case, the wording has been broken down so that the operative segments can be compared alongside one another.

In the Working Party's opinion, the proposed additional or alternative wordings shown in Figure 17 do not substantively change the way in which the uncertainty is being presented. Although they have been presented side-by-side with the existing wordings, there will be some circumstances where there is not a direct read-across from one to the other. As a result, care is needed in determining the appropriate wording to be used in each situation. Although it is beyond the remit of the Working Party to address the overall structure of additional wordings to be used by actuaries, the Working Party notes the challenges presented by increasing the number of wording variants used.

The Working Party has suggested that the current wordings' reference to "exposure" is replaced by "the reserves". The Working party consider this to be simpler language than is currently used and removes the need for the user to bridge from "exposure" (however assessed) to the "estimated amount of future payments" and ultimately to the "reserves" held for those future payment liabilities. The reserves, after all, are the measure on which the opinion is being provided.

The Working Party consider the additional wordings will need further debate and discussion with stakeholders[84] prior to any universal acceptance and are not wishing to suggest a particular timeframe within which these proposals might be adopted. Given the complexity of the issues arising, it may be necessary and prudent to allow for a proper degree of discussion to take place.

[84] Including, for example: insurance managers, investors, creditors and policyholders, auditors, regulators and standard setters.

Figure 17 Established and Additional Wordings compared side-by-side

Established wordings		Additional wordings	
1	I am satisfied that the company/syndicate has **no material exposure** to the Uncertainty Source.	1A	I am satisfied that the reserves of the company/syndicate have **no material additional uncertainty** *as a result of [liabilities arising from]* the Uncertainty Source.
2	The company/syndicate has **material exposure** to the Uncertainty Source. However, this exposure does not lead to a material increase in the uncertainty of the company/syndicate's total reserves [in an adverse direction].	2A	The reserves of the company/syndicate have **[the potential for] additional uncertainty** *as a result of [liabilities arising from]* the Uncertainty Source. However, this exposure does not lead to a material increase in the uncertainty of the company/syndicate's total reserves [in an adverse direction].
3	The company/syndicate has **material exposure** to the Uncertainty Source. This increases the uncertainty of the company/syndicate's total reserves, but does not increase that uncertainty [in an adverse direction] significantly beyond the normal range of uncertainty for insurance liabilities at this stage of development.	3A	The *reserves* of the company/syndicate have **the potential for material additional uncertainty** *as a result of [liabilities arising from]* the Uncertainty Source. This increases the uncertainty of the company/syndicate's total reserves, but does not increase that uncertainty [in an adverse direction] significantly beyond the normal range of uncertainty for insurance liabilities at this stage of development.
4	The company/syndicate **has material exposure** to the Uncertainty Source. The ultimate amounts of these claims are subject to a great deal of uncertainty which, combined with their total size, increases the level of uncertainty for the total reserves of the company/syndicate significantly beyond the normal range of uncertainty for insurance liabilities at this stage of development.	4A	The *reserves* of the company/syndicate have **the potential for material additional uncertainty** *as a result of [liabilities arising from]* the Uncertainty Source. The ultimate amounts of these claims are subject to a great deal of uncertainty which, combined with their total size, increases the level of uncertainty for the total reserves of the company/syndicate significantly beyond the normal range of uncertainty for insurance liabilities at this stage of development.

In each of the additional wordings the following additional text may be inserted at the actuaries' discretion between the first and second paragraphs of the additional wordings.

> *I [have/have not] included an additional explicit allowance in this regard[, and this allowance is not a material share of the reserves].*

Given the parallel with Wording 4, it may be reasonable to assume that Wording 4A may cause auditors to conclude that its use is equivalent to the accounting concept of fundamental uncertainty and may therefore give rise to accounts being qualified.

Where the actuary elects to use one of the new alternative wordings, they will need to be able to justify why they have not adopted the corresponding established wording. This could be for one of the reasons described earlier in this section 3.3 or for another reason.

The working party has included a minor refinement to the wordings (in italics in Figure 17) to refer to "the reserves of the company/syndicate" rather than just "the company/syndicate" to clarify the context in which the uncertainty is being considered. This refinement could equally be applied to the established wordings. If the wordings were to be revised, there may be scope for further refinements, including, for example, commentary as to whether any explicit allowance has been made in the reserves for the uncertainty and, if so, whether this allowance is material.

3.6 Proposed Solution in situations where the actuary lacks sufficient information to rule out material uncertainties

In section 3.4, we highlighted two scenarios that present practical challenges for reserving actuaries:

- Where Climate Change reserves do not make up a material explicit share of reserves.
- Where the actuary believes that there may be material risk arising from Climate Change but lacks the information to test this assertion.

Section 3.5 seeks to address the first of these questions. This section addresses the second. The Working Party envisages a scenario where the reserving actuary:

- Can identify and has reasonable grounds to believe that there is exposure to the issue.
- Considers that the issue has potential to be material.
- Does not have available information with which to make use of existing wordings.

The reason that this situation has arisen in the context of Climate Change is because industry data and models do not yet provide a framework with which actuaries can fully develop loss scenarios. While the actuary may be able to articulate scenarios, we believe it is highly likely that many will lack the information with which to parameterise them with sufficient confidence. To narrow the focus on the specific dilemma, they do not yet have sufficient evidence to support use of a *Wording 4 or 4A*, but equally cannot provide sufficient assurance that such material levels of uncertainty do not exist.

The Working Party believes that although this may be a particular issue currently for Climate Change, it is possible that new issues may arise in future, where a similar approach will need to be adopted. It is unclear to the Working Party whether the recent changes to TAS 100 requiring risk identification will increase the frequency with which a reserving actuary chooses to adopt such an approach. The Working Party's observations on when it would, and would not, be appropriate to do so are set out at the end of this section. An example situation is set out in Figure 18.

Figure 18 Historical liability insurance coverage of energy industry example

An actuary is considering whether to highlight the potential uncertainty in reserves arising from historical underwriting of occurrence-based policies for energy industry firms. The actuary has good reason to believe that this was an area where the insurer was an active industry participant.

At this stage, the actuary is aware that:

- *There are very large potential economic losses faced by society.*
- *Social attitudes relating to Climate Change are evolving, and will continue to develop, particularly following major physical events (such as wild-fires, heatwaves, droughts, hurricanes) that are being linked to a changing climate.*
- *Climate science continues to evolve, in particular the field of attribution science, which seeks to attach a cost to past actions of specific parties.*
- *The energy industry is a particular target of litigation, with a number of specific cases being brought in a number of jurisdictions.*
- *The energy industry insurance market might be described as having multi-year, high value and multiple insured take-up of coverage by sophisticated insurance purchasers with varied, bespoke and potentially large limit coverages.*
- *There is specialist third party litigation finance supporting the claims activity.*

However, aside from uncertainty regarding the outcome of such litigation or the size of any awards or settlements affecting energy industry firms, the actuary does not know:

- *Whether any awards or settlements may be insured.*
- *If they are, how much insurance cover might be exposed.*

The actuary may not have a reliable means of forming an estimate of adverse or even worst-case scenarios if:

- *They have no assessment of the exposures that the insurer might have to potentially exposed parties. This might arise where exposures could arise from policies written many years ago. Not only will this information need to be extracted and digitised from policy information, but work will also be required to assess where earlier or ongoing claims against these policies have already reduced the remaining cover that may be available.*
- *They have no insured market loss estimate upon which they might prepare some approximate top-down market-share based scenario. The alternative broad-brush approach of applying a market share factor to historical market-wide loss estimates may not be possible while so much uncertainty surrounds the size of possible insured losses.*

Figure 18 describes a reserving situation where an actuary currently has no clear way to classify succinctly the uncertainty in reserves. We can imagine many natural questions going through the actuary's mind:

- Does the nature of the loss exposure in the reserves need a *Wording 4* statement given the potential catastrophic outcome for the insurer?
- Will the actuary be exposed to potential criticism and/or censure for failing to mention an obvious issue?
- Is it appropriate to include or exclude explicitly such extreme scenarios given the number of hurdles still to be cleared before the loss might crystallise for the insurer?
- Surely all stakeholders are aware that this exposure exists, and an additional wording provides them with no additional information regarding the position of the insurer?

Fortunately, it is not the role of the Working Party to answer these questions.

What we do wish to highlight is that regardless of the legal merits and chances of success or otherwise of such cases against insured, insurers and reinsurers, there appears to be a gap in the

toolkit. Reserving actuaries who wish to highlight an emerging uncertainty of the sort described here presently have no effective and generally accepted means of doing so in advance of data and models being sufficiently well developed.

