

Modelling it all: Secondary Perils in a warming world

Amidst an evolving climate risk landscape, how can the insurance industry refine the way it defines, measures, and underwrites secondary perils?

The University of Cambridge Institute for Sustainability Leadership

The University of Cambridge Institute for Sustainability Leadership (CISL) partners with business and governments to develop leadership and solutions for a sustainable economy. We aim to achieve net zero, protect and restore nature, and build inclusive and resilient societies. For over three decades, we have built the leadership capacity and capabilities of individuals and organisations and created industry-leading collaborations to catalyse change and accelerate the path to a sustainable economy. Our interdisciplinary research engagement builds the evidence base for practical action.

Authors and acknowledgements

The lead authors of this report were Deloitte's Katherine Lampen, Greg Lowe, Will Rees, Rebecca Lewis, Joey Galloway, Rosie Woodall and Amhar Nayab. The study design and editorial process were led by Bronwyn Claire and Meng-Lian (Lily) Li from CISL and Lucy Stanbrough, the ClimateWise Managing Committee Chair from Willis Towers Watson. The authors would like to thank colleagues from participating organisations, including Aon, AXA XL, Beazley, Canopus, Conduit Re, DAC Beachcroft, Hiscox, Howden Group, JBA Risk Management Ltd., Liberty Specialty Markets, Marsh, Santam and Willis Towers Watson for their contributions to the research and report.

Citing this report

University of Cambridge Institute for Sustainability Leadership (CISL). (2022). Modelling it all: Secondary Perils in a warming world. Cambridge, UK: University of Cambridge Institute for Sustainability Leadership.

Copyright

Copyright © 2022 University of Cambridge Institute for Sustainability Leadership (CISL). Some rights reserved. The material featured in this publication is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike License.

Disclaimer

The opinions expressed here are those of the authors and do not represent an official position of CISL or any of its individual business partners or clients.

Table of Contents

Executive Summary	3
1. Introduction: setting the scene	4
Research methodology	6
2. The current landscape: the definition, perception, and underwriting of secondary perils	7
3. The challenges in addressing secondary perils	16
4. The solutions and associated opportunities	21
Conclusion: Findings and Recommendations	28
Glossary	31
Bibliography	32

Executive Summary

Secondary perils are increasing in frequency, severity, and impact, causing significant economic loss and negatively impacting communities and policyholders. However, despite industry-wide concern, there is no consistent understanding of the definition of secondary perils. They are more poorly modelled than historical 'primary' perils.

This report seeks to understand how secondary perils, in the context of a changing climate, are currently perceived, measured and underwritten by the insurance industry. To enhance the management and insurability of secondary perils, we outline five key issues the sector faces regarding secondary perils and identify three challenges that inhibit it from taking action to resolve these issues and build resilience. The report offers six high-level, practical recommendations to empower the insurance industry across the value chain, aiming to increase financial, social and climate resilience and raise awareness of the urgent need for change.

Our research shows three critical criteria often influence whether perils are considered 'primary' or 'secondary'. In this report, we take all three into account and refer to 'secondary perils' as:

- i. Perils with a lower frequency/severity and impact than others;
- ii. Perils that take place as a result of another event; *and/or*
- iii. Perils that are less well and less widely modelled

We identify a need to break the cycle of circumstances that, to date, has discouraged the industry from taking the requisite steps to understand and address changing secondary peril climate risk. This is hampered by **five key issues on the topic of secondary perils**:

1. Inconsistency in the definition and use of the term secondary perils
2. The lack of quality and consistency in secondary peril data
3. Differential treatment of secondary perils across the insurance value chain
4. Changes in physical landscapes due to climate change and non-climate shifts are contributing to the changing nature of secondary perils
5. This changing nature of secondary peril risk threatens societal, financial and physical resilience worldwide

These issues are exacerbated by **three fundamental challenges which are inhibiting action by the industry**:

1. Modelling limitations and prioritisation of resources towards more significant 'primary' perils
2. Lack of data availability and quality inhibiting risk understanding and management
3. Commercial, competitive and market considerations inhibiting data sharing and accurate pricing

The report concludes with **six key recommendations for industry participants**:

1. Standardise the definition of secondary perils.
2. Bold leadership focused on education and communication
3. Rethink value-chain engagement and collaboration on secondary perils.
4. Diversify modelling approaches and challenge assumptions.
5. Accelerate the deployment of capital.
6. Encourage dynamic underwriting practices to enhance secondary peril exposure management capabilities, and incentivise resilience measures among policyholders.

Together, these responses could help the industry break the cycle, allow it to deliver on insurance's role in the transition, and help drive societal responses to key climate mitigation and adaptation challenges.

1. Introduction: setting the scene

In our changing climate, economic losses incurred from the increasing physical, financial, and human impact of risks are proliferating. This is particularly the case with economic losses from ‘secondary perils’, a term used to describe events including but not limited to floods, wildfire, and severe convective storms (SCS). The insurance industry, at the forefront of understanding and managing climate risk, is highly aware of the urgent need to address the challenges posed by secondary perils. However, the industry is yet to develop a consistent approach to this, and is not currently providing the required resilience for policyholders and society against these events.

Consistency in secondary peril terminology, understanding and treatment are essential both for the insurance industry’s understanding of evolving climate-driven risks and for its policyholders and society more widely. The issues are industry-wide: the definition of secondary perils is unclear; their modelling limited, and the communication of this risk data even more so. Without consistent use of the term, it is challenging for the industry to collect relevant data that will support risk modelling and management of secondary perils. The insurance industry must urgently act to inform, manage, and finance our rapidly changing risk landscape more effectively.

Experiencing climate change through extreme weather events

Extreme weather events are one of the most tangible ways in which climate change can be felt by humankind. The Intergovernmental Panel on Climate Change (IPCC)’s 6th Assessment Report confirms that rising global temperatures are contributing to higher frequency and intensity of extreme weather events worldwide, including heavy precipitation/flooding, droughts, wildfires, storms and heatwaves (IPCC, 2022).

In addition to this, rising global temperatures also interact with underlying societal and economic vulnerabilities, such as political events and health crises, that can leave institutions and individuals struggling to respond when climate events take place. (Red Cross Red Crescent Anticipation Hub, 2021). Risk exposure is absolute, whereas vulnerability is a complex combination of economic, social, and physical risk factors. The COVID-19 pandemic demonstrates this with acute clarity (International Federation of the Red Cross, 2021).

Figure 3: Headlines reflect the ‘dual calamity’ of extreme weather events and the COVID-19 pandemic



“October 2020, record-breaking rainfall resulted in severe flooding across the central and southern states in India, resulting in significant fatalities, casualties and damage. Media reported at least 80,000 evacuated people to relief camps, with families lacking basic facilities including health services and access to safe drinking water. Large numbers of evacuees tested positive for COVID-19, further complicating recovery efforts and raising the need for Infection Prevention, and Control (IPC) measures in evacuation sites.”

(UN Office for the Coordination of Humanitarian Affairs, 2020)

Increasing climate risk and the Climate Emergency are demonstrated by global headlines, with record-breaking flooding just one of many types of events causing enormous physical and financial damage, ruining lives and livelihoods. However, as recent regulatory exercises and scenario analyses show, data gaps still exist and there is a need for the insurance industry to do ‘much more to understand and manage their exposure to climate risks, with actors needing to take action early to avoid the worst financial impacts (Prudential Regulatory Authority, 2022). The challenges of building financial resilience against climate events for people, organisations, and governments worldwide are highly complex and urgent. They will require a “whole economy” response (Carney, 2021), bringing together tools, information, innovation, and partnerships from across all industries.

The Role of Insurance

The ClimateWise membership brings together representation from leading global insurance organisations across the entire insurance value chain, who directly support the societal response to the risks and opportunities that climate change poses. The insurance industry has a critical role in helping facilitate a climate-resilient future through risk modelling, providing protection and financial resilience through underwriting, or providing the capital flows needed for green products, infrastructure, and technological innovation through its investments. The insurance industry interacts with climate risk and secondary perils in three key ways:

- i. **Risk analysis and insight:** The insurance industry is uniquely placed to inform climate risk analysis and understanding, given its history and core capabilities in measuring, managing, transferring, and financing risk. To enable the insurance industry to build a holistic understanding of climate and weather-related perils, addressing the consistency and coverage of data at a geographical and peril level is essential.
- ii. **Exposure:** There is mounting pressure from regulators pushing insurers to understand and disclose their exposure to evolving and complex climate risk. In 2021, it was estimated that natural catastrophes caused insured losses of USD 119 billion, of which weather catastrophes account for USD 111 billion (Swiss Re Institute, 2022), making 2021 the fourth highest year on record for natural catastrophes. With extreme weather on the rise – particularly secondary peril events – the protection gap is also broadening.
- iii. **Resilience and adaptation:** defined as the ability of individuals, institutions, and societies to “prevent, resist, absorb, adapt, respond and recover positively, efficiently and effectively when faced with risks” (UN Sustainable Development Group, 2020), resilience and adaptation efforts involve building financial and physical resilience to catastrophes. Insurance can be a vital tool in both these aspects of adapting to climate change (Global Commission on Adaptation, 2019) through the provision of risk understanding, management, and reduction, as well as transfer and financing.

Research methodology

This paper explores the need to refine the industry approach to defining, measuring, and underwriting secondary perils in the face of climate change. ClimateWise and Deloitte developed the report concept. A topic-focused Steering Committee, convened under the ClimateWise membership, is set to steer this project and help identify the challenges and opportunities presented to the insurance sector on the topics of secondary perils.

The report findings are informed by a three-month research phase, including literature reviews and industry practitioner interviews and surveys. Fourteen interviews were conducted with industry experts from across the insurance value chain between March and April 2022, covering the following topics:

- The current definition and perception of secondary perils.
- The changing nature of climate risk and exposures, key perils of concern, and the usefulness of the division between traditionally defined 'Primary' and 'Secondary' perils.
- Insurers and regulators' role in adapting to the physical impacts of climate change.
- Wider impact of secondary perils and their perception across the insurance value chain
- Potential areas of innovation to ensure insurance plays a role in building climate resilience for all

We invited interviewees from across the ClimateWise and Deloitte insurance communities, spanning a range of professions, roles, organisations, and regions across the insurance value chain. These include leaders in catastrophe modelling, underwriting, broking, risk strategy, insurance innovation and legal advice. The report is further supported by a quantitative survey in which we invited ClimateWise members and Deloitte's insurance clients to participate. 24 insurance practitioners completed the survey on their definition, perception and approach to secondary perils and resilience in insurance. Geography locations of survey respondents are 86% in Europe, 9% in North America and 5% in Africa. This is to note that this geographical weighting must be factored in when considering results and findings.

