ClimateWise

Insuring a sustainable future

Physical risk framework

Understanding the impacts of climate change on real estate lending and investment portfolios

Summary for decision makers

UNIVERSITY OF CAMBRIDGE
INSTITUTE FOR SUSTAINABILITY LEADERSHIP

ClimateWise

ClimateWise is a global network of leading insurers, reinsurers, brokers and industry service providers who share a commitment to reduce the impact of climate change on the insurance industry and society. It is a voluntary initiative, driven directly by its members and facilitated by the University of Cambridge Institute for Sustainability Leadership (CISL).

All members produce a detailed annual report providing evidence of action against the ClimateWise Principles. As of 2019, the ClimateWise Principles are fully aligned with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations.

In 2016, the ClimateWise Insurance Advisory Council was established to lead research into ways the insurance industry can support the transition to a low carbon economy. The Council is formed by a group of C-Suite level executives from across the ClimateWise membership and is currently chaired by Dominic Christian, Global Chairman, Reinsurance solutions at Aon.

The University of Cambridge Institute for Sustainability Leadership

The University of Cambridge Institute for Sustainability Leadership (CISL) is a globally influential Institute developing leadership and solutions for a sustainable economy. We believe the economy can be 'rewired', through focused collaboration between business, government and finance institutions, to deliver positive outcomes for people and environment. 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.

Rewiring the Economy

Rewiring the Economy is our ten-year plan to lay the foundations for a sustainable economy. The plan is built on ten interdependent tasks, delivered by business, government, and finance leaders co-operatively over the next decade to create an economy that encourages sustainable business practices and delivers positive outcomes for people and societies.

Publication details

Disclaimer
The opinions expressed here are those of the authors and do not represent an official position of their companies, CISL, the wider University of Cambridge or clients.

Author and acknowledgements
The study design and editorial process was led by Dr Bronwyn Claire, Andrew Voysey, Rachel Austin, Emma Jillings, Dr Tom Herbstein, Amy Nicholass and with input from Adele Williams and James Cole of CISL.

The authors of this report were Mark Westcott, John Ward and Swenja Surminski (Vivid Economics) and Paul Sayers (Sayers and Partners LLP), with expert input provided by David Bresch (ETH Zurich). The authors are grateful for the guidance of the ClimateWise Insurance Advisory Council and for the advice and feedback received from members of the Advisory Panel which was established for this project. With special thanks to The Lighthill Risk Network for their support.

Vivid Economics
Vivid Economics is a leading strategic economics consultancy with global reach which strives to create lasting value for clients, both in government and the private sector, and for society at large.

Reference
Please refer to this report as: Cambridge Institute for Sustainability Leadership (CISL). (2019). *Physical risk framework: Understanding the impacts of climate change on real estate lending and investment portfolios:* the Cambridge Institute for Sustainability Leadership.

Copies
This full document can be downloaded from ClimateWise's website: www.cisl.cam.ac.uk/climatewise

Contact
To obtain more information on the report, please contact:
E: climatewise@cisl.cam.ac.uk
T: +44 (0)1223 768 850

February 2019

Executive summary

The changing climate poses new risks to investors and lenders.

The world is currently on track to see substantial climate change throughout the 21st century. As well as bringing higher temperatures, changes in precipitation and a range of other impacts, climate change will also influence the likelihood and intensity of extreme weather events. Collectively, these 'physical risks', threaten the interests of investors and lenders, especially those with interests in real estate and infrastructure assets.

This report shows how investors and lenders can make use of well-established insurance models, tools and metrics to improve their management of some of the physical risks of climate change. Natural catastrophe models have long been used by the insurance industry to assess and price extreme weather event risk, and hence help them and their clients manage these risks. This report shows how outputs from climate models can be used in combination with natural catastrophe models to assess some of the physical risks of climate change in different scenarios.

The physical risk framework is a practical guide containing an open, repeatable methodology which investors and lenders can follow, refining to suit their own needs. The methodology has the potential to become increasingly sophisticated over time as understanding of the impacts of climate change improves.