We believe that this is an important issue to address for the following reasons:

- To provide a form of wording that actuaries can adopt where they might otherwise feel obliged to stay silent on the issue.
- To support a consensus in the wording used for those actuaries who wish to highlight the issue.
- To avoid a scenario where collectively the actuarial profession is criticised retrospectively by stakeholders for failing to identify an emerging issue in a timely fashion.

Proposed Wording

The Working Party has therefore developed a possible wording "*Wording 5"* that it may be appropriate to use in situations of this nature.

> The *reserves* of the company/syndicate have **the potential for material additional uncertainty** as a result of [liabilities arising from] the Uncertainty Source.
>
> The limited [and evolving] current state of knowledge surrounding the Uncertainty Source means that I consider the likelihood of materially adverse scenarios arising from it to be remote. However **it is not possible for me to determine the materiality of the increase** in the [level of] uncertainty of the [company/syndicate's] [total] reserves arising from its exposure to the Uncertainty Source.

As for the wordings in Figure 17, the additional paragraph (shown in blue text after Figure 17) may be inserted within this Wording 5.

In essence, this wording is seeking to:

- Highlight the potential that the insurer might be exposed to remote adverse scenarios arising from the Uncertainty Source in question.
- Avoid giving false comfort regarding the Uncertainty Source.
- Indicate that at this stage it is too early to tell whether the issue materially increases the uncertainty in the reserves or not.

Other non-climate change example issues against which this proposal could be considered are opioids, Per- and polyfluoroalkyl substances (PFAS). In short, any issue where the available information or knowledge at a given point is a constraint on the actuary's ability to opine.

Implications for Auditors

While it will be for auditors to determine whether or not this form of wording represents a fundamental uncertainty, the Working Party believe that it is helpful to set out their observations on the criteria that should be applied when choosing whether to use this new wording:

- The scenarios arising from the Uncertainty Source need to be sufficiently remote that such a position can be justified. We believe that this means that there is a series of possible, albeit unlikely, and *distinct* events that need to occur[85]. See Figure 19 for an example.

[85] This might be regarded as a form of "known unknown" event.

Figure 19 Why Climate Change litigation scenarios are sufficiently remote

A: Shortly before a major legal ruling
Shortly after a major ruling, insurers will seek to quantify the impact that such a ruling will have on their reserves. However, it is not unreasonable to assume that the ruling would not have come as a surprise to them. Even if the particular outcome was considered unlikely, or even highly unlikely, it should not have been discounted as a remote scenario that effectively could not have arisen. This scenario is not then what is envisaged under Wording 5.

B: Climate change litigation
Climate change litigation, while it has been ongoing for a number of years, remains an area where its success remains highly uncertain. Beyond this stage, for insurers to become liable for a material share of any losses will require not only an additional set of legal questions to be resolved but future developments in scientific research to prove to a sufficient standard a causal link between the actions of the insured and the losses suffered and subsequently to determine the insured's financial obligations in respect of those losses. As a result, it may not be unreasonable for a reserving actuary today to consider such scenarios to be remote and so Wording 5 may be considered appropriate.

- Conversely, the issue should not be so remote that the potential scenarios that might give rise to such losses can legitimately be excluded[86]. See Figure 20 for an example.

Figure 20 Why Climate Change litigation scenarios are not too remote

A: Generic new mass tort
A new mass tort similar in scale to the US asbestos and pollution claims arising in the 1980s might be considered to be too remote to merit Wording 5. While the possibility of <u>something</u> arising cannot and should not be ruled out, the Working Party does not consider a generic class of events to be sufficiently specific to merit this type of wording.

B: Climate change litigation
Climate change litigation, while it has been ongoing for a number of years, can be narrowly and specifically defined. A logical chain of losses from litigants to insured parties to insurers can be identified. Even though there remain complex legal and scientific matters to be addressed at each stage, the actuary may feel justified in concluding that the scenario can be sufficiently well defined and is gaining sufficient widespread acceptance that an adverse ruling may arise in the not too distance future.

The limited state of knowledge referred to by the actuary needs to be a legitimate information gap, not one arising from a lack of effort by the actuary or the insurer. We believe that firms subject to such wordings may be expected by stakeholders to describe and report upon their state of knowledge and their progress towards placing an upper bound upon the uncertainty. In section 3.7 we have set out a basic maturity model that firms might adopt to report on their state of understanding of the issue.

[86] In contrast to Figure 17, this might be regarded as a form of "unknown unknown" event.

3.7 Maturity Model for "Wording 5" Scenarios

To complement the additional wording, the Working Party believes that it will be helpful for reserving actuaries and the firms that they advise or represent to have a common framework for communicating the position of the firm, and the steps required to enable the actuary to adopt one of the more established wordings, or the proposed variants, as set out in Figure 17 above.

The Working Party has therefore proposed the following five-tier model, set out in Figure 21, regarding the data and information gathered regarding the exposures of the firm. This framework is deliberately high level. It is envisaged that actuaries will develop and enhance this core conceptual model over time.

Note that this has been developed with the specifics of Climate Change latent liability reserve risk in mind and may need to be adapted for other sources of uncertainty.

Figure 21 Five-tier Model of Insurer Issue Knowledge

Tier	State of Knowledge
1	Little or no knowledge or information regarding the firm's historical underwriting activities.
2	Partial awareness of underwriting periods, lines of business, basis of cover and industry sectors covered.
3	Complete awareness of underwriting periods, lines of business, basis of cover and industry sectors covered. Little or no details surrounding underlying insured names, policy limits, coverage, terms and conditions with which to determine extent of exposure to liability from specific litigation or general classes of litigation.
4	Complete awareness of underwriting periods, lines of business, basis of cover and industry sectors covered. Partial details surrounding underlying insured names, policy limits, coverage, terms and conditions with which to determine extent of exposure to liability from specific litigation or general classes of litigation.
5	Complete awareness of underwriting periods, lines of business, basis of cover and industry sectors covered. Comprehensive details surrounding underlying insured names, policy limits, coverage, terms and conditions with which to determine extent of exposure to liability from specific litigation or general classes of litigation.

The Working Party's expectation is that at the time of writing few firms will be in Tier 1, and as a result unable to form an initial view regarding whether there is a need to carry out more in-depth investigation of exposures.

The terms "partial", "complete" and "comprehensive" are intended to indicate outcomes as follows:

- Partial - Sufficient data to enable the actuary to form an opinion based on extrapolation of this information, albeit with a considerable degree of uncertainty. Possibly 40% - 80% coverage may meet this requirement.
- Complete/comprehensive - Sufficient data to enable the actuary to form an opinion with a reasonably high degree of confidence. Likely to be in excess of 80% portfolio coverage required.

3.8 Concluding Comments

Climate Change is an important issue for reserving actuaries presenting a novel type of uncertainty in reserves. The current framework for describing this uncertainty has stood the test of time well, however the Working Party believes that Climate Change presents some new challenges to it.

We have recommended some enhancements to the framework, that cater for two specific situations that are likely to be faced by reserving actuaries in the coming years. These are:

- When describing the uncertainty arising from Climate Change where the reserves, or possibly the explicitly identified reserves, held are not material.
- When the actuary has grounds to believe that there could be a material element of uncertainty in the reserves, but does not have sufficient information to provide a definitive opinion on whether this is the case.

In the latter case, we have also suggested a framework around which the maturity of the firm's understanding of the uncertainty can be described by actuaries.

We hope that these suggestions serve to stimulate debate and greater understanding of the reserving issues presented by Climate Change. In doing so, we hope that this will help the profession reach a consensus on the appropriate way ahead in advance of any major uncertainties arising from Climate Change crystallising.

4 Assessing Climate Change Exposures using Qualitative Methods

4.1 Introduction

This section aims to assist actuaries assess the climate risk exposure in their portfolio through a series of qualitative tools and techniques. Through wider reading, engagement with stakeholders and the application of qualitative tools a reserving actuary should be able to provide a better understanding of climate change exposure within the portfolios they are considering.

Section 4.2 proposes ways an actuary may want to get an initial view of climate risks through a better understanding of the subject matter as well as internal knowledge, assumptions and processes and useful external documents. This includes further resources with which to build an understanding of the subject matter and questions and issues to explore through engagement with internal and external stakeholders.