2. The current landscape: the definition, perception, and underwriting of secondary perils

Climate change is already impacting the landscape of physical risk. In line with these systemic changes in climate risk, there has also been a shift in narrative in recent years around so-called secondary perils. Those in industry engaging with climate risk and the topic of increasingly severe and frequent extreme weather events will be familiar with recent trends and industry reports around secondary perils:

- “Secondary Perils accounted for 73% of all natural catastrophe insured losses in 2021” (Swiss Re Institute, 2022)
- “More than 60% of 2020’s insured losses were caused by Secondary Perils, and 8 of the last 10 years have seen higher economic losses from Secondary Perils than primary perils” (Aon, 2020)
- “Hurricane Ida in the US may have been the costliest event in 2021, but more than half of losses came from so-called Secondary Perils such as floods, thunderstorms, tornadoes and even winter freezes, which can often be local, but increasingly costly events” (Allianz, 2022)

These reports align with the global experience of increasing weather events and losses, but there are many questions to be asked around the secondary perils narrative. The use of the term is not without its issues. The following key issues were identified through the three research phases – interviews, surveys and literature review. They have been grouped into two categories; (i) the perception and treatment of secondary perils and (ii) the physical landscape of secondary peril risk.

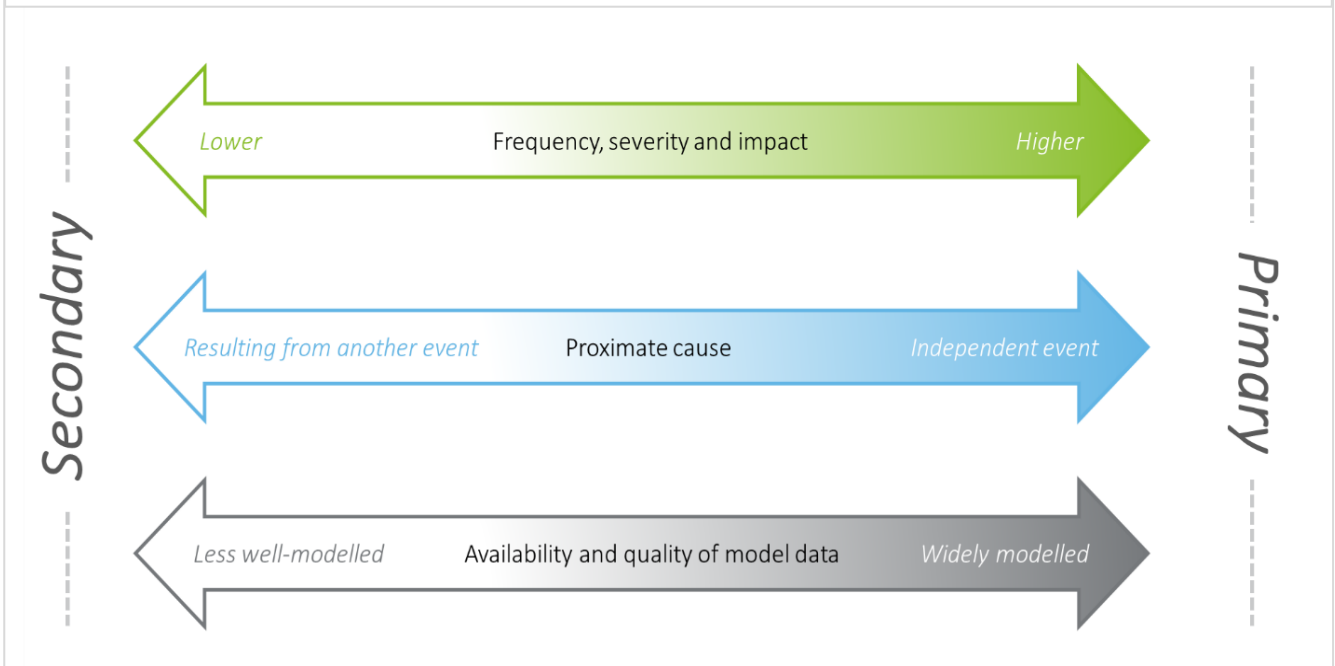
Figure 4: The issues identified in interviews, surveys and wider research around secondary perils and the current discourse

Theme	Issue
The perception and treatment of secondary perils	<ol style="list-style-type: none"> 1. Inconsistency in the definition and use of the term secondary perils 2. The lack of quality and consistency in secondary peril data 3. Differential treatment of secondary perils across the value chain
The physical landscape of secondary peril risk	<ol style="list-style-type: none"> 4. Changes in physical landscapes due to climate change and non-climate shifts are contributing to the changing nature of secondary perils 5. This changing nature of secondary peril risk threatens worldwide societal, financial and physical resilience

Issue #1: Inconsistency in the definition and use of the term secondary perils

What is a secondary peril? “Ask a dozen insurers, and you’ll likely get a dozen different answers”, hypothesised an industry-leading risk modelling firm in a thought piece published earlier in 2022 (AIR Worldwide, 2022). There is no official definition of secondary perils. Research demonstrates that the term is most often used to group perils that are generally seen as ‘smaller’, the result of another event, or, less commonly, perils that are not well-modelled by the industry. The term’s use can either indicate one, two or all three of these characteristics and varies between individuals and organisations. It is essential to note that different perils are, of course, ‘lesser’ (in frequency, severity, impact) in different geographies and to different insurers depending on their individual exposures and portfolios. Therefore, it would not be possible or helpful to categorise all insurance perils as either ‘primary’ or ‘secondary’ across geographies or insurers.

Figure 5: What characteristics of a peril make it ‘primary’ or ‘secondary’?



Different organisations, even different parts of the same organisation, employ the term for different groups of risks. Very few organisations have published an official view or definition of the term secondary perils, including within the insurance, broker, and regulatory communities. However, the following uses of the term are evidenced across online publications:

Organisation	Organisation type	Description of secondary perils	Description of frequency	Examples of perils cited
Swiss Re (Swiss Re, 2019)	Re/Insurer	Low-to-medium severity events, both standalone and as secondary effects of primary perils	High frequency	Hailstorms, flash floods, tornadoes, landslides, drought and wildfires, tropical cyclone-induced flooding, liquefaction and landslides
Allianz (Allianz Re, 2021)	Re/Insurer	Local but increasingly costly, occurring at a higher frequency than primary perils “Winter Storm Uri and other secondary perils events caused more than half of total losses [2021]”	Increasing in frequency	Floods, heavy rain, thunderstorms, tornadoes, winter freezes, straight-line winds and hail
Guy Carpenter (Guy Carpenter, 2021)	Broker	Small-to medium-sized catastrophe events occurring at a higher frequency than primary perils	High frequency	“The designation of these perils is regionally specific” Tsunamis in Japan, floods in India, bushfires in Australia
Zurich (Zurich, 2022)	Insurer	Natural perils not including the primary catastrophic natural hazards of hurricanes and earthquakes	“Growing threat”	Hail, tornadoes, floods, wildfires, strong convective storms and extremes of heat and cold
The Bank of England’s Prudential Regulation Authority (PRA)	Regulator	Risks not captured within standard models and/or secondary impacts of primary perils	“In recent years, such secondary perils have contributed significantly to the overall annual aggregate insured losses”	Inland flooding following a hurricane, tropically induced flooding following a US hurricane, tsunami following an earthquake

Figure 6: How do different insurance organisations use the term ‘secondary perils’ in their publications on the topic?

In our research, both interview and survey responses reflected this inconsistency and unclear use and understanding of the term secondary perils:

“In my experience the term is used to mean two different things: (i) The traditional use of the term is to describe secondary effects of a primary peril, such as tropical cyclone induced flooding, fire following earthquake. (ii) It is also employed to describe independent loss events, such as wildfire and inland flood, which have relatively high frequency but low to medium (‘secondary’) severity compared to primary perils.”

Head of Aggregation, London Market Insurer

“Secondary perils are not understood well enough by the market in order to start quantifying the impact of climate change.”

Chief Underwriting Officer, Global Insurer

“From a legal perspective, there is no industry-wide definition of secondary perils, it is more of a category or ‘bucket’ and has not yet been quantified or analysed. We see the term used in relation to both the secondary impacts of primary perils, and any peril that is less modelled or not yet fully understood.”

Climate Change Lead, International Law Firm

“Secondary perils are very inconsistently defined across the industry, and we do not use the term. I would suggest the key Primary Perils are wind and earthquake, so by process of elimination, secondary perils could be defined as everything else – including both ‘smaller’ independent events, and secondary effects of those primary perils.”

Portfolio Manager, Global (Re)Insurer

“The historic distinction between ‘Primary’ and ‘Secondary’ Perils is no longer useful. People hear the word “secondary” and think that means less important or lower-impact, and that simply is not the case.”

Head of Catastrophe Risk Insight, Global Reinsurance Broker

When asked about their understanding of the use of term secondary perils, survey responses demonstrate similar themes around the inconsistently defined term, with 28% of respondents employing the ‘independent event’ definition of secondary perils, 19% using the ‘secondary impact of primary event’ definition, and 43% using both.

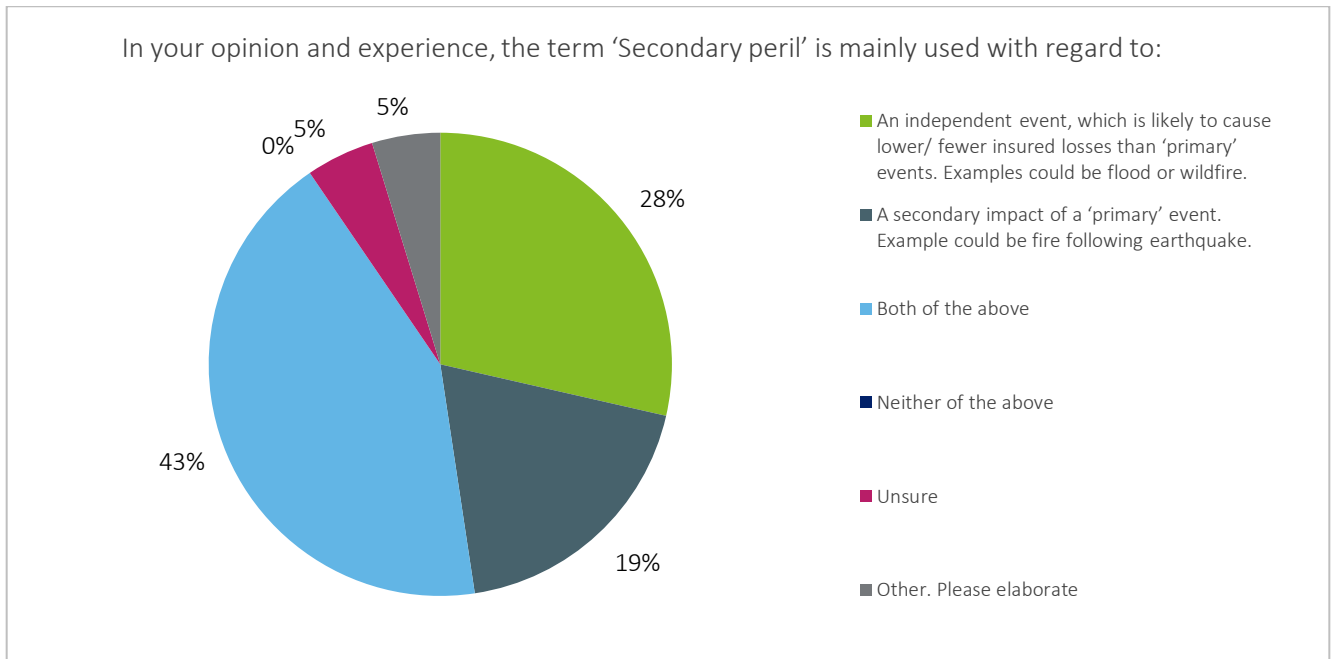


Figure 7: Survey respondents share their understanding of the use of the term ‘secondary perils’

When asked whether they agree that “there is a **reasonably consistent** understanding of the term ‘secondary perils’ across the insurance industry”, only 23% of survey respondents agreed that there is. In comparison, 50% of respondents either disagreed or strongly disagreed.