As an illustration, applying this methodology to a sample of 12 real estate portfolios – with a total market value in excess of £2 trillion, spread across Europe, North and South America and Asia – highlights some important preliminary findings:

1. Climate change is anticipated to have large impacts on the risk of losses from floods in the UK and tropical cyclones in North America and the Pacific Rim.
2. The estimated changes in risk, especially in the climate scenario most aligned with the current warming trajectory, raise important questions for investors, lenders, insurers and policymakers. They will need to consider how these expected increases in risk can be managed in the most cost-effective manner and, especially, the strategy of organisations set up to help address the insurance protection gap.
3. Not all investors and lenders are expected to be equally exposed. One of the most important ways that investors and lenders can influence their exposure to physical climate change risk is through both strategic location investment decisions (which region/country/continent) and local asset-siting decisions; although any changes should be done carefully, in a phased, managed way.
4. Adaptation measures can materially reduce losses from the physical risks of climate change, and these are proportionally most effective when combined with global efforts to reduce emissions.
5. There is a powerful opportunity for investors, lenders and policymakers, working with insurers, to target the uptake of adaptation measures in the most beneficial areas.

The collective understanding of the risks posed by climate change will be enhanced as more investors and lenders undertake similar analysis. This will allow investors and lenders to take better, more informed decisions.

ClimateWise members 2019

Contents

Forewords

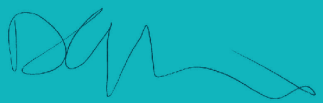
Dominic Christian

We convened the ClimateWise Insurance Advisory Council to help understand the increasingly complex nature of risk affecting the financial services sector. Our aim is to inform stakeholders of the true nature of the 'physical', 'transition' and 'liability' risks affecting our industry while identifying ways that insurance expertise can support other parts of the financial services sector in their response. The ClimateWise Physical risk methodology is the one of our first outputs.

Globally we are seeing increasing losses from physical risks, through both climate factors and the accumulation of assets in locations exposed to such hazards. Recent wild fires, typhoons and hurricanes demonstrate the impact of physical risks and the knock-on effect to the economy. In 2018, Swiss Re Institute estimated total economic losses from natural and man-made disasters of USD 155 billion, with insured losses from catastrophes being USD 79 billion, and more importantly claiming more than 11 000 victims. Different parts of the financial sector have differing abilities to respond to changes in the physical risk profile of assets. It is valuable to highlight the role of short-term insurance placements, and longer term asset holdings and adaptation measures.

Insurers have an opportunity and the responsibility to share knowledge and experience of managing risk with other stakeholders in order to build resilience within the financial sector and society more broadly. The industry's expertise with natural catastrophe modelling is perfectly placed to inform management of the physical risks associated with a changing climate. The open and repeatable methodology outlined in this report is designed for use by investors, lenders and supervisors to better understand exposure and consider adaptation. The model uses best current available climate science and provides transparency on the assumptions used. As climate projections become more accurate, the transparency of the model allows for quick updates to the analysis and assessments.

The insurance industry is called on to collaborate with other financial industry players to use our unique expertise across the industry and improve the financial resilience of the economy as a whole.



Dominic Christian,
Chair of ClimateWise and
Global Chairman,
Reinsurance Solutions at Aon

Russell Picot

Climate risk is a major societal risk, with an intergenerational quality that goes beyond traditional business strategy, decision and reporting horizons. The gap in current business assessment and response to climate change provides a possible first mover competitive advantage to adopting methodologies, such as outlined in this CISL report. The Bank of England's recent report finds that 30% of companies view climate change through the lens of corporate social responsibility, rather than taking a responsive or strategic approach.