Sections 4.3 and 4.4 consist of case studies for two lines of business which are likely to be impacted by climate change. These are, respectively, Directors' and Officers' ("D&O") and Property Damage/Business Interruption ("Property") insurance business. The case studies are not meant to be an exhaustive list of all the possible climate related risks in a D&O or Property portfolio but aim to provide a high-level view of current known areas of risk, and those that have been identified by this working party as potential risks. This section also explains how the findings of these case studies can be applied to other lines of insurance business.

Each case study includes initial heatmaps of potential climate change risks and triggers which actuaries may adopt or adapt using the acquired from the activities described in section 4.2. The heatmaps aim to provide a framework for reserving actuaries to assess the impact of climate risks on their reserves. To derive the heatmaps, the Working Party first undertook research to understand the risks relevant to the selected classes as well as to identify other types of qualitative tools which are already available. The D&O heatmap was constructed using the litigation case studies as a primary reference point and after consulting with relevant experts, while the Property heatmap classifies the exposure by perils and use specific weather-related perils and events for reference.

The heatmaps follow a similar structure, with the sections of the heatmap being split between:

- Triggers/drivers of claims (down the side for D&O and across the top for Property)
- Climate related risks facing this type of business (across the top for D&O and down the side for Property)

The heatmaps describe the impact of the trigger and the risk on the respective class of business. The heatmap square also contains information on possible causes of these claims. Each square has been attributed a RAG (Red, Amber, Green) status based on the working party's opinion of the impact these claims could have on an insurance business portfolio, with a red rating indicating a significant impact and a green rating a less significant impact.

4.2 Exposure to climate change risks

Section 2 of this paper provides an overview of the key aspects of climate change for reserving actuaries. Inevitably, it is not exhaustive, and can only scratch the surface of the subject. In forming their views on the exposure of a portfolio to climate risks, actuaries may wish to obtain a broader understanding of climate related risks and review some of the extensive literature that is available. A list of sources which have been identified by the working party as useful has been provided in Appendix 2.

Climate change related risks: key stakeholders and questions to ask

Once this grounding in key climate change issues and risks has been established, the next step will be for the reserving actuary to engage with internal stakeholders. Holding conversations and asking questions to internal stakeholders of the business helps inform an initial view. Similar conversations with external advisors and stakeholders (auditors, regulators, industry bodies and third-party

consultants) may be helpful to obtain a wider perspective or to benchmark the actuary's findings with others.

The working party has therefore identified some possible questions that actuaries could ask to initiate these conversations. Key questions are outlined in Figure 22 and a list of broader questions is outlined in Appendix 3.

Figure 22 Understanding climate change risks questions to internal stakeholders

Team	Questions
Yourself / Your team	What exposure does my company and the book under investigation have in respect to past written liability business?
	Have we researched the current legal environment across jurisdictions where we have exposures?
	Have we considered underwriting actions taken on future written business? What does that mean for the back book?
Wider actuarial team	What previous analysis has been performed on climate-related risks and exposures?
Board / ESG Committee	What public statements has the company already made regarding climate risk?
Risk team	Have climate change considerations been integrated into risk appetite statements / wider risk management frameworks?
Underwriting and pricing teams	What changes in the policy terms and conditions have been applied over the last few years to manage exposure to emerging trends? For example: • Have any contracts recently been non-renewed for reasons not related to the specific experience of the insured? • Have there been any exclusions, deductibles or limit clauses added over the last few renewals?
	How are trends in experience allowed for in pricing and how are they determined? Are there any explicit climate change trends/loadings currently considered or planned? • Within CAT modelling • Within non-CAT expected loss ratios
Claims teams	What claim watch-lists are currently maintained? Is there a flag to identify climate change related claims? If so, how is a "climate change related claim" recognized and isolated from the remaining claims?
	Are there any new causes of claims that have been emerging over the last few years?
Capital team	What changes in internal model parameter calibration have been implemented over the past reporting cycles? Do any of these have potential links with trends from climate change?

4.3 D&O case study

4.3.1 Directors' and Officers' insurance

D&O insurance provides legal liability protection for the directors and officers of a company and so can be heavily impacted by climate-related litigation. The current climate litigation environment is complex and extensive. A snapshot of the increase in climate related litigation has been outlined in Section 2 of this paper. Whether a D&O insurance loss is triggered by a current or future climate liability litigation case (including the major ones discussed) will depend on the specific language of a company's insurance policy. This can vary significantly across different insurers and over time, and considerations will need to include whether the costs incurred in defending a case are covered.

Whether a climate litigation case will result in a D&O claim will also depend on specific policy exclusion wordings. Policies often include a 'conduct exclusion' which limits coverage to exclude fraudulent or intentionally wrongful conduct. However, this may only apply if there is a final judgement

of wrongful conduct against the insured. The exclusion may therefore not apply if an out of court settlement is reached. D&O policies may also include exclusions for pollution, although the definitions will need to be understood, and may also exclude liabilities arising from bodily injury or property damage.

4.3.2 D&O Heatmap

The heatmap shown in Figure 23 sets out different causes of D&O claims on the side and possible climate risks that could impact a D&O policy across the top. More detail on the causes of litigation claims for each of these triggers is shown in the table below the heatmap.

When interpreting the heatmap content, please note the following:

- A RAG status has been applied to highlight areas the working party considers likely to be of greatest concern to re/insurers.
- Cases can generally be classified between:
    - Inaction;
    - Errors in Action; and
    - Misstatement.

  These are further explained within the heatmap.
- Of the many climate-related cases, the working party's focus has been on those that they understand have been selected by legal experts for their plausibility and greatest likelihood of impact upon insurers across all jurisdictions.
- Note that some of these sections may be irrelevant to a given portfolio and business, dependent on the applicable wordings and exclusions.

Figure 23 D&O insurance Heatmap

D&O Triggers	Transition Risks - Transitioning to a low carbon or "Green" economy			Physical risks - Damage to assets/indirect impacts to supply chains etc.
	GHG Emissions Related	Change in consumer and investment sentiment	Policy/Legal changes (e.g. not meeting net zero targets)	Acute - Events and Chronic - Long-Term Changes
A: Climate Attribution for past Emitters and Climate Inaction (Cases A)	Stakeholder action against companies that have been responsible for emitting GHG emissions including new developments in attribution science, where the relationship between emissions and climate change impacts is quantified		There may be legislation that comes in that makes companies pay for the damage that climate change has caused.	
B: Failure to adapt - Continued inaction/denial/Investing in causes of climate change.	Climate inaction by continuing BAU without changing strategy e.g. continuing to invest in fossil fuels with no transition plan in place i.e. not reducing carbon footprint	Claims against companies for not sufficiently addressing consumer/investor needs to reduce their carbon footprint	Claims against companies whose targets are not aligned with net zero and are not aggressive enough	Trend - Sewage and Water companies being sued as heavy rainfall is going into storm drains and causing flooding.
C. Failure to comply with regulations - Breach of Duty	Failing to comply with the emissions laws prevailing in respective jurisdiction.	Companies investing heavily in "green" ways of doing business at the cost of profits and so failing their fiduciary duty to make shareholders money.	Litigation against companies for anti-competition where they are working with competitors towards net zero.	Claims against companies for causing a major natural disaster such as a wildfire not complying the regulations.
D: Misrepresentation of exposures/reporting disclosures – Greenwashing	Failure to disclose climate change risks, misrepresenting its business practices related to use of proxy costs of carbon.	Claims against companies for overstating their green credentials to meet stakeholder expectations	Failure to report climate related risks	
E: Misleading/ Misdirection /Conflict of Interest - Greenwashing	Where firms cynically divert public attention away from say a polluting activity.	Companies advertising better green credentials than they have as society is more climate conscious.		