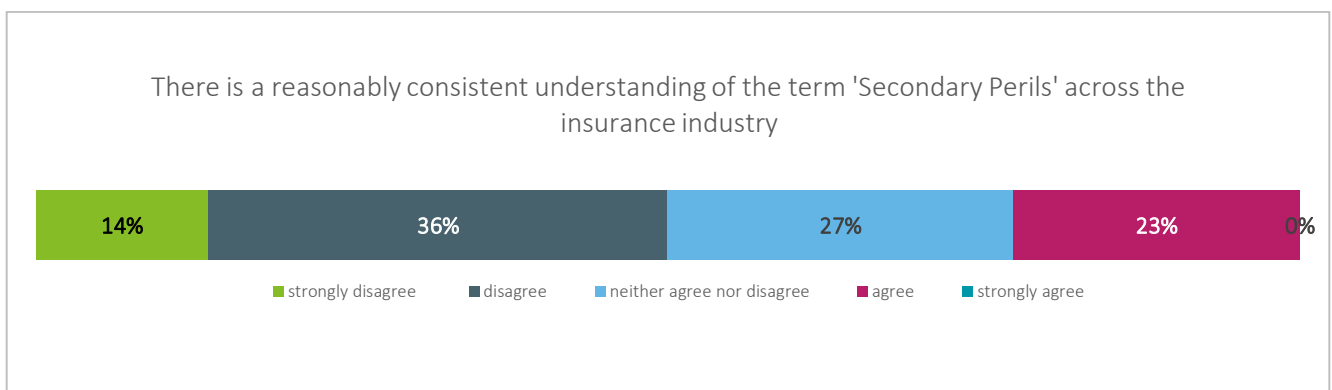


Figure 8: Survey respondents share their views on whether there is a consistent industry understanding of the term ‘secondary perils’

This report has sought to mobilise an industry-wide dialogue on the topic of secondary perils. This has been done by exploring the definition and use of the term secondary perils, and the impact and relevance of the topic for the industry as it deals with climate change. In the face of increasingly extreme weather events, a shift in global climate change dialogue, and pressure from customers, regulators and governments to respond, this essential topic must be managed and understood better by the insurance industry.



Figure 9: Swiss Re Institute publications reflect the severity of secondary peril events

Issue #2: The lack of quality and consistency in secondary peril risk data

Without a shared definition of the term, it is challenging for the industry to collect relevant data to support risk modelling and management of secondary perils. Despite the narrative and recognition of this issue across the insurance supply chain, there is limited industry resource, capacity and expertise being allocated and mobilised to enhance the accuracy and consistency of secondary peril data.

Many observe that insurance market conditions are becoming 'harder', driven by an unprecedented combination of factors including long-term impacts of the COVID-19 pandemic, climate change, war in Ukraine, energy crises, and record-breaking inflation (Financial Times, 2022). Understanding and communicating risk while maintaining forward-thinking commercial strategies are more important than ever for insurers and insureds alike. As climate change, along with other systemic risk, continues to develop, the ambiguity and lack of understanding around secondary perils could lead to risks including:

- I. A dependency on historical claims data
- II. Underestimate risk exposures
- III. Lack of clarity for consumers
- IV. Unclear regulatory treatment
- V. Difficulty in mitigating risks and preparing for extreme weather events

Issue #3: Differential treatment of secondary perils across the value chain

Secondary perils are understood, modelled, and treated differently by different organisations and actors across the insurance value chain. While this could be beneficial – offering a multifaceted view of risk – it can also be a source of tension and inconsistency. When asked their opinion on which part(s) of the insurance value chain currently has the strongest understanding of secondary perils, survey respondents consistently listed (i) actuaries, analysts, and catastrophe modellers; (ii) exposure management teams; and (iii) Climate and ESG teams, while consistently ranking regulators, investment, reserving and wordings teams as understanding secondary perils less well.

“We are behind as an industry. Understanding how climate risk exposures are shifting – particularly around Secondary Perils – is an enormous task. We need a cross-company, cross-function response to build new models, develop consistency in understanding, inform impacts on pricing, and develop robust strategies and business models.”

Chief Underwriting Officer, Global Insurer

Issue #4: The changing nature of secondary peril risks threatens resilience worldwide

The increasing severity and frequency of secondary peril events impact resilience in three key ways. First, physical climate resilience such as the resilience of infrastructure, second, the financial resilience of industries including the insurance industry. Third, social resilience such as the resilience of climate-vulnerable populations and communities.

The financial resilience provided by the insurance industry is centred around risk expertise, analysis, and insight. In the survey, only 19% of respondents agreed that “Insurers are evolving and innovating at an adequate rate to build resilience against and adapt to climate change and the related shift in risk exposures”, while 56% of respondents disagreed with such a statement. When considering secondary peril risk, which is partly exacerbated by climate change, new products and thinking could certainly help develop thinking around climate resilience.

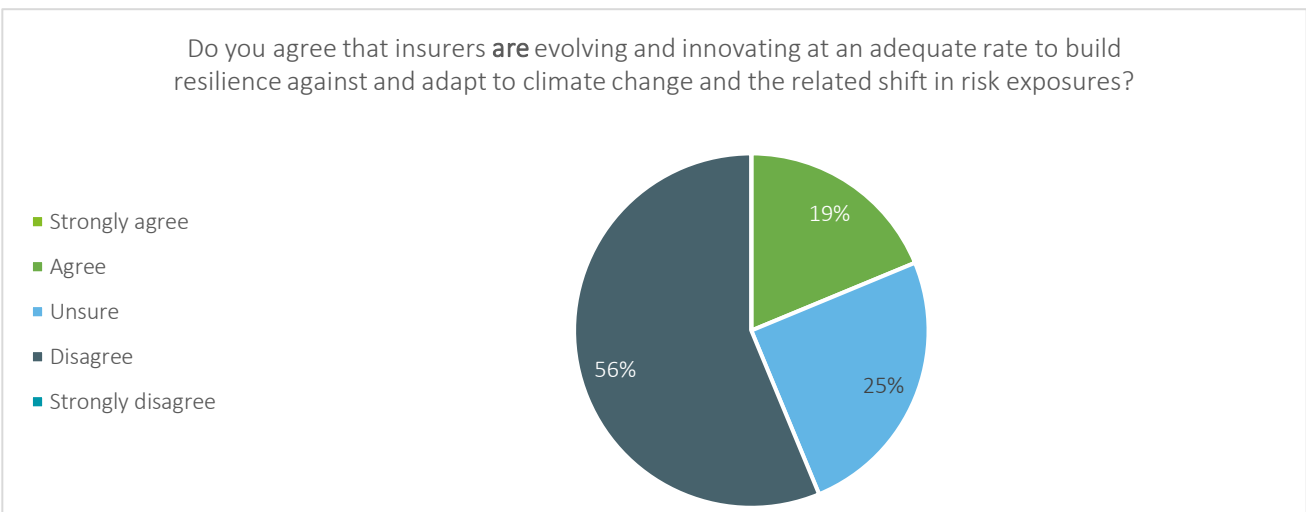


Figure 10: Survey respondents share their view on the rate at which insurers are evolving and innovating to climate change

“The industry plays a significant role in preparing for future changes, and not enough has been done to dig into the concept of industry resilience. It is important to look at how we preserve livelihoods and capital across the industry and not just focus on risk exposure to individual balance sheets.”

Chief Underwriting Officer, Global Insurer

The primary role of insurance in society is to provide companies, individuals, and governments with financial protection against the risks of everyday life (ABI, 2018) (Cambridge Institute for Sustainability Leadership, 2021). This resilience contributes to economic and social development and helps facilitate innovation. Considering a phenomenon as all-encompassing as climate change and its role in changing the frequency and severity of certain weather events, it is urgent for the insurance industry to improve its understanding of secondary peril risk as part of its overall efforts to enhance the modelling and management of climate risk.

While building climate resilience is an essential task for people and organisations everywhere – not least insurance organisations themselves – it is hard to ignore the protection gap in developed versus developing economies when considering secondary peril exposure. The protection gap is the difference between total economic damage caused by catastrophic events and the insured losses incurred (Lloyd's of London, 2018). In 2021, total economic damage caused by natural catastrophes stood at USD 270 billion, while the insured losses were USD 119 billion. This leaves governments, companies and individuals as their own ‘default insurers’ after extreme events and natural catastrophes, resulting in an estimated natural catastrophe protection gap of USD 151 billion in 2021, with 56% of natural catastrophes uninsured (Swiss Re Institute, 2022). As secondary peril losses become more frequent and more severe, the duration and growth of this underinsurance will inevitably present further problems, both within the insurance industry and more broadly, across society, governments, regulators and policyholders.

Issue #5: The changing nature of secondary perils: non-climate systemic drivers

While climate change is undeniably a driver of some of the shifts in secondary perils, other factors are also at play. Inflation, exposure growth, geopolitics, and the long-term impacts of the COVID-19 pandemic are also highly relevant risks faced by people, communities, and businesses, increasing their vulnerability to secondary perils. Covid-19 was an “unprecedented test” of the world’s ability to manage compound risks, with record-breaking flooding in South Africa in 2020 just one example of a ‘secondary’ peril event that intersected with the pandemic to cause even more damage than it otherwise would have (Phillips et al., 2020). Evidence shows that population growth and urbanisation also significantly affect societies and economies, with more people settled in high-risk areas resulting in a higher probability of casualties and economic losses after a climatic or geodynamic event (UN Department of Social and Economic Affairs, 2019). Our research demonstrated an awareness of these critical systemic factors across the insurance industry, with 82% of respondents saying they either ‘agreed’ or ‘strongly agreed’ that the “increased frequency and/or severity of secondary peril losses can be attributed at least partly to urban growth and development” (Figure 11).

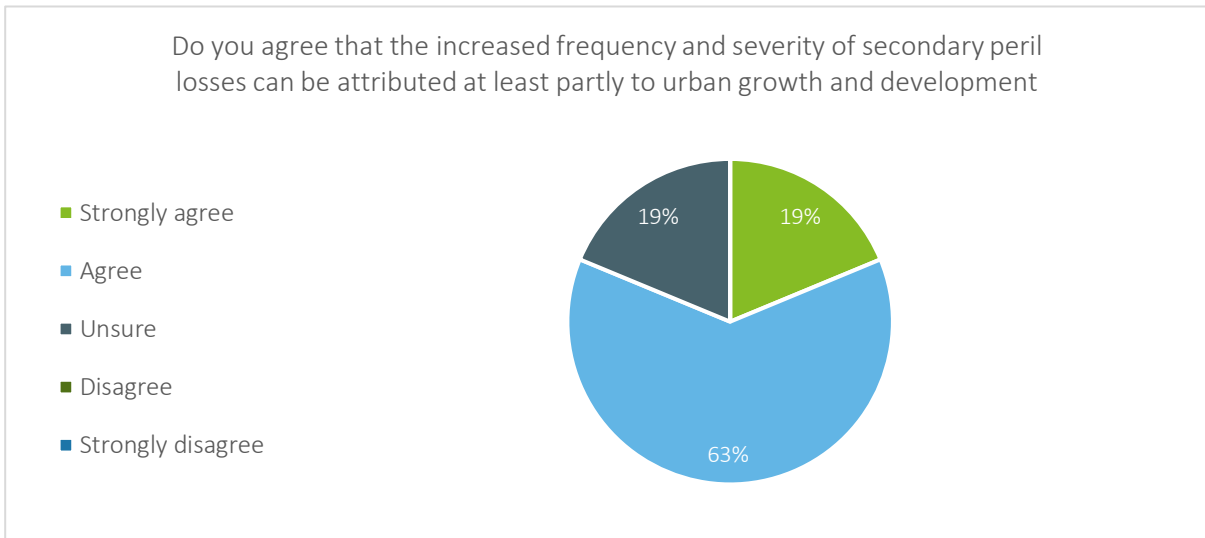


Figure 11: Survey respondents share their view on the causal relationship between urban growth & development and the frequency and severity of secondary peril losses

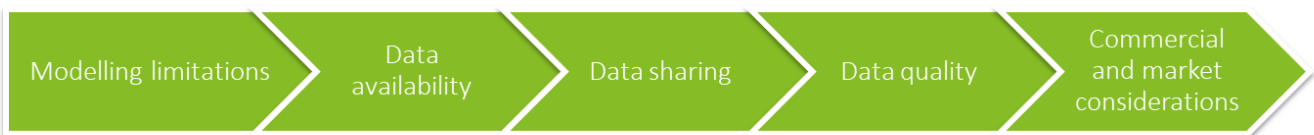
3. The challenges in addressing secondary perils

"Uncertainty around these perils is inhibiting innovation and resilience-building efforts"

Head of Aggregation, London Market Insurer

The challenges that arise from this research range from the technical to the commercial and economic. Broader industry challenges such as short-termism, short-term memory bias, reactive thinking and hesitancy around innovation also beset responses to the issues identified. The challenges explored in this report are:

Modelling limitations



Inconsistent understanding and labelling of secondary perils, as outlined in issue one above, leads to systemic underestimation of their frequency, severity, and exposure. Since the 1990s, climate and natural catastrophe models have driven insurance underwriting for physical climate risk. Their development is key to enhancing understanding of physical risk (Cambridge Institute for Sustainability Leadership, 2021). However, firms have dedicated resourcing developing models for primary perils at the expense of secondary perils, where modelling capabilities are limited due to a combination of market demand and data constraints (Swiss Re, 2021, p. 22). Overall, secondary perils events tend to be more localised and frequent but relatively small and harder to identify than primary perils (Swiss Re, 2021). This has contributed to widespread acknowledgement of the need to enhance modelling capability to inform better risk assessments and pricing, with 88% of our survey respondents agreeing the industry needed to improve modelling capabilities (see figure 12 from the survey).

Many discussions around Secondary Perils focus on the apparent underestimation of their impact/frequency. Given this perception, the insurance industry needs to re-evaluate the way it measures, models and prices Secondary Perils

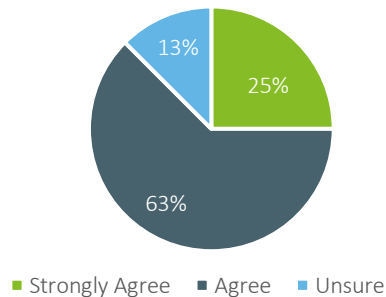


Figure 12: Survey respondents share their views on the industry's need to re-evaluate its approach to measuring, modelling, and pricing secondary perils

Limitations in modelling capabilities for secondary perils are partly due to historical and prioritised focus on primary perils such as tropical cyclones and earthquakes in the industry's natural catastrophe models or focus on specific secondary perils in specific geographies and regions. This was due to the volatility, size of peak losses and impact of regulatory focus on solvency requirements at the expense of longer-term attritional losses (Swiss Re, 2021). Furthermore, losses from secondary perils have a lesser tendency to reach reinsurance trigger levels. As a result, reinsurers have historically de-prioritised resource allocation to these in favour of primary perils.

Modelling capabilities also vary across secondary perils, with some, such as flood (see case study) and severe convective storms (SCS), having probabilistic models that have improved in accuracy and reliability in recent years (Swiss Re, 2021). Others, such as wildfire and subsidence, are more complex and harder to model as they are more dependent on human and socio-economic factors, such as forestry management, zoning codes, and resources available for physical risk mitigation and adaptation. There is geographic variability too, largely reflecting levels of economic development and insurance coverage. North America and Europe, which constitute the majority of global insurance premiums, have more advanced and reliable models that cover secondary perils in greater depth than those in less economically developed regions.

Compounding effects and interlinkages between different perils are still relatively poorly understood, such as the impact of drought on wildfire and subsidence. As with primary perils, non-linear impacts of certain secondary perils complicate this further. For example, above 100km per hour, a 10% increase in wind speed usually causes 50-60% more damage (Society of Actuaries, 2020). A small percentage increase in rainfall is enough to overwhelm urban drainage systems and cause flash flooding. In other cases, there is a lack of historical data to develop reliable models. For instance, Californian and Australian wildfire events lack 40-50 years of the historical dataset to develop reliable models that balance frequent and distribution of events with a long-term average.

Case study: Modelling flood risk

Modelling a secondary peril such as flood risk on a sufficiently granular level for insurers is extremely challenging. This excerpt from a study conducted by the Society of Actuaries outlines some of the data and technical detail required to model and price flood risk:

“Modelling flood risk is an extremely complex process. The phenomenon is highly stochastic and driven by numerous interconnected financial and non-financial factors. On the one hand, such environmental characteristics as the watershed properties, topography and land use must be taken into account when modelling the frequency and severity of flood events. On the other hand, characteristics of the involved assets including, for example, the location, type and age of structure play a prominent role in predicting the financial loss under a given flood risk scenario. The relative scarcity of data related to flood losses adds to the complexity.”

... Although it has been an internationally accepted belief that flood damage is mainly influenced by the inundation depth, the inclusion of additional predictors of flood intensity metrics, for example, duration, flow velocity and contamination, as well as the asset’s characteristics, such as building type, quality, number of floors should provide notable improvement of the prediction power of the vulnerability models. Vulnerability models that account for more than one predictor are considered to be multivariate.”

(Society of Actuaries, 2019)

Data availability

Data limitations pervade climate risk assessments for the industry and, more broadly, across financial services (PRA). A lack of readily accessible data in useable formats and at a sufficiently granular level is another important challenge to addressing the problem of consistent secondary peril risk data (issue two). In our survey, 91% of respondents identified a lack of readily available data as the key challenge for the industry when addressing secondary perils. This increases for reviews of secondary threats, where the events are more localised, and data required from a wider variety of sources and geographies, such as claims reports, and loss statistics from government agencies and insurers.

The lack of available data is partly driven by the individual portfolios and exposures of insurers and modelling firms, which have traditionally focussed on primary perils from European and North American markets. Loss data for North American property from Hurricanes, with relatively high insurance penetration, is far more advanced than floods and wildfires in Asia, Africa and Australia (Aon, 2021). Observational bias also impacts data availability. For example, the introduction of Doppler weather radars and the expansion of tornado spotters in the US in the 1990s significantly increased the number of reported tornadoes (Swiss Re, 2021). Tornadoes, floods and SCS hitting rural areas or regions with low insurance coverage will often not significantly impact loss and claims statistics. Less economically developed areas may not have the weather modelling or remote sensing technology to track and record the more frequent but less severe secondary peril events. As with many aspects of risk information, the resources and available science disproportionately favours the global north (Insurance Development Forum, 2020).

Data sharing

In cases where data may be readily available, the reluctance to share and pool data between industry participants is another significant challenge. This is more important for secondary perils where events are localised, and exposure and experience may be limited within the market. This reflects historical reluctance to share potentially commercially sensitive data and concerns over competition and antitrust laws. A lack of data sharing has the compounding effect of making entry into new markets less appealing for potential entrants due to a lack of historic loss data, creating a 'chicken and egg' scenario (see figure 14).

An overreliance on a small number of global modelling firms focused on the largest exposures means that underwriters could be reluctant to seek out alternative models or sources of data better suited to their portfolios. JBA, for example, has developed a Global Flood Model that covers flood risk in any location, including less economically developed areas with lower insurance penetration (JBA Flood Model, 2022).

- I. **Low insurance penetration** – Market with low insurance penetration makes enticing prospect for new entrants
- II. **Lack of available loss data** to price risk. Available data is held by current participants isn't shared with new entrants.
- III. **Reluctance to enter new markets.** Participants enter new markets tentatively and withdraw after some high losses without appetite to recalibrate.
- IV. **Less data generation.** Insurers withdraw. There is less insurance coverage and less loss data generated. This creates the potential conditions for entry in point 1.