For each of the D&O triggers in Figure 23, Figure 24 below provides relevant examples of current litigation cases and possible future litigations that the working party has identified as well as the main area/s these litigation cases are likely to impact. For a complete list of climate change-related litigation cases split by jurisdiction or by principal law please refer to the following URL: https://climatecasechart.com/[87]

[87] Sabin Center for Climate Change Law · U.S. Litigation Chart made in collaboration with Arnold & Porter Kaye Scholer LLP

Figure 24 Litigation examples by D&O triggers

Triggers Impacting Exposure	Current Litigation Examples	Main Area Impacted
A: Climate Attribution for Past Emitters / Climate Inaction	• Lliuya v. RWE AG (see section 2.4) - A Peruvian farmer and mountain guide has brought a claim against German energy company RWE. The claim argues that the impact of climate change on glacial melt has increased flood risk and that RWE should contribute to the cost of flood defences in proportion with its contribution to global emissions. • Shell and Exxon - Newly found documents from the 1980s show that fossil fuel companies privately predicted the global damage that would be caused by their products (see case study one in section 2 which is an example of this type of case). • Exxon's total CO_2 emissions in the past 120 years, at 20.3 billion tonnes, have been about three times the current annual global emissions from fossil fuels. Two states have launched fraud investigations into Exxon over climate change and sued (one went to trial in 2019, and the attorney general lost). Nine cities and counties, from New York to San Francisco, have sued major fossil fuel companies, seeking compensation for climate change damages.[88]	The largest sector impacted is oil and gas majors, but any large carbon emitters could also be targeted as carbon attribution science advances. Any historical policies written on a losses occurring during (LOD) basis could have exposure to these types of claims, as well as current policies written on a claims made basis.
B: Failure to adapt - Continued inaction / denial / Investing in causes of climate change	• The resolution, filed by ShareAction in 2023 against HSBC, calls on the bank to take urgent action to scale back its exposure to fossil fuel assets in line with the timeline set out by the Paris climate agreement. (See Appendix 2, Item 28 for more detail). • Shell - shareholder litigation to reduce global carbon emissions. In May 26, 2021, The Hague District Court ordered Royal Dutch Shell plc ("Shell") to reduce its worldwide CO_2 emissions by 45% by 2030 (compared to 2019 levels). Directors are personally being held liable for perceived mismanagement of climate risk by failing to implement a corporate strategy that is aligned with Paris Agreement goals (Breach of duty). (See Case 1 in the Climate Litigation Risk Chapter produced by the UK Financial Conduct Authority - Climate Financial Risk Forum publication for more detail[89]).	These examples are largely against oil and gas majors and financial institutions. However, any carbon emitting or investing company could be targeted.
C: Failure to comply with regulations / Breach of Duty	• SEC v. Volkswagen Aktiengesellschaft, et al - The issue was about the company's claimed "clean diesel" engines. It is asserted that Winterkorn (chairman of VW) and other senior officials and engineers at VW knew that VW's clean diesel engine was a fraud because it failed to comply with applicable U.S. emissions laws. (See Appendix 2, Item 29 for more detail). • Pacific Gas & Electric (2018) A California utility has pleaded guilty to the deaths of 84 people in a wildfire, the deadliest US corporate crime ever successfully prosecuted. Due to wildfire caused by PG&E's, the executives were held responsible for failing to take action that would have controlled a major natural disaster. In a compensation lawsuit, executive officers at PG&E are alleged to have breached their fiduciary duties by failing to implement critical safety measures that could have potential prevented, or limited, the damages. (See Case 6 in the Climate Litigation Risk Chapter produced by the UK Financial Conduct	Any sector or company where there is a regulatory requirement could have exposure to this type of claim.

[88] Reference to be completed.
[89] CFRF: Scenario analysis working group: climate litigation risk chapter (fca.org.uk)

Triggers Impacting Exposure	Current Litigation Examples	Main Area Impacted
	Authority - Climate Financial Risk Forum publication for more detail[90]).	
D: Misrepresentation in reporting disclosures of "green" credentials or climate risks	• Abrahams v Commonwealth Bank of Australia - Shareholders of the Commonwealth Bank of Australia (CBA) alleged that it violated the Corporations Act by issuing its 2016 annual report, which failed to disclose climate change-related business risks specifically including investment in the controversial Adani Carmichael coal mine (See Case 11 in the Climate Litigation Risk Chapter produced by the UK Financial Conduct Authority - Climate Financial Risk Forum publication for more detail[91]). • McVeigh v. Retail Employees Superannuation Trust - Australian pension fund violated the law by failing to disclose information on climate business risks and its strategies to address these risks. However, it agreed to incorporate climate change financial risks in its investments and implement a net-zero by 2050 carbon. (See Case 16 in the Climate Litigation Risk Chapter produced by the UK Financial Conduct Authority - Climate Financial Risk Forum publication for more detail[92]). • O'Donnell (as class action representative) v Commonwealth of Australia (December 2020). Commonwealth officers are in breach of statutory prohibitions against misleading or deceptive conduct and statutory and fiduciary disclosure duties. (See Case 17 in the Climate Litigation Risk Chapter produced by the UK Financial Conduct Authority - Climate Financial Risk Forum publication for more detail[93]).	Any public company or sector that has regulatory reporting requirements or any companies who voluntarily disclose this information have exposure to this type of liability.
E: Misleading advertisement / Greenwashing	• Coca Cola - June 2021 - lawsuit for falsely advertising that it is sustainable and eco-friendly despite being the largest plastic polluter in the world. (Annex A. 1.a. Earth Island Institute vs The Coca-Cola Company in the in the Climate Litigation Risk Chapter produced by the UK Financial Conduct Authority - Climate Financial Risk Forum publication for more detail [71]). • Client Earth vs KLM - A Dutch environmental group sued Koninklijke Luchtvaart Maatschappij N.V. (KLM) in May claiming that the airline's 'Fly Responsibly' advertising campaign and carbon-offsetting scheme was misleading and amounted to greenwashing. (See Case 9 in the Climate Litigation Risk Chapter produced by the UK Financial Conduct Authority - Climate Financial Risk Forum publication for more detail[94]).	These cases can cover many types of sectors, industries, and jurisdictions, much like with false advertising. Future cases are likely to be determined by new laws and standards relating to advertising.

[90] Ibid.
[91] Ibid.
[92] Ibid.
[93] Ibid.
[94] Ibid.

4.3.3 How to assess the additional allowance needed for climate risks in the reserves

Some of the climate change-related triggers in the heatmap have characteristics which are similar to traditional D&O claims, for example claims resulting from a failure to comply with regulatory requirements or false advertising claims and so are likely triggers that a reserving actuary may have already considered or included allowances in the reserves. Climate litigation is relatively new to the market and current reserve estimates are based on a market with little climate litigation history and so uplifts may need to be made for the impact of climate change.

Other types of claims such as climate attribution for past emitters are example of possible new types of D&O claims. Reserving actuaries have limited historical data to inform the allowance required in the reserves.

A proposed approach is to consider each square of the heatmap individually:

- Understand if this would be excluded or limited on policies written in the portfolio, considering that wordings and policy bases (LOD/claims made) have changed over time.
- Consider what allowance you currently have for the trigger, e.g. it is likely that there is an allowance in the reserves for false advertising which greenwashing may come under.
- Understand if the addition of climate-related risks and climate litigation outlined would change the frequency and/or severity of claims, e.g. with the addition of greenwashing you may see false advertising claim frequency increase.
- Talk to pricing and underwriting teams to ascertain if a margin for climate related risks has been factored in the pricing basis.
- Make the necessary adjustments to the reserving basis.

This approach may also be helpful when the actuary is considering the knowledge maturity model described in section 3.7.

4.3.4 Application to other lines of business

The heatmap and the information in the section above have been created through the lens of D&O insurance business. But this could easily be adapted for use in other Professional Indemnity lines of business as well as other insurance lines of business.

The information about the litigation cases and the categorisation of climate risks are not specific to D&O, but common triggers of D&O policies have been used to categorise these cases further. Instead triggers for other insurance business policies or lines of business could be used.

4.4 Property case study

4.4.1 Property damage / business interruption insurance

Property Damage insurance covers the cost of repairing or rebuilding the insured property and covers risks such as escape of water, fire, flooding, storms, subsidence, falling trees and theft. Property Damage insurance is subdivided into two types:

- Buildings insurance - covers the cost of repairing or rebuilding the insured property if it is damaged or destroyed.
- Contents insurance - covers the cost of replacing the contents if damaged or stolen.

The above apply to both commercial and residential properties.

Business interruption applies to commercial properties and covers the loss of profits or increased costs due to the inability to undertake business activity following an insured event. For the purpose of this paper property damage and business interruption are considered together as Property.

Property insurance covers both business interruption and property damage perils. It is heavily impacted by acute and chronic physical risks of climate change. Appendix 4 provides illustrative examples of insured events resulting in significant property claims as a result of climate change affecting the property line of business. Given the potential material impact that climate related risks have on the property line of business, the Working Party has used it as a second example of how a climate-related heatmap can be developed.

4.4.2 Property Heatmap

Using the climate risks taxonomy set out in section 1.3 of this paper, the heatmap splits the perils into physical and transition risks as follows:

Physical risks

Acute physical risks are likely to increase property damage claims and can additionally lead to supply chain disruptions. For example, an increase in global temperatures has the potential to generate acute changes in climate through heatwaves and increase the spread of wildfires (Jones et al 2020)[95].