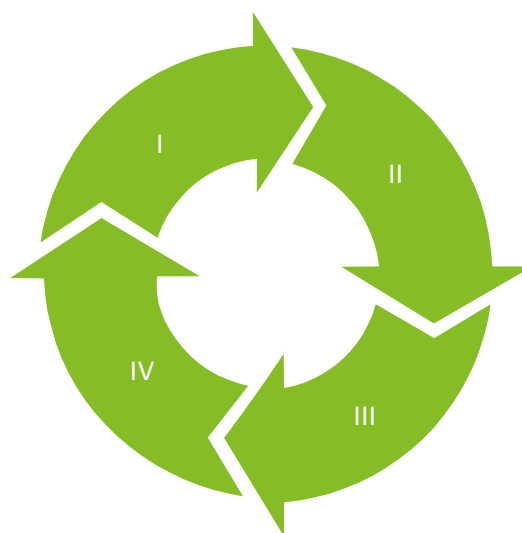


Figure 13: The data availability-protection gap cycle

Data quality

Where data does exist and is readily available, it is often unstructured, of poorer quality or unavailable in a readily accessible format (Geneva, 2018, p. p22). Large loss datasets are often insufficiently granular and not at the requisite regional level required for secondary perils. Loss and claims data are often not coded sufficiently to develop reliable models that can communicate at the individual risk or postcode level. This has prevented the industry from communicating risk to clients, contributing to historic reluctance or underestimation of risk (Cambridge Institute for Sustainability Leadership, 2021).

It is important to note that data quality also varies by individual peril and geography. Data on the impact of drought on subsidence, for example, is scarce due to the long build up times between the event and property damage. Meteorological data, such as wind speeds and precipitation in winter storms, may be more accessible, but corresponding loss data may limit its utility. Uncertainty around transit data and a lack of claims-driving exposure data further complicates modelling capability. Data quality can undoubtedly be impacted by factors such as location of weather

stations, which tend to be built for scientific research and public safety (e.g., airport and airline safety), and therefore away from the built environment (Geneva, 2018). In many developing countries, large amounts of data for historical hazard recording remains paper-based and has not yet been digitized. This creates a significant risk of the data being lost due to degradation, lack of adequate storage, disasters, conflicts and war (Geneva, 2018).

Commercial & market considerations

Commercial considerations, and the interactions between participants within the insurance industry, as identified in issue four, also contribute to the widespread underestimation of secondary peril risk exposure. The development of natural catastrophe models was driven by a few specialised firms with a globalised focus (Swiss Re, 2021). This often relies on 'off-the-shelf' models rather than dedicated resources to develop in-house modelling capability, which can be prohibitively expensive for smaller insurers. Estimations of exposure and subsequent pricing are also dependent on market conditions. Market demand, relative differences in commercial power and tension between underwriters and brokers can also depress pricing. Fears that the accurate reflection of risk would effectively price insurers out of certain markets and the emergence of subsequent protection gap considerations for regulators and governments present further challenges for the industry. This further exacerbates problem three; reducing clients' and communities' abilities to enhance financial climate resilience. In 2002, German floods (which caused €9bn in economic losses) led to an increase in premiums of up to 50% and a reduction in areas where flood insurance was offered by 10-20%. (CROF, 2019).

Short term memory bias and reactionary response to recent loss events in the industry, a key theme in the interviews, can also be argued to have contributed to the underestimation of secondary perils. The natural catastrophe modelling industry itself developed mainly in response to Hurricane Andrew in 1992 (Business Insurance, 2012). Wildfire losses in California and subsidence losses in France, for example, rose rapidly in the past five years compared with historical averages, which drives attention and recalibration of pricing and investment in modelling these perils (Swiss Re, 2021). The Japanese typhoons of 2018 and 2019 drove the development of further wind modelling capabilities in those regions.

4. The solutions and associated opportunities

Despite the issues and challenges the industry faces due to the rise of secondary peril losses, there are opportunities for market participants to innovate, lead, and create value both for their organisations and wider society.

Significant action is needed at every step of the value chain, targeting the following three themes:

Collaboration

74% of survey respondents believe more partnerships and engagements between industry and government are required to address any changes to secondary peril exposure.

Leadership

59% of survey respondents hold a neutral stance on whether the insurance industry is effective in incentivising buyers to engage in appropriate risk mitigation mechanisms.

Innovation

68% of survey respondents believe that anticipatory action will be key in addressing the secondary peril protection gap.

4.1 Collaboration

Meaningful industry collaborations and public-private partnerships have developed over recent years, particularly regarding climate change and the protection gap. However, often the scope of these is broad. The challenges posed by Secondary Peril losses require more targeted collaboration across more stakeholder groups. ClimateWise members are encouraged to engage with a variety of organisations to help improve their understanding of physical climate risk, including secondary perils, so they are well placed to drive further progress in this area.

Redefining Secondary Peril exposures - An issue cannot be solved unless it is well defined. Without an established definition of Secondary Perils, the industry will struggle to mobilise a cohesive response to the issues faced. A community approach across the value chain will be required to work together to achieve a meaningful outcome that will take one of two forms:

- a. Removing the term from the industry lexicon all together. Instead, exposure and loss information would be put out at the region-peril intersection to improve understanding among industry participants and the wider value chain (governments and policyholders). In doing so, the industry will enhance transparency through more accessible language. However this will likely take time to action, given how commonplace the term has become.
- b. Standardising the industry definition of secondary perils. This is to create an accepted definition and scope for using the term. In establishing a universally accepted definition the industry can again begin to rebuild trust from wider stakeholders and add meaning to current information already published.

Both options will require cross-industry collaboration. ClimateWise members are well placed as industry leaders to engage with counterparties regarding which option is preferred. For this to be meaningful and drive real insight and change, other stakeholders will need to be consulted, particularly regulators who are well placed to mandate change of this kind.

Open-source models and data - The industry recognises the need for open-source loss modelling and data sharing frameworks. As experts in modelling and risk management, the insurance industry is uniquely placed to enhance the sophistication of our collective understanding of climate risk for individuals and business. By leveraging its own data and expertise, and that of NGOs and governmental institutions, the industry can help inform a more precise view of natural catastrophe risk exposure. Below we have outlined some examples of where public-private partnerships are redefining modelling and risk management capabilities:

- I. Oasis Loss modelling framework (Oasis LMF): Designed to enhance the transparency of catastrophe modelling by providing free to use data, tools and models (Oasis Loss Modelling Framework, 2022).
- II. The Insurance Development Forum and the V20 (Vulnerable 20 Group of Ministers of Finance for 48 climate-vulnerable countries) announced a partnership at COP26 to build risk analytics capabilities for climate-vulnerable developing countries, with a focus on local ownership of risk analysis and a goal of mobilising climate and disaster risk financing (Insurance Development Forum, 2021).

However, more should be done. EIOPA's promotion of open-source modelling and data in relation to climate risks as part of its three-year plan is a welcome development from a regulatory perspective (EIOPA, n.d.). Increased standardisation principles on quality, integrity and transparency of open source climate data are also required. Icebreaker One's SERI programme aims to create a detailed data governance framework, encouraging sector-wide data sharing and further development of climate risk products (Icebreaker One, 2021).

Additionally, engagement with public institutions at the right level of granularity allows insurers to embed innovative product design features and pooling arrangements (i.e., parametric triggers). For example, Swiss Re is the reinsurance partner to a public-private disaster risk insurance scheme in the Indian state of Nagaland, which uses parametric insurance solutions to trigger pay-outs following monsoon or earthquake events (Swiss Re, 2020).

Similarly, firm and industry wide partnerships with NGOs are central to a successful response to the threat posed by rising exposures from Secondary Perils, particularly in climate-vulnerable developing countries where NGOs collect vast amounts of data from governments and communities. Insurance industry actors who wish to successfully navigate the complex intersection between risk transfer and development should rely on sharing climate risk modelling insights with NGOs on the ground to build a more accurate picture of exposures. By working with NGOs, the industry can leverage their data on exposed communities and the sophistication of disaster response mechanisms and work with them to develop innovative risk transfer solutions that meet the increasing demand from exposed regions. Solutions of this kind already exist, for example the world's first catastrophe bond for volcanic eruption issued by Howden in partnership with the Danish Red Cross (Howden Group Holdings, 2021). More targeted and proactive engagement with NGOs of this kind could also spark innovation with respect to Secondary Perils.

Finally, the community relationships and trust held by these organisations can be used as an effective communication tool for the industry to share its vast climate risk knowledge. This way, it

could help communities foresee natural disaster events and focus their funding and coverage appropriately. It also allows insurers to exchange ideas on how insurance solutions can meet the risk transfer needs of such communities in an innovative manner that works commercially, for example through scalable, impactful inclusive insurance and microinsurance programmes.

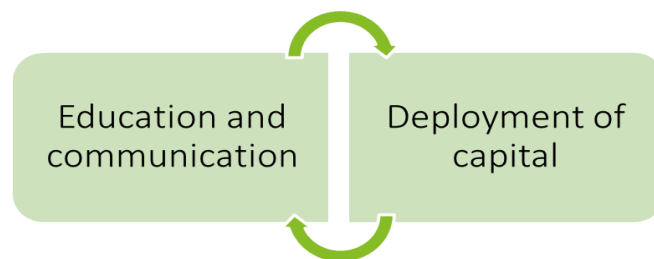
Academia - Natural catastrophes can cause significant environmental damage to ecosystems that act as natural barriers to the primary impacts of the catastrophe itself. For example, powerful oceanic storms put coastal communities at risk of flooding and can increase beach erosion, heightening the risk of future floods and economic losses. Scientific research and academia can play a crucial role in understanding how these events inter-relate and, in doing so, allow the insurance industry to better manage their exposures and interpret model outputs.

As highlighted in a recent Lloyd's industry publication (Lloyd's Exposure Management, 2022), staying abreast of peer-reviewed, high quality scientific literature is of paramount importance for a forward-looking approach to catastrophe modelling and exposure management. The industry benefits from partnering with and monitoring the activities of academic institutions and research personnel on topics such as refining modelling criteria and using forward-looking scenario analysis overlaid with peril-specific scientific research.

For instance, Aon partnered with Columbia University that explores how different climate-related assumptions impact their hurricane models (Columbia Climate School, 2020). However, outside of the largest industry participants, this remains an exception, with small and medium-sized firms less likely to have the resources for these opportunities to partner with research facilities. Effective mobilisation of the full value chain can change this.