Chronic physical risks are associated with changing climate patterns such as severe weather events and changing precipitation patterns or from longer term trends such as temperature changes/volatility and rising sea levels. These lead to a wide range of impacts including consequences such as changes in land use, and land and soil productivity. In turn, these are likely to have a longer-term adverse impact on property lines of business and on the frequency and severity of claims experienced.

On the frequency side, actuaries can expect to see an increase in the number of claims, including greater clustering of events. In addition, more extreme temperatures may take more of a toll on the materials used to construct property, which could decrease their lifespan, thereby causing an increase in the frequency of claims.

On the severity side, the claims cost may increase as the severity of "attritional" events increases, for example, the damage caused from a hail event involving larger, baseball-sized, hailstones will be considerably greater than from a hailstorm with pea-sized hailstones. There appears to be an emerging pattern of increasingly severe weather events which is likely to lead to higher claim amounts, meaning that there may be larger claims than historically seen from events previously categorised as attritional.

Transition Risk

There is large uncertainty in the possible causes of loss arising from new technology that has been brought in as part of a move to a greener way of living. These are new types of assets and hence new claim types, with their frequency and severity less certain or unknown. The new technology may also impact insurance on other assets. For example, there could be greater numbers of home insurance claims arising from faulty batteries or solar panels setting houses on fire.

In addition, the understanding of how these technologies will stand the test of time is unknown. It is important for actuaries to understand what is and is not included in any assumptions on which any reserve projections are based.

The heatmap presented in Figure 25 below shows different property coverages across the top and possible climate risks that could impact a property policy on the side. More detail on the property perils for each risk is shown in the table below the heatmap.

[95] Jones, M, A Smith, R Betts, J Canadell, I Prentice and C Le Quéré (2020): "Climate change increases risk of wildfires", ScienceBrief Review, January, sciencebrief.org/briefs/wildfires.

Figure 25 Property damage / business interruption insurance heatmap

		Property damage/ Business interruption	Contingent business interruption
Physical risk - Acute	Flood	Increase in property damage and business interruption due to widespread flood events caused by e.g. rising sea levels. More severe flooding covering more territories, as observed for example in Europe in 2021, leading to significant claim costs for insurers (damage and loss of assets that then lead to service disruption).	A major natural catastrophe can lead to global supply chain impacts that can lead to e.g. delay in support of goods and services (example Thailand Floods (2011)). Power outage and damage to transportation infrastructure due to a wide-scale flood occurring. Coastal flooding due to rising sea levels can lead to significant supply chain disruptions.
	Windstorm	Increase in windstorm damage due to climate change resulting in buildings needing to be repaired more frequently. Hurricane seasons become longer and more intense. Storm Ciara (2020) and Storm Dennis (2020) have hit the UK and Europe in recent years.	A major natural catastrophe can lead to global supply chain impacts that can lead to e.g. delay in supply of goods and services. Power outage and damage to transportation infrastructure due to a wide-scale windstorm occurring.
	Wildfire	Increased frequency and severity of wildfire events leading to property damage. Due to changing climate patterns, wildfires are happening more often and for longer (exacerbated by longer and hotter days). New territories are also being exposed to wildfires (e.g. UK and Europe). This can be exacerbated by inability to increase loss prevention e.g. number of firefighters.	Wildfires can lead to communications, power, water support and gas service disruption.
Physical risk – Chronic	Drought/ Extreme heat	Extreme heat can lead to increased frequency and severity of damage to crops.	Extreme heat can lead to operational disruptions such as power outages and interruptions in the supply chain.
	Subsidence	Hotter and drier summers being driven by global warming are leading to the ground under houses shrinking and cracking, increasing property losses.	
	Freeze/ Extreme cold	Increase in damage due to more extreme cold weather leading to e.g. burst pipes in properties (e.g. Beast from the East (2018))	
Transition risk	New government policies along with societal/ technology shifts are leading to insurance of “greener” property assets	Insurers are insuring a range of new assets. This causes greater uncertainty on future payments e.g. electric/hydrogen vehicles. Some claims costs can be both positive and negative.	

For each of the property perils in Figure 25, Figure 26 below, provides relevant examples of such perils. The incidence and impact of extreme weather events related to climate change appears to impact most territories of the world. For example, an article published by the World Meteorological Organisation[96] explains how extreme weather is the new norm across the world. During August 2023, there were record heatwaves in Europe sparking wildfires across a number of countries, a record-breaking wildfire season in Canada to hurricane Hilary (2023) bringing about record rains in southern California. This adds to the overall uncertainty of claims arising from climate change impacts.

Figure 26 Perils on a property damage insurance policy

Perils	Examples
Flood	Cresta has updated its industry loss estimates and provided a quarterly update, in which the organisation says that the insurance and reinsurance market loss from the July 2021 European flooding is now estimated to be $13.8 billion. In the UK, current annual damages from coastal flooding are estimated at over £500 million per year and costs are likely to increase under projections of future sea-level rise.
Windstorm	Hurricane Laura (2020) caused substantial wind and storm surge damage and triggered widespread flooding that extended far inland. Overall losses came to US$ 13bn, with insured losses of US$ 10bn. Hurricane Ida (2021), where damage stretched from New Orleans to New York, resulted in $30-$32 billion in insured losses. As a result of Storms Dudley, Eunice and Franklin (2022), there have been 177,000 claims notified for damaged homes, businesses and vehicles, with total payouts of £497million expected. Of these claims, 169,500 relate to property damage costing £473 million.
Wildfire	Insured losses from the most destructive wildfire month in California's history (2018) climbed $614 million in the first three months of the year, pushing total claims over $12 billion as of April 2019. The Woolsey Fire (2018) cost $4.2 billion in estimated losses, or $4.56 million with inflation.
Drought / Extreme Heat	LV=General Insurance said it was dealing with claims worth £1.2 million after the extreme heat that hit the UK between 17 and 20 July 2022.
Subsidence	Insurers expect to pay £219 million in subsidence claims made in 2022, many of which were caused by last summer's record-breaking high temperatures. The average subsidence claim incurred was £9,600. Of the 23,000 subsidence claims made during the year, the majority -18,000- were in the second half of the year following the summer heatwave.
Freeze / Extreme Cold	Escape of water claims increased to £368 million in 2022 Q4, the highest for any quarter recorded by the ABI. A significant reason for such an increase in claims was the 56% rise in total domestic and commercial escape of water claims, likely due to the freezing weather across winter causing pipes to burst. Overall, with losses of US$ 30bn (half of which were insured), the Texas freeze (2021) was the year's third-costliest natural disaster.

4.4.3 Property: how to assess the allowance needed for climate risks

Given that climate change has been an ongoing issue for a number of years it is likely that for the acute physical risks, (re)insurers are already including an allowance for the likely adverse impact in their pricing, exposure management and other areas of the business. As outlined in the earlier sections of this paper, this is still an area of uncertainty and the allowance needs to be refined over time, particularly as the impact of climate change events feeds through the historical claims data. In particular, when modelling catastrophe scenarios, the layering of climate change is still evolving.

[96] https://public.wmo.int/en/media/news/extreme-weather-new-norm

The Working Party recommend that actuaries should understand whether the reserves already include an implicit allowance for climate change (both for catastrophe and attritional reserves). The questions raised in the earlier sections of this paper could assist in determining such allowance. Actuaries should also ask questions about what is not included (e.g. allowance for chronic risks).

Once actuaries are able to determine the allowance (already implied and included by other teams such as claims) they need to ascertain the level of comfort with this allowance. It is also important to determine if the implicit allowances are feeding through the reserves (e.g. using pricing initial expected loss ratios).

Actuaries should then ascertain whether any additional allowances for climate change related risks are required. For example, attritional claims (e.g. burst water pipes from extreme cold) should be expected to increase with climate change. The working party recommends that actuaries could:

- Consider the locations of the property risks within the portfolio around the world and whether they would be exposed to increased risk.
- Ascertain whether the impact of climate related risks is already coming through the historical claims data (e.g. frequency trends).
- Understand if the pricing for property damage and business interruption policies already includes an allowance for climate related risks.
- Understand if rates have been adjusted to allow for the additional risk posed by the same property but in more changeable weather.

Once the above exercise is completed, actuaries should be in a better position to assess what adjustment should be made to the reserving methods/assumptions and whether any additional explicit allowance is needed on top.

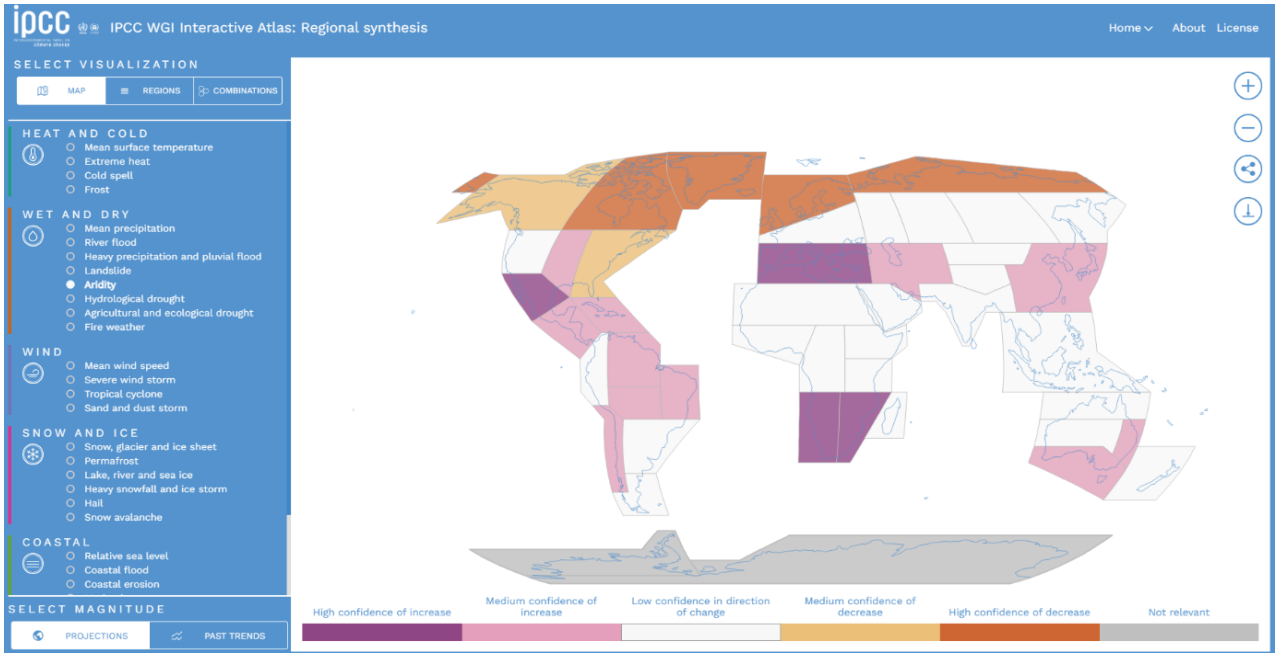
4.4.4 Application to other lines of business

The heatmap and the information in the section above has been constructed with Property business in mind but it does not mean this could not be adapted for other classes that cover similar risks.

For physical risks, there are many examples of heatmaps that could be used additionally to help assess impacts by other factors. An example is the interactive atlas prepared by the IPCC[97] shown in Figure 27. The image provided from this interactive atlas, illustrates the regions which are mostly affected by aridity (i.e., the state of being very dry and without enough rain). Many other types of peril are also covered by the IPCC interactive atlas. This illustration could assist actuaries ascertain the impact on insurance portfolios of the changing environment.

[97] https://interactive-atlas.ipcc.ch/

Figure 27 Intergovernmental panel on climate change interactive atlas[98] - aridity filter applied



4.5 Use of underwriting portfolio risk assessment tools

The preceding material in this section has sought to provide initial guidance on how actuaries can better understand and analyse climate change-related risks within their reserving portfolios. Because it is not exhaustive, and alternative avenues could be explored, the working party emphasises the importance for actuaries of considering the uncertainty surrounding the data and arising from the developing and evolving nature of climate science.

Another approach that actuaries might wish to apply here is to develop and make use of survey tools (e.g. web-based questionnaires) designed to gather information about how businesses are thinking about the impacts of climate change and to provide informative benchmarks.

The main reasons for undertaking such an exercise across the business are:

- To ensure a robust ongoing process to identify climate change risks and opportunities.
- To help identify, assess and rank the impacts of climate change and emerging trends across each line of business.
- To engage with key stakeholders, including underwriters.

The main outcome and benefits of such an exercise are:

- To assess the impact of climate change across each line of business for both claims and premiums.
- To capture detailed climate insights and trends from the first line risk owners and other key stakeholders.
- To support future business decisions and operational processes in areas such as risk appetite, pricing, reserving risk aggregation/ exposure management, new product development and improved internal reporting.

[98] https://interactive-atlas.ipcc.ch/

The exercise above may also have a second-order business impact. For example to provide additional insight to a heatmap analysis into the prospective shape of risks insured. The analysis could help reserving teams provide feedback into premium pricing methodologies used by underwriting teams as the risks underwritten may be affected by climate related risks. For example if certain geographical areas are more likely to experience floods due to changes in precipitation levels, the premium rating factors may need to be adjusted to allow for this.

This section has talked about changes in claims due to the inclusion of climate related risks, however, it is worth considering the changes to the premium due to climate risks, especially if this is used as a base for any reserve projections. Changes to assets covered (e.g. policyholder has added solar panels to their roof) may not be included in rate indices and it is important to ensure you have talked to the underwriting team to understand what is included in the RARC (risk adjusted rate change) calculations.

It is also worth noting that some market participants may withdraw from the market due to the uncertainties associated being too great or the market premium being insufficient, or conversely to expand into markets where they perceive underwriting opportunities. These market dynamics may disguise other in the underlying risk profiles of a seemingly stable portfolio.

4.6 Concluding Comments

This section 4 has presented a method for reserving actuaries to use to assess climate risk in a qualitative fashion as they seek to understand better the extent of climate change related risks and exposure within their portfolios.

Whilst the full science of how to allow for climate-related risks in reserving has not yet been fully developed, the working party recommends that a starting point is to consult existing literature and engage with key stakeholders within the business. From these conversations reserving actuaries should gain a better understanding of the climate-related risks and the additional uncertainty around the reserves. As a subsequent step, the working party recommends the use of heatmaps as a visual tool to analyse and illustrate the potential physical and transition risks faced and the triggers or events causing the risks.

Heatmaps have been presented for two lines of business: directors' & officers' liability and property damage/business interruption insurance. These heatmaps have a two-fold purpose: to show where in each portfolio the working party considers the most significant risks for insurers exist, and to provide a framework that reserving actuaries can adopt and adapt in considering their portfolios more generally.

This guidance is not intended to be exhaustive and alternative avenues could be explored. The working party believes that these qualitative tools can provide a helpful starting point for reserving actuaries seeking to gain an understanding of the impact of climate change as required by TAS 100 v2.0. Armed with this analysis, actuaries may be better placed to communicate the uncertainties arising in reserves as has been explored in section 3 of this paper.

Such qualitative tools will represent only an initial step along what the working party sees as a long path towards the development of effective quantitative modelling tools. The development of tools to gather information about how businesses are thinking about climate change and to benchmark performance may prove helpful, particularly in the short-term.

Further spin-off benefits arising from the use of the qualitative tools described in this section are to enhance the ability of the reserving actuary to provide feedback loops into pricing, planning and exposure management teams within the business.

5 Conclusion

The working party believes that climate change is now a critical issue for reserving actuaries. Not only is there now an established and well-regarded body of scientific evidence, but there is also a clear societal recognition of changing patterns of weather and severity of extreme weather events. Not only are these events leading to economic losses resulting in greater insurance claims, but they are resulting in an emerging, and sophisticated approach to litigation.

As a result, it is no longer appropriate for reserving actuaries to view climate change as an area for pricing and capital modelling actuaries. The working party believes that it is now time for reserving actuaries to become better educated and more engaged in this area as part of their reserving responsibilities.

In this paper, the working party has given particular attention to the evolving climate litigation landscape, where new legal arguments are being put forward to challenge and influence governments and corporations, and to seek compensation for past actions. The working party believes that this complex and evolving area is worthy of reserving actuaries' attention, to understand these new trends and developments, and to inform the identification and assessment of risks within their own portfolios.

Communicating these changes, and the uncertainty within reserve estimates is likely to be the first hurdle faced by reserving actuaries. This paper has set out some suggestions as to how existing approaches to formal uncertainty reporting might evolve. It also highlights how actuaries might respond to the challenge that the working party anticipates will arise from there being insufficient information with which the actuary can reach a conclusive position on uncertainty in reserves.