4.2 Leadership

As risk experts, the insurance industry is ideally placed to lead the response to rising exposures from secondary peril events and set a precedent for other organisations and individuals to follow. Most insureds have already made changes to their business and lives for sustainability purposes. This highlights a shift in society's mindset, with climate resilience, mitigation and adaptation at the forefront. Insurers can accelerate these behavioural changes and capitalise on them through active leadership in the following areas:



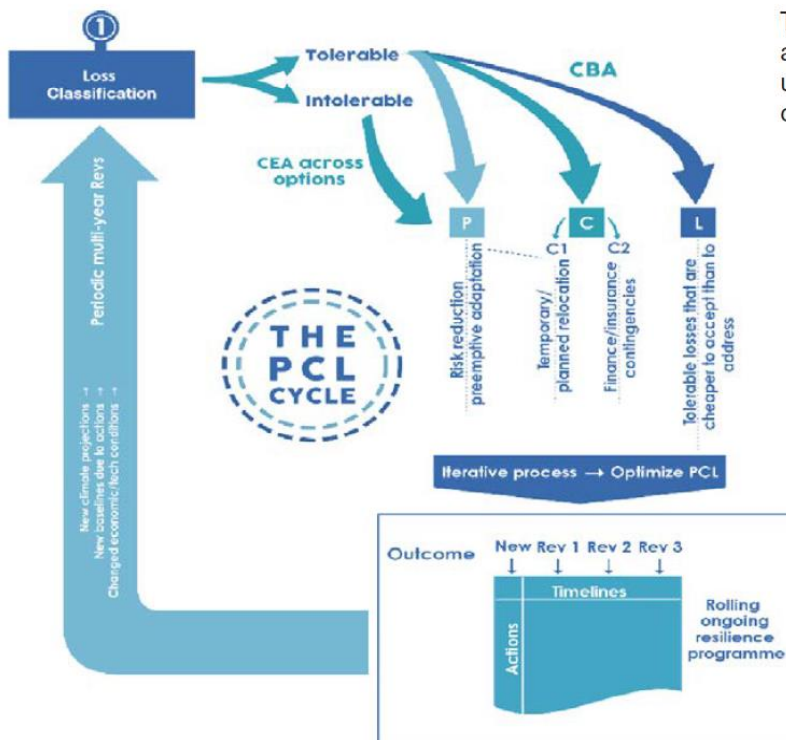
The insurance industry controls key data and insights, which can significantly impact the resilience and protection of society and businesses. The position that annual policies or contracts are sufficient to insulate the non-life insurance industry from the impacts of climate change is fading as communities and businesses become less insurable in the face of rising attritional losses. To successfully correct this trajectory, the industry needs to simplify its language and share risk management skills with policyholders and public policymakers in a more digestible way. Often stakeholders from outside the industry will not know the extent to which they are exposed to

climate related perils. So as the proprietors of this information, the industry should be specific yet transparent in communication.

For example, by explaining to customers that 2022 is the coolest year we are going to experience for the foreseeable future, rather than the warmest we have seen in the recent past, customers become more aware of the rising secondary peril losses and more engaged with adaptation, risk reduction and mitigation techniques. Similarly, technological solutions can also foster trust, accessibility and customer confidence. The development and use of effective early warnings/early action techniques, such as those championed by the Risk-informed Early Action Partnership (REAP) and the Red Cross, facilitate on-the-ground risk understanding and deliver “reliable, understandable and actionable” risk management and mitigation of events such as floods, storms and heatwaves (REAP, 2022).

The insurance industry is engaged in the ‘Early Warning Early Action’ dialogue but this partnership could go further to provide industry-quality data and financing solutions for climate-vulnerable people. A user-friendly platform for sharing views of risk, particularly locally led views of risk, is still lacking (Insurance Development Forum, 2021).

Using the data and experience gained from mature markets on how economic and environmental factors have combined to increase exposures to secondary perils, insurers should also develop specific educational programmes focusing on resilience and adaptation for communities in developing markets. The PCL framework (Nassef, 2020) is one example of a climate risk management and adaptation strategy that seeks to target societal buy-in and impact. It is based on three main clusters of actions: pre-emptive adaptation (P), contingent arrangement and risk reduction activities (C), and loss acceptance (L):



The PCL cycle ⁴⁴

The PCL framework is an iterative process, updated as conditions and circumstances change.

Figure 14: The PCL Framework (Nassef, 2020)

Insurance risk insights can also be deployed for investment and capital decisions targeted at adaptation and resilience measures in highly exposed regions.

The insurance industry can deliver insights to investors, governments and NGOs, as well as their own investment teams, on changes in the risk exposure of specific infrastructure and communities to secondary perils. In doing so, the industry can facilitate more targeted, impactful investment that protects these assets and communities and enhances their resilience. By financing these adaptation measures, insurers could increase the scope of coverage available and help develop and empower emerging markets.

4.3 Innovation

As explored above, what is causing a rise in insured losses from natural catastrophe events is multifaceted and not exclusively a result of climate change. However, it is a significant factor driving more severe and frequent catastrophe events.

“There has been a dramatic shift in the last 2 to 3 years in people thinking about climate, but we seem to still be in the thinking stage and identifying challenges and barriers rather than directly addressing it.”

Head of Aggregation, London Market Insurer

A previous whitepaper by ClimateWise explored the critical role of the insurance industry in enabling the transition to a decarbonised economy through impactful product innovation (Cambridge Institute for Sustainability Leadership, 2021). The paper outlined nine key opportunity areas for product innovation and detailed seven key actions to speed up the pace of change. These actions are discernibly relevant to the challenges faced by the industry around rising secondary peril losses while at the same time benefitting from the opportunities on offer. Below we look at some of the principal opportunities and how innovation can bring success and resilience to the industry and society.

Dynamic underwriting - Traditional property and casualty re/insurance is underwritten annually, with pricing reviewed at renewal dates. Many see this as an inhibitor to progress on climate change within the industry as it promotes short-termism and reduces the incentivisation across the value chain to mitigate and adapt to the long-term risks. In particular, the reinsurance industry has been reluctant to take multi-year positions when covering secondary perils, impacting the availability and flexibility in the direct insurance market.

Dynamic underwriting and flexible policy structures could help solve this by fostering longer-term thinking. Rigid structures should be avoided when entering new markets and geographies to incentivise insurance uptake and better control exposures.

Whilst understanding the scientific basis for more frequent and severe catastrophe events is fundamental to accurate forecasting models, the role of underwriting cannot be ignored. Studies predict that global property and casualty premiums will reach USD 4.5 trillion by 2040, with climate change accounting for 30-40% of this increase (Capgemini Research Institute, 2022). Embedding

scientific forecasts into underwriting models and taking climate-related factors into account at the policyholder level would allow more immediate action to be taken concerning exposure management, in turn making firms more able to focus on innovation and expansion on the back of robust, forward-looking scientific data.

An underwriting framework equipped with the right technology, skills, and resources which incorporate ESG at every stage of the underwriting value chain will enable firms to better control secondary peril exposures, but also help them meet their wider ESG and Net Zero commitments.

Similarly, technology will underpin how successful the industry is in managing climate-related peril exposure whilst unlocking the opportunities it presents. AI-based platforms are already revolutionising the insurability of some Californian residential properties deemed too exposed to wildfire risk using traditional products. The Silicon Valley start-up Zesty.ai has developed a proprietary risk evaluation platform that uses high-resolution satellite imagery to evaluate exposure to wildfire risk and analyse key property characteristics. A number of insurance carriers already use this in their underwriting processes (Cutter, 2021).

Redefining risk transfer mechanisms through parametric solutions - Parametric insurance also has the potential to provide accessible coverage for exposed regions that are currently, or are at risk of becoming, uninsured. However, the discussion about parametric solutions needs to move beyond the confines of the industry. The insurance value chain will need to work collectively to educate policyholders on the benefits of parametric solutions (see the section on education and communication above). More awareness of the challenges we all face will filter through the economy, promoting resilience and scaling new products. Scalable solutions are already in operation, with Floodflash in the UK and the US providing commercial flood insurance based on parametric triggers (Floodflash, 2022) and the wide ranging commercial covers available through BMS Australia (BMS, 2022).

An essential requirement for parametric insurance to be viable is the availability of good quality data and sufficient expertise and knowledge when pricing the risk. In mature markets, improvements in data quality and analytics have led to certain perils being better understood (e.g., some flood risks). However, a focused collaboration of the type mentioned above will enhance the quality of data and analytics across all peril – region types. For example, by partnering with academia, the industry could enhance the commercial viability of parametrics by developing new mechanisms to establish appropriate payment thresholds.

Looking beyond underwriting - It is not just the underwriting function that has the power to address secondary peril challenges through innovation. Claims management is going to be central to the industry's response. Some technology-based solutions are already improving the efficiency of the claims management process with respect to secondary peril losses. In Australia, FloodMapp uses enhanced data modelling and machine learning to derive more accurate impact models for flood events, showing river height in real-time, direction and on-the-ground exposure (Insurance Business Australia, 2022). This will allow insurers to access real-time data on flood impacts at the property and business level, which should reduce adjuster costs for the insurer and allow more efficient claims settlements to customers allowing them to recover more quickly from shocks.

Good practice is also emerging within claims servicing and the impact of “building back better”. By adopting minimum standards for the climate-resilience of its repairs and replacements of damaged assets, insurers can directly impact the resilience of communities and enhance the future

insurability of these assets. Similarly, insurers could go further, for example by working with policymakers to redesign building standards and promote resilience across the industry. In hurricane-prone Florida, a study of insurance data found that new buildings adhering to a stricter building code suffered far less damage in extreme weather events, yielding \$3.50 in benefits for every \$1.00 in extra compliance costs (Simmons, 2019). A Global Commission on Adaptation (GCA) report identified \$1.8trn in resilience-building investments that could deliver net benefits of \$7.1trn by 2030 (Global Commission on Climate Adaptation, 2019).

Insurance product design is moving beyond traditional insurance structures in the face of climate change, with customers expecting more than a pure risk transfer mechanism, and also seeking partnership and information that will add value through risk assessment, management, and mitigation. This has the added benefit of increasing the insurability of many exposed regions and properties.

Conclusion: Findings and Recommendations

Rising secondary perils losses are the canaries in the coal mine when it comes to the disruptive economic impacts caused by climate change. The insurance industry has significant exposure to these risks and unique tools and data to address the changing climate risk landscape. The insurance industry is a critical influencer in the societal response to climate mitigation and adaptation challenges. To successfully develop a range of responses to the challenges posed by secondary perils, we have identified six key recommendations for the insurance industry:

1. **Standardise the definition and use of the term secondary perils.** This report identifies the need to urgently drive consistency in using the term 'secondary perils' as a top priority. ClimateWise members should work together to decide whether this should take the form of:
 - i. An industry-wide - wording
 - Including collaboration with national regulators or international bodies such as the IAIS or EIOPA to seek a standardised set of characteristics, parameters and/or measurements
 - ii. A set of parameters to inform the use of the term, such as size, frequency, impact and location of perils.
 - iii. A requirement that industry participants using the term provide their own interpretation, inclusions and exclusions under the heading.
 - iv. At its extreme, this solution could entirely remove the term from industry parlance. Removing the term from industry lexicon could be beneficial in the long-term, with exposures instead referred to at the peril-region intersection.