The working party believes that this will require them to challenge their existing methodologies and assumptions, with the use of past data to support the evaluation of risk, and the valuation of liabilities and assets. Therefore, the existing actuarial reserving toolkit will need to be adapted. With care, judgement and a commitment to a sound, data-driven approach, the role of the reserving actuary will remain not only relevant, but central to how firms respond to climate change.

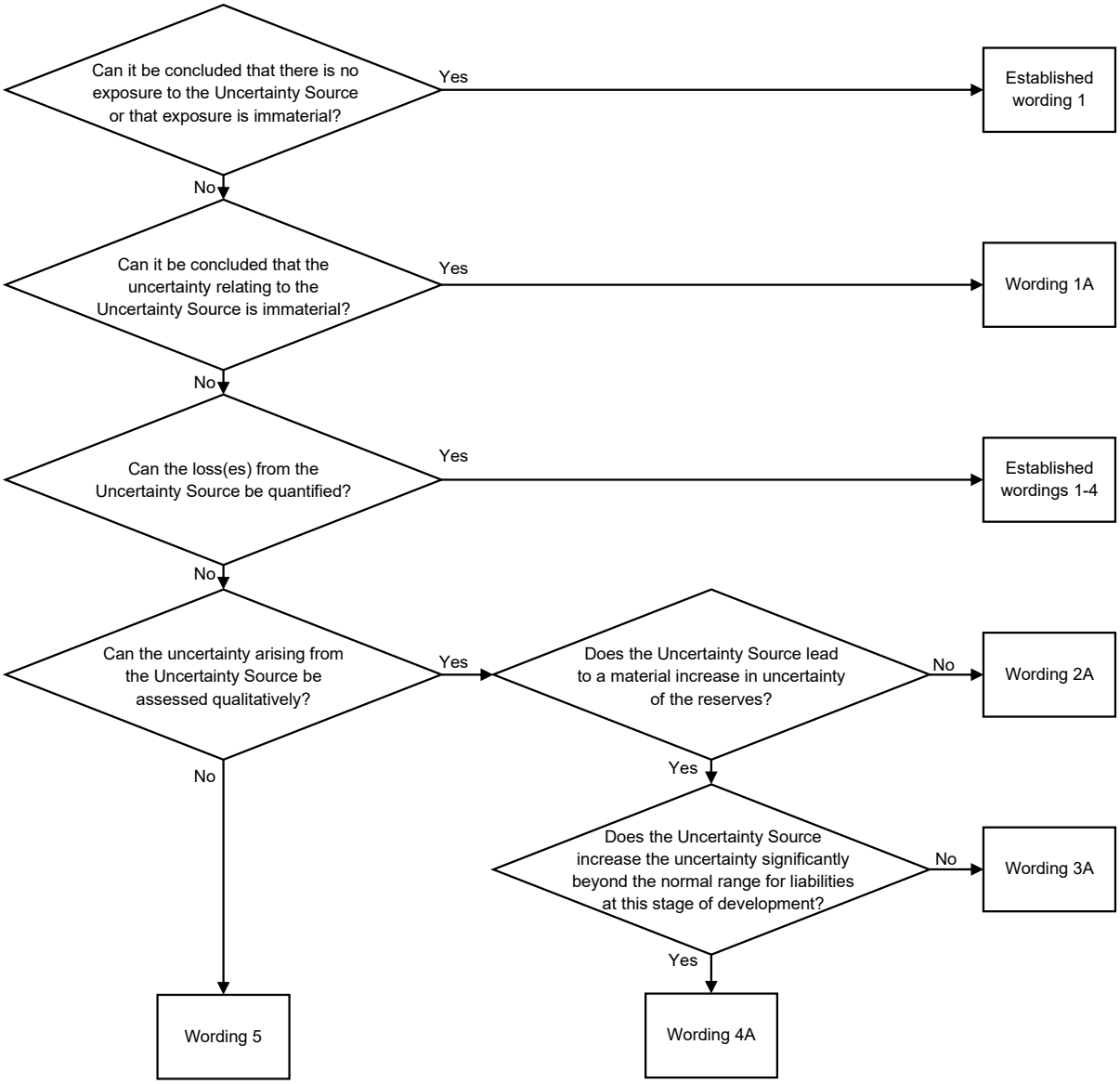
The working party believes that the many layers of uncertainty and lack of reliable data are likely to mean that it is premature to apply quantitative tools and techniques to reserve estimation. The focus of this paper has therefore been on presenting some qualitative approaches that the working party believes will provide reserving actuaries with a framework and foundation with which to perform an analysis. In future papers, it is hoped that it will be possible to set out some quantitative techniques and industry-wide data sources that can help inform reserving work.

With systemwide and potentially disruptive effects from climate change, the working party believes that reserving actuaries and the firms they serve will need to look with fresh, curious and (even) inventive eyes to provide the necessary insights and assurance to navigate the journey into a changed world. It is the working party's hope that this report will have provided some modest help in responding to these new challenges and opportunities.

Appendix 1 - Flowchart - Identification of large loss wordings

Figure 28 below indicates how large loss wordings might be selected, considering both the established wordings and the wordings proposed in this paper.

Figure 28 Large loss wordings decision tree



Appendix 2 - Useful reading list on climate change

1. Aon (2023). *Global Catastrophe Recap*. [online] Available at: https://www.aon.com/reinsurance/getmedia/760ea02e-ce76-4348-800a-cb8d99ca2a8f/20230720-1h-2023-global-cat-recap.pdf [Accessed 28 Aug. 2023].

2. Australian Prudential Regulation Authority (2019). *Climate change: Awareness to action*. [online] Available at: https://www.apra.gov.au/sites/default/files/climate_change_awareness_to_action_march_2019.pdf.

3. Cho, R. (2019). *How Climate Change Impacts the Economy*. [online] State of the Planet. Available at: https://news.climate.columbia.edu/2019/06/20/climate-change-economy-impacts/.

4. Committee on Climate Change (2016). *Committee on Climate Change - UK Climate Change Risk Assessment 2017 Synthesis Report - July 2016*. [online] Available at: https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Synthesis-Report-Committee-on-Climate-Change.pdf.

5. CRO Forum (2019). *The heat is on Insurability and Resilience in a Changing Climate Emerging Risk Initiative -Position Paper*. [online] Available at: https://www.thecroforum.org/wp-content/uploads/2019/01/CROF-ERI-2019-The-heat-is-on-Position-paper-1.pdf.

6. Department for Business, Energy & Industrial Strategy (2014). *Climate change explained*. [online] GOV.UK. Available at: https://www.gov.uk/guidance/climate-change-explained.

7. Environment, U.N. (2023). *Climate Change 2023: Synthesis Report*. [online] UNEP - UN Environment Programme. Available at: https://www.unep.org/resources/report/climate-change-2023-synthesis-report#:~:text=The%20report%20reiterates%20that%20humans.

8. Ferrazzi, M., Kalantzis, F., Zwart, S. and Bending, T. (2021). *How to calculate climate change risk for a developing country*. [online] European Investment Bank. Available at: https://www.eib.org/en/stories/climate-change-risks-developing-countries.

9. Gambhir, A., George, M., McJeon, H., Arnell, N.W., Bernie, D., Mittal, S., Köberle, A.C., Lowe, J., Rogelj, J. and Monteith, S. (2022). Near-term transition and longer-term physical climate risks of greenhouse gas emissions pathways. *Nature Climate Change*, [online] 12(1), pp.88-96. doi: https://doi.org/10.1038/s41558-021-01236-x.

10. Hillson, D. (2016). *The risk management handbook: a practical guide to managing the multiple dimensions of risk*. London; Philadelphia: Kogan Page.

11. HM Government (2022). *UK Climate Change Risk Assessment 2022*. [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf.

12. HM Government (2017). HM Government UK Climate Change Risk Assessment 2017 [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584281/uk-climate-change-risk-assess-2017.pdf.

13. International Monetary Fund (2020). *Global Financial Stability Report: Markets in the Time of COVID-19*. [online] IMF. Available at: https://www.imf.org/en/Publications/GFSR/Issues/2020/04/14/global-financial-stability-report-april-2020#Chapter5.

14. IPCC (2014). *AR5 Climate Change 2014: Mitigation of Climate Change — IPCC*. [online] Ipcc.ch. Available at: https://www.ipcc.ch/report/ar5/wg3/.

15. IPCC (2021a). *AR6 Climate Change 2021: the Physical Science Basis — IPCC*. [online] Ipcc.ch. Available at: https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/.

16. IPCC (2021b). *AR6 Climate Change 2022: Impacts, Adaptation and Vulnerability — IPCC*. [online] Available at: https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii.