2. **Bold leadership with a focus on education, communication and wider risk management services** to guide stakeholders towards active risk management and responses and resilience-building activities. Insurers can build trust with their policyholders by being transparent on the secondary peril exposures. By condensing the vast amounts of data held on secondary peril exposures into meaningful insights for wider society, and using accessible technological solutions to engage with customers, the industry can bolster resilience, shift societal expectations with regards to insurability, and promote wider insurance use within communities. Participants should also look to scale their risk management offerings targeted at Secondary Peril events as a standalone service to build more resilient communities and diversify their income base.

3. **Rethink value-chain engagement and collaboration on secondary perils.** Targeted engagement across the insurance value chain and with public institutions, NGOs and academia to upskill internal stakeholders, speed up the rate of innovation, and ensure the cross-sector collaboration currently demonstrated across various climate issues is also applied to 'secondary' climate risks. There should be a focus on data sharing, including claims and loss data for secondary peril exposures. Firms should leverage existing relationships with industry initiatives such as ClimateWise to promote focused engagement with governments, NGOs and academic institutions in order to in upskill internal stakeholders and speed up the rate of innovation with respect to Secondary Peril events. In the short-term, regulators and policymakers could encourage attempts to share data,

accommodate collaboration and assuage concerns around anti-competitive practices. Medium to longer terms solutions will be borne out of strategic innovation and partnerships with academic professionals. NGOs, charities and local communities will also need to be taken on this journey as they are often on the front line and will be most impacted by inaction around increasingly frequent and severe Secondary Peril events.

- 4. Diversify modelling approaches and challenge assumptions.** Industry participants should consult and dedicate resources to accessing a wider variety of models, data and assumptions when assessing exposure to secondary peril risks. By using powerful technological solutions such as Artificial Intelligence (AI) and the Internet of Things (IoT) to provide live data on secondary peril exposures, industry participants will enhance the predictive nature of climate modelling and begin to form a forward-looking strategic view of exposure management. This would strengthen modelling accuracy and provide a springboard for targeted, effective resilience measures. To achieve this, insurers will need to rethink their business models with added emphasis on unlocking the potential of new data through the Chief Technology Officer.
- 5. Accelerate the deployment of capital.** This report identifies industry innovation and technology as an essential part of the action needed to address secondary peril risk and build policy-holder resilience. This will require new and significant resources. Leveraging the impact of the investment function of insurers' balance sheets towards green solutions, and for mitigation, resilience and adaptation against climate-related secondary perils, for example investments in flood-resilient infrastructure. Using the industry's risk expertise to consult on targeted adaptation measures designed to combat climate change, and financed by third party institutions or local communities, insurers can enhance the immediate and long-term insurability of certain Secondary Perils by region. In addition, the value chain needs to work together to find creative solutions to unlock additional capital in both private and public markets. This could be in the form of weather-based ILS products, alternative risk transfer (ART) solutions, or parametrics. Educating customers and communities about these products will be crucial to their success. Nephila Climate is a valuable example of where unique approaches are challenging the status quo regarding traditional risk transfer solutions (Nephila Climate, 2022).
- 6. Prioritise Dynamic Underwriting** to continually reassess and reprice policies based on the most recent climate science and macro-economic drivers of exposure. This will help alleviate the pressure on models and model outputs when assessing the potential impact of climate related perils. In addition, dynamic underwriting should be used as a push factor to incentivise policyholder behaviours to change. Rigid policy structures should be avoided. Insurers should look to personalise solutions for individual customers, such as offering the option of no claims bonuses or other risk mitigation advice for the same product, be transparent about the social and financial impact of losses for policyholders, and market where adaptation and mitigation practices have been implemented by individual policyholders as a way to normalise these behaviours.

Some of the mechanisms for change described above are not unique to the challenges posed by secondary perils. Many examples exist of the successful implementation of these recommendations when looking beyond these challenges. However, that is no reason to discount them. Responding to rising exposures and losses from secondary perils requires new partnerships, products, and strategic thinking. Meanwhile, existing practices can help pave the way and accelerate necessary changes.

Similarly, many of the solutions mentioned already exist. To be effective, more targeted engagement is required that focuses on the distinct challenges faced concerning secondary peril exposures. With bold action, industry participants who take account of these recommendations will be able to enhance their competitive advantage and improve the resilience of many exposed businesses and communities.

Glossary

Exposure is the state of being subject to loss because of a hazard or contingency. It is also used as a measure of the premium base of a risk.

Fluvial flood is flooding that occurs when water from an established river or drainage channel spills onto the floodplain.

Hazard is something that increases the probability of loss or damage.

Peril is a harmful event which may be covered under a contract of insurance or reinsurance as an insured peril or excluded from it.

Primary Perils are events that may damage or inhibit assets, activities or life. Primary perils have the highest loss potential, and are well monitored and usually covered by catastrophe models, such as earthquakes and tropical cyclones.

Protection gap is the difference between total economic damage caused by catastrophic events and the insured losses incurred.

Proximate cause. The cause or event that has the most significant impact in bringing about the loss under a first-party property insurance policy when two or more independent perils operate at the same time (i.e., concurrently) to produce a loss.

Pluvial flood, commonly known as 'flash flooding' - is flooding that occurs when an extreme rainfall event creates a flood independent of an overflowing water body.

Subsidence is when the ground beneath a property sinks, pulling its foundations down. Subsidence usually occurs when the ground loses moisture and shrinks due to prolonged dry spells or the presence of trees and shrubs, which cause the soil to lose moisture.

Secondary perils are two categories of events that have historically been localised, less significant in physical impact and loss and less well modelled. Traditionally, these perils are the secondary effects of primary or peak perils, such as hurricane-induced flooding, coastal storm surges, tsunamis and earthquake-induced wildfires (secondary effect perils). More recently, secondary perils also refer to independent events that generate small to mid-sized losses, such as hail, flood or wildfire (non-peak perils).

Severe Convective Storm (SCS) are storms associated with thunder, lightning, heavy rain, hail, strong winds and sudden changes in temperature.

Bibliography

- ABC News . (2022). Climate change has made old measures predicting weather events in Australia 'essentially worthless'. Retrieved from <https://amp-abc-net-au.cdn.ampproject.org/c/s/amp.abc.net.au/article/101076960>
- ABI. (2018). *Association of British Insurers: Pricing Risk*. Retrieved from https://www.abi.org.uk/globalassets/sitecore/files/documents/publications/public/migrated/how-insurance-works/abi-insurance-in-the-uk_the-benefits-of-pricing-risk.pdf
- ABI, Flood Re, JBA. (2021). *Modelling the Impact of Spending on defence maintenance on Flood losses*. <https://www.abi.org.uk/globalassets/files/publications/public/flooding/modelling-the-impact-of-spending-on-defence-maintenance.pdf>.
- AIR Worldwide. (2022). All Perils are Perils. Retrieved from <https://www.air-worldwide.com/blog/posts/2022/01/what-are-secondary-perils/>
- Allianz. (2022). Allianz Risk Barometer. Retrieved from <https://www.agcs.allianz.com/news-and-insights/reports/allianz-risk-barometer.html>
- Allianz Africa. (2021). *Digitization of Agriculture Insurance through Parametric solutions*. Retrieved from <https://www.allianz-africa.com/content/dam/onemarketing/africa/allianz-africa-com/document/AllianzAfricaParametricsWebinarPresentation.pdf>
- Allianz Re. (2021). *Quad-state tornado: a new devastating record?* Retrieved from https://www.allianz.com/en/press/news/commitment/environment/211217_Quad-state-tornado.html
- Aon. (2020). Reinsurance Market Outlook. Retrieved from <http://thoughtleadership.aon.com/sitepages/display.aspx?tl=1157>
- Aon. (2021). *2021 Weather, Climate and Catastrophe Insight*. <https://www.aon.com/weather-climate-catastrophe/index.html>.
- BMS. (2022). *Australia, Parametric Insurance*. Retrieved from <https://australia.bmsgroup.com/solutions/parametric-insurance?msclkid=94d3545ec70b11ec81e38c2aef7c4cb9>
- Business Insurance. (2012). *How hurricane Andrew impacted how industry models catastrophe risks*. Retrieved from BusinessInsurance.com: <https://www.businessinsurance.com/article/20120819/news06/308199984/hurricane-andrew-impacted-how-industry-models-catastrophe-risks>
- Cambridge Institute for Sustainability Leadership. (2021). *Climate product innovation within the insurance sector*. Retrieved from <https://www.cisl.cam.ac.uk/climate-product-innovation-within-insurance-sector>
- Cambridge Institute for Sustainability Leadership. (2021). Risk Sharing in the Climate Emergency: Financial regulation for a resilient, net zero, just transition. Retrieved from <https://www.cisl.cam.ac.uk/resources/publications/risk-sharing-climate-emergency>
- Carney, M. (2021). COP26 Private Finance Strategy. Retrieved from https://ukcop26.org/wp-content/uploads/2020/11/COP26-Private-Finance-Hub-Strategy_Nov-2020v4.1.pdf

- Chubb. (2021). *Climate Related Financial Disclosure and Environmental Report*.
https://www.chubb.com/content/dam/chubb-sites/chubb-com/us-en/about-chubb/environment/doc/Chubb_2021_Climate-Related_Financial_Disclosure_and_Environmental_Report.pdf.
- Columbia Climate School. (2020). *Columbia Researchers Team With Global Firm to Enhance Hurricane Risk Scenarios*. Retrieved from <https://news.climate.columbia.edu/2020/11/16/aon-lamont-hurricane-risk-scenarios/>
- CROF. (2019). *The heat is on: Insurability, Resilience in a changing climate. Emerging Risk Initiative – Position Paper*. Retrieved from <https://www.thecroforum.org/2019/01/24/crof-eri-2019-the-heat-is-on-insurability-and-resilience-in-a-changing-climate/>
- Cutter. (2021). *AI's Role in Wildfire Prevention and Mitigation*. Retrieved from <https://www.cutter.com/article/detecting-and-mitigating-impact-wildfires-ai?msclkid=4cc3a3d6c70711ecba8abee2d00b0f8a>
- EIOPA. (n.d.). *Sustainable finance roundtable: EIOPA announces its sustainable finance activities for the coming three years | Eiopa (europa.eu)*. Retrieved from https://www.eiopa.europa.eu/media/news/sustainable-finance-roundtable-eiopa-announces-its-sustainable-finance-activities-coming_en
- Financial Times. (2021). *Extreme weather blows out catastrophe insurance losses to \$40bn*. Retrieved from <https://www.ft.com/content/1053aebb-474f-4f35-9034-2475272404e1>
- Financial Times. (2022). *UK inflation jumps to highest level in 30 years*. Retrieved from <https://www.ft.com/content/9188e191-4c1c-4968-a3af-9a43f086de6b>
- Floodflash. (2022). Retrieved from <https://floodflash.co/?msclkid=bf3aad4fc70b11ec8a99e750f05e9081>
- Geneva. (2018). *Managing Physical Climate Risk: Leveraging Innovations in Catastrophe Risk Modelling*. Retrieved from <https://www.genevaassociation.org/research-topics/climate-change-and-emerging-environmental-topics/managing-physical-climate-risk>
- Geneva Association. (2020). *Social Inflation: Navigating the evolving claims environment*. Retrieved from https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public/social_inflation_brief_web.pdf
- Global Commission on Adaptation. (2019). *Insurance for Climate Adaptation: Opportunities and Limitations*. GCA. Retrieved from <https://www.insdevforum.org/wp-content/uploads/2020/08/Insurance-for-Climate-Adaptation-Opportunities-and-Limitations.pdf>
- Global Commission on Climate Adaptation. (2019). *Adapt Now: A Global Call for Leadership on Climate Resilience, (Commission on Climate Adaptation, 2019)*. <https://gca.org/global-commission-on-adaptation/report>.
- Global Parametrics. (2022). Retrieved from <https://www.globalparametrics.com/solutions/technology/>
- Guterres, A. (2022). *UN Climate and Environment*. United Nations. Retrieved from <https://news.un.org/en/story/2022/02/1112852>
- Guterres, A. (2022). *UN Secretary General*. Retrieved from <https://www.un.org/press/en/2021/sgsm20847.doc.htm>
- Guy Carpenter. (2021). *Managing 'Secondary Perils' in the APAC Region*. Retrieved from <https://www.guycarp.com/content/dam/guycarp-rebrand/pdf/2022.3-Secondary-Perils-APAC-v4-final.pdf>