17. Massey, M. (2022). *Climate Change Enterprise Risk Management*. Kogan Page.

18. Massey, M. and Irmcert, B. (n.d.). *Institute of Risk Management Climate Change Risk Management Guidance IRM Climate Change Special Interest Group Report*. [online] Available at: https://www.theirmindia.org/uploads/thought-leadership/publications/climate-change-risk-management-guidance-report.pdf.

19. McKinsey Global Institute (2020). *Climate risk and response Physical hazards and socioeconomic impacts*. [online] Available at: https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/climate%20risk%20and%20response%20physical%20hazards%20and%20socioeconomic%20impacts/mgi-climate-risk-and-response-full-report-vf.pdf.

20. National Geographic (2022). *The Influence of Climate Change on Extreme Environmental Events | National Geographic Society*. [online] education.nationalgeographic.org. Available at: https://education.nationalgeographic.org/resource/influence-climate-change-extreme-environmental-events/.

21. NOAA (2021). *Climate change impacts*. [online] National Oceanic and Atmospheric Administration. Available at: https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts.

22. Quiggin, D.D., Meyer, D.K.D., Hubble-Rose, D.L. and Froggatt, A. (2021). *Climate change risk assessment 2021*. [online] Chatham House - International Affairs Think Tank. Available at: https://www.chathamhouse.org/2021/09/climate-change-risk-assessment-2021.

23. Swiss Re (2020). *A truly global risk*. [online] Available at: https://corporatesolutions.swissre.com/dam/jcr:071c5173-84d0-43d2-8038-0e287e6f3306/climate-change-report.pdf [Accessed 28 Aug. 2023].

24. Swiss Re (2021). *In 5 charts: natural catastrophes in a changing climate | Swiss Re*. [online] www.swissre.com. Available at: https://www.swissre.com/risk-knowledge/mitigating-climate-risk/sigma-in-5-charts.html.

25. United Nations (2021). *Secretary-General Calls Latest IPCC Climate Report 'Code Red for Humanity', Stressing 'Irrefutable' Evidence of Human Influence | UN Press*. [online] press.un.org. Available at: https://press.un.org/en/2021/sgsm20847.doc.htm.

26. USGCRP (U.S. Global Change Research Program) (2018). Fourth National Climate Assessment. *Globalchange.gov*, [online] II, pp.1-470. Available at: https://nca2018.globalchange.gov/chapter/2/.

27. World Meteorological Organization (2023). *State of the Global Climate 2022*. [online] Available at: https://library.wmo.int/doc_num.php?explnum_id=11593.

28. ShareAction (2021). HSBC Resolution Wording. | ShareAction [online] shareaction.org. Available at: https://shareaction.org/reports/hsbc-resolution-wording

29. U.S. Securities and Exchange Commission (2019). Securities and Exchange Commission v. Volkswagen Aktiengesellschaft, et al., No. 19-cv-01391 (N.D. Cal.) (filed March 14, 2019) | SEC [online] www.sec.gov. Available at: https://www.sec.gov/litigation/litreleases/lr-24422

Appendix 3 - Additional questions actuaries can ask to internal teams to get an overall understanding of claim change risks and uncertainties

Below is a list of additional questions actuaries may want to ask to better understand climate related exposures.

Ask **yourself/your team**:

- What existing settled claims notifications or current legal cases to climate change are we already aware of?
- How are we able to "tag" current claims that are climate change related - attribution of climate change to the claim.
- What data should I be collecting to identify the exposure? (Number of policies, jurisdiction, industry, line of business, legal cases/legal costs)
- What tools and techniques should I develop to better understand future exposure? Examples include stress and scenario testing and horizon scanning.
- What portion of the policies are long-term contracts that could be impacted by climate change?
- What type of claims are going to be most impacted by physical, transition and liability risks across each line of business?

Ask the **wider Actuarial team** / company:

- What is the actuarial function report's opinion on the topic?
- If set-up, contribute / discuss with internal structures such as working groups or committees that the company has already set up to tackle the wider climate change requirements.

Ask the **Risk team**:

- Are there any climate related scenarios considered in the latest Stress & Scenario Testing exercise?
- Are there any climate related scenarios considered in the latest Own Risk and Solvency Assessment (ORSA) report?
- If the risk team own internal model validation, ask if anything specific is done there?

Ask the **Underwriters and Pricing teams**:

- What deep-dives into historic business are under way across your portfolios? Do any of these have links with trends from climate change? What are the key outputs and milestones related to these?
- Has there been any influence from the Board / wider company on our underwriting appetite and anything we are moving towards e.g. excluding certain covers? Is this in relation to any climate risks?
- Are any external data sources being used? If so, have any climate impact assessments been performed to ensure the data appropriately allows for climate change related risks?
- How do you currently assess a portfolio's potential exposure to climate change related claims? Examples include:
    - Physical risks: any changes to the data required or are there any additional requirements?

    - Liability risks: have any considerations been given to collect data on industry, likelihood of litigation, etc. In the affirmative, what data has been collected and what risks is it intended to measure?
- How is the re/insurer that the actuary is working for adapting their risk appetite to allow for climate related risks?
- How is the re/insurer that the actuary is working for allowing for climate change in the future pricing strategy?

Ask the **Planning team**:

- How are trends in experience allowed for in planning forecasts and how are these determined?
    - Are there any explicit climate change trends/loadings currently considered or planned?
    - If not, what are the risks that the re/insurer is not proactive? Have these been assessed? For example, is the re/insurer waiting to see clear trends and when these materialize it may be too late!

Ask the **Claims and Legal teams**:

- Are there any types of claims where a change in claim frequency over the last few years has been observed?
- Are there any trends in claims severity that are not explained by economic or social inflation?
- Does the re/insurer have contacts with any climate-related litigation experts? Are developments in the climate litigation space being monitored? How do you think this might impact your portfolio?

Ask the **Capital team**:

- Have any of the internal model parameters been directly calibrated with climate related risks?
- Are adjustments to CAT models from vendors allowed for, such as do you believe that models adequately capture climate related risks sufficiently or are separate uplifts applied?

Ask the **Exposure Management team**:

- What actions are exposure management taking? Have they sourced or acquired climate change models?
- What trends are they seeing in exposure/experience?
- (How) are exposures to climate related claims monitored? Are there identifiers/flags for climate exposure set-up?

Appendix 4 - Helpful Sources of Information - Property Impacts related to climate change

- Cresta has updated its industry loss estimates and provided a quarterly update, in which the organisation says that the insurance and reinsurance market loss from the July 2021 European flooding is now estimated to be $13.8 billion. (https://www.artemis.bm/news/cresta-raises-july-2021-european-flood-industry-loss-estimate-to-13-8bn/#:~:text=Cresta%20has%20updated%20its%20industry,estimated%20to%20be%20%2413.8%20billion)
- Hurricane Laura caused substantial wind and storm surge damage and triggered widespread flooding that extended far inland. Overall losses came to US$ 13bn, with insured losses of US$ 10bn.

  Hurricane Ida, where damage stretched from New Orleans to New York, resulted in $30-$32 billion in insured losses.

  (https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2021/2020-natural-disasters-balance.html)
- Insured losses from the most destructive wildfire month in California's history climbed $614 million in the first three months of the year, pushing total claims over $12 billion as of April 2019

  (https://www.insurance.ca.gov/0400-news/0100-press-releases/2019/release041-19.cfm)
- The Woolsey Fire cost $4.2 billion in estimated losses, or $4.56 million with inflation

  (https://www.bankrate.com/insurance/homeowners-insurance/wildfire-statistics/#the-worst-wildfires-in-us-history)
- LV=General Insurance said it was dealing with claims worth £1.2 million after the extreme heat that hit the UK between 17 and 20 July 2022.

  (https://www.theguardian.com/business/2022/aug/10/uk-fire-subsidence-claims-extreme-heat-insurer-lv-gi)
- Escape of water claims increased to £368 million in 2022 Q4, the highest for any quarter recorded by the ABI. A significant reason for such an increase in claims was the 56% rise in total domestic and commercial escape of water claims, likely due to the freezing weather across winter causing pipes to burst.

  (https://www.zurich.co.uk/news-and-insight/escape-of-water-perils-of-plastic)
- In the UK, current annual damages from coastal flooding are estimated at over £500 million per year and costs are likely to increase under projections of future sea-level rise.

  (https://www.bgs.ac.uk/news/sea-level-rise-and-coastal-erosion-whats-the-real-impact/)

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