- Howden Group Holdings. (2021). *World's first catastrophe bond for volcanic eruptions launched by Danish Red Cross to raise disaster aid*. Retrieved from <https://www.howdengroupholdings.com/news/2021/pr-21-03-22.html>
- Icebreaker One. (2021). *Standard for Environment, Risk and Insurance*. Retrieved from: <https://icebreakerone.org/seri/>.
- Insurance Business Australia. (2022). *Can this claims system with real-time flood forecasting save insurers millions of dollars?* Retrieved from <https://www.insurancebusinessmag.com/au/news/natural-catastrophe/can-this-claims-system-with-realtime-flood-forecasting-save-insurers-millions-of-dollars-401317.aspx>
- Insurance Business Magazine. (2022). *Soaring repair costs: What's the impact on business and residential property insurance?* Retrieved from https://www.insurancebusinessmag.com/au/news/property/soaring-repair-costs-whats-the-impact-on-business-and-residential-property-insurance-403784.aspx?utm_source=GA&e=d3JlZXNAZGVsb2l0dGUuY28udWs&utm_medium=20220427&utm_campaign=IBUKW-Newsletter-20220427&u
- Insurance Development Forum. (2020). *The Development Impact of Risk Analytics*. London: Insurance Development Forum. Retrieved from http://www.insdevforum.org/wp-content/uploads/2020/12/IDF_Risk_Analytics_21Dec.pdf
- Insurance Development Forum. (2021). *IDF and V20 Announce Partnership in Risk Understanding to Build Global Resilience to Climate Risk*. Retrieved from <https://www.insdevforum.org/press-release-cop26-idf-and-v20-announce-partnership-in-risk-understanding-to-build-global-resilience-to-climate-risk-idf-announces-other-multi-partner-resilience-actions/>
- International Federation of the Red Cross. (2021). *The compound impact of extreme weather events and COVID-19*. Retrieved from https://www.ifrc.org/sites/default/files/2021-09/RCCC%20IFRC%20Climate%20disasters%20COVID-20210910_V2.pdf
- IPCC. (2022). *Intergovernmental Panel on Climate Change: Sixth Assessment Report*. UN. Retrieved from <https://www.ipcc.ch/report/ar6/wg1/#FullReport>
- JBA Flood Model. (2022). Retrieved from <https://www.jbarisk.com/flood-services/catastrophe-models/flood-models/global-flood-model/>
- Lazare, S. (2020). *Colonising the Atmosphere: how rich, western nations drive the climate crisis*. Retrieved from In These Times: <https://inthesetimes.com/article/climate-change-wealthy-western-nations-global-north-south-fires-west>
- Lee, H. (2022). *UN Climate and Environment*. United Nations. Retrieved from <https://news.un.org/en/story/2022/02/1112852>
- Lloyd's Exposure Management. (2022). *Thematic Review: Catastrophe Modelling & Climate Change*. Retrieved from <https://assets.lloyds.com/media/7fc3779d-53cd-4e63-86fb-64238c5525cb/thematic-review-catastrophe-modelling-and-climate-change.pdf>
- Lloyd's of London. (2018). *A World at Risk: Closing the insurance gap*. Retrieved from <https://assets.lloyds.com/assets/pdf-lloyds-underinsurance-report-final/1/pdf-lloyds-underinsurance-report-final.pdf>
- Nassef, Y. (2020). *The PCL Framework: A strategic approach to comprehensive risk management in response to climate change impacts*. Retrieved from

https://www.researchgate.net/publication/340644210_The_PCL_Framework_A_strategic_approach_to_comprehensive_risk_management_in_response_to_climate_change_impacts

Nephila Climate. (2022). *Nephila Climate*. Retrieved from <https://www.nephilaclimate.com/main>

Oasis Loss Modelling Framework. (2022). *Oasis Loss Modelling Framework - An open source catastrophe modelling platform, free to use by anyone*. Retrieved from <https://oasislmf.org/>

Phillips et al., C. C. (2020). *Compound climate risks in the COVID-19 pandemic*. Retrieved from <https://www.nature.com/articles/s41558-020-0804-2>

PRA. (2021). *PRA Climate Change Adaptation Report 2021 - Climate-related financial risk management and the role of capital requirements*. Retrieved from <https://www.bankofengland.co.uk/prudential-regulation/publication/2021/october/climate-change-adaptation-report-2021>

Prudential Regulatory Authority. (2022). *Bank of England's 2021 Climate Biennial Exploratory Scenario*. <https://www.bankofengland.co.uk/news/2021/june/key-elements-of-the-2021-biennial-exploratory-scenario-financial-risks-from-climate-change>.

REAP. (2022). *Early Action: The State of Play 2021*. Retrieved from https://www.early-action-reap.org/sites/default/files/2022-04/REAP_StateofPlay2021_FINAL_summary%20version.pdf

Red Cross Red Crescent Anticipation Hub. (2021). Retrieved from <https://www.anticipation-hub.org/about>

Reinsurance News. (2021). *Innovative finance models needed to plug disaster funding gap: Howden*. Retrieved from <https://www.reinsurancene.ws/innovative-finance-models-needed-to-plug-disaster-funding-gap-howden/>

Santam. (n.d.). *Building partnerships for risk and resilience*. Retrieved from <https://www.santam.co.za/financial/sustainability/building-partnerships-for-risk-and-resilience/>

Simmons, C. D. (2019). *Economic Effectiveness of Implementing a Statewide Building Code: The Case of Florida*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2963244: SSRN .

Slater, T. e. (2021). *The Cryosphere, 15, 233–246, 2021*. Retrieved from European Geosciences Union: <https://tc.copernicus.org/articles/15/233/2021/tc-15-233-2021-assets.html>

Society of Actuaries. (2019). *Modeling, Measuring and Pricing Flood Risk*. Retrieved from <https://www.soa.org/globalassets/assets/files/resources/research-report/2019/2019-flood-risk.pdf>

Society of Actuaries. (2020). *Climate Change and Environmental Risks*.

Swiss Re. (2019). *Secondary perils – a misnomer for mounting risks*. Retrieved from <https://www.swissre.com/risk-knowledge/mitigating-climate-risk/natcat-2019/secondary-perils-misnomer-for-mounting-risks.html#:~:text=Short%20of%20a%20formal%20definition%2C%20the%20industry%20considers,hailstorms%2C%20flash%20floods%2C%20tornadoes%2C%20la>

Swiss Re. (2020). *Insurance protection against natural catastrophes & disaster risks through parametric insurance*. Retrieved from <https://www.swissre.com/our-business/public-sector-solutions/historic-first-india-insurance-protection-against-natural-catastrophes.html>

Swiss Re. (2021). *Natural catastrophes in 2020: secondary perils in the spotlight, but don't forget primary-peril risk*. Retrieved from <https://www.swissre.com/dam/jcr:ebd39a3b-dc55-4b34-9246-6dd8e5715c8b/sigma-1-2021-en.pdf>

Swiss Re. (2021). *Small, localised and expensive: why we must urgently learn more about secondary perils*. <https://www.swissre.com/risk-knowledge/mitigating-climate-risk/we-must-learn-more-about-secondary-perils.html>.

Swiss Re Institute. (2022). *Sigma report, Natural Catastrophes in 2021: the floodgates are open*. Retrieved from <https://www.swissre.com/dam/jcr:326182d5-d433-46b1-af36-06f2aedd9d9a/swiss-re-institute-sigma-natcat-2022.pdf>

UN Department of Social and Economic Affairs. (2019). *Exposure and vulnerability to natural disasters for world's cities*. Retrieved from <https://www.un.org/en/development/desa/population/publications/pdf/technical/TP2019-4.pdf>

UN Office for the Coordination of Humanitarian Affairs. (2020). *Dual calamity floods hit India's Bihar state amid pandemic*. Retrieved from <https://reliefweb.int/report/india/dual-calamity-floods-hit-india-s-bihar-state-amid-pandemic>

UN Sustainable Development Group. (2020). *UN Common Guidance of Helping Build Resilience Societies*. Retrieved from <https://unsdg.un.org/sites/default/files/2021-09/UN-Resilience-Guidance-Final-Sept.pdf>

United Nations Office for Disaster Risk Reduction - UNDRR. (2022). *Global Assessment Report (GAR) on Disaster Risk Reduction*. Retrieved from <https://www.undrr.org/gar2022-our-world-risk#container-downloads>

Vulnerable group of 20. (2021). *V20 Statement on Opportunities for the Resilience and Sustainability Trust to Deliver Accelerated Support for Climate-Vulnerable Nations*. Retrieved from <https://www.v-20.org/our-voice/statements/group/v20-statement-on-opportunities-for-the-resilience-and-sustainability-trust-to-deliver-accelerated-support-for-climate-vulnerable-nations>

World Meteorological Organisation. (2021). *The State of the Global Climate 2020*. WMO. Retrieved from <https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate>

Zurich. (2022). *Inflation, rising catastrophe costs are challenging Property lines*. Retrieved from <https://www.zurichna.com/knowledge/articles/2022/04/inflation-rising-catastrophe-costs-are-challenging-property-lines>