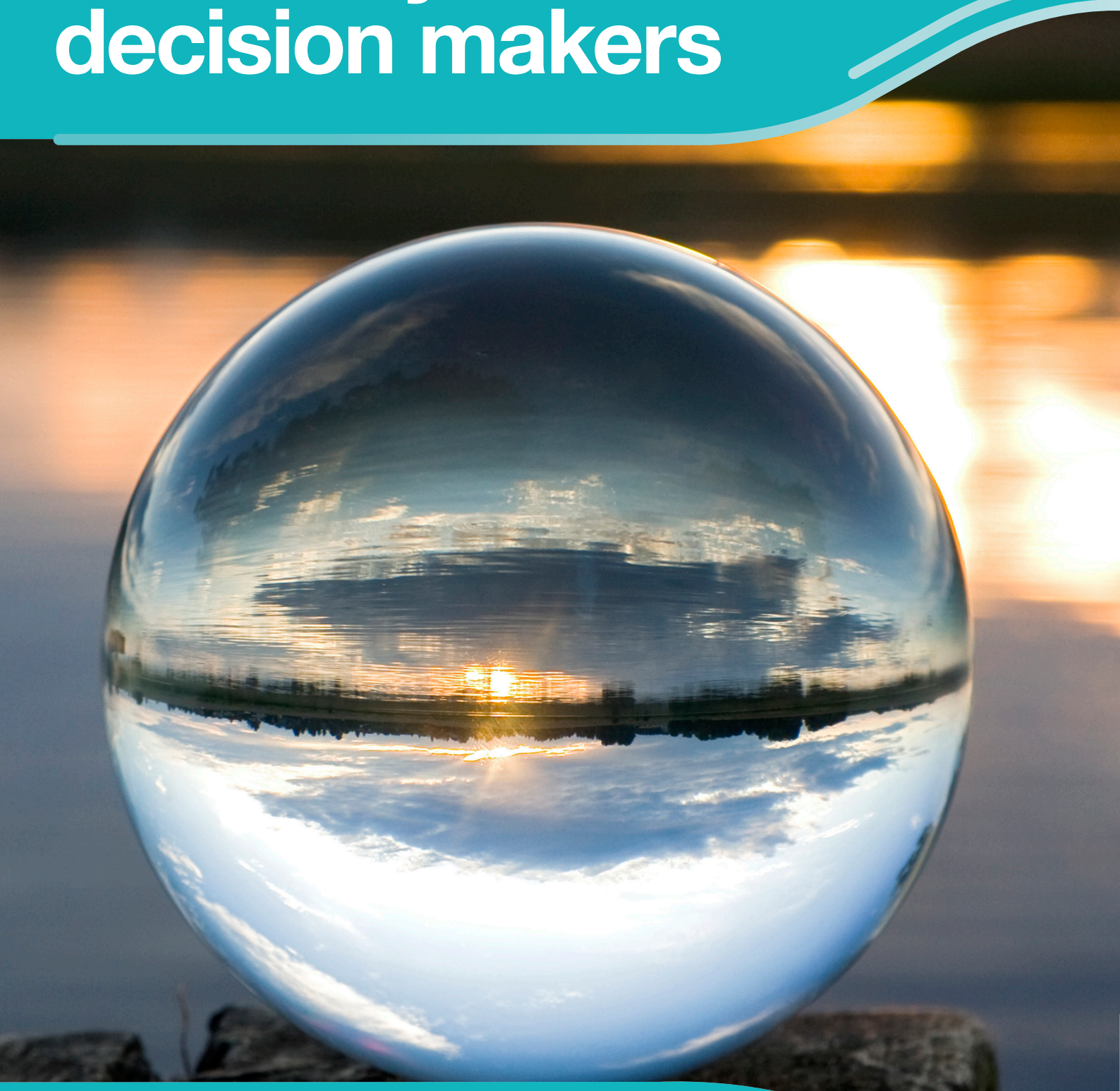
The conversations of senior executives and the boardroom have changed over the past few years, to reflect external and internal drivers of integrated thinking on climate change risks. The finance function provides key input on the exposure and forecast response to climate risks, including physical risk. The modern finance function needs to move beyond integrated reporting to integrated thinking on how a business assesses, reports and responds to physical climate risks. Taking integrated thinking into the mainstream of a business moves it towards leading practice.

The TCFD sees leading practice for assessing the resilience of portfolios as scenario analysis, with the recognition that the tools will be developed and improved over time as practice and enhanced data availability move the industry forward. The physical risk assessment methodology presented in this report is an important development in the range of scenario tools for business. The research highlights how different aspects of the financial services sector can benefit from working together to improve the management of the physical risks of climate change across investment, underwriting, lending and project finance. Also, the illustrative results highlight how pertinent it is for a business to assess its exposure to physical climate risks, and the role adaptation can play to mitigate exposure.

I would like to thank the ClimateWise Insurance Advisory Council for progressing the physical risk capabilities of the financial sector by expanding our response to climate risk beyond the insurance industry to the whole of the financial services sector.

Russell Picot,
Special Adviser to the FSB Taskforce on Climate-related Financial Disclosure
Board Chair of HSBC Bank (UK) Pension Scheme Trustee

Summary for decision makers



What are physical risks and why are they important for investors' and lenders' needs?

The changing climate poses new risks and challenges to investors and lenders. While much attention has focused on transition risk – the risks posed by rapid decarbonisation of the world economy – at present, political agreements to cut emissions have not been matched by equivalent action on the ground. Instead, the world is currently on track to see substantial climate change throughout the 21st century. This creates heightened risks to investors and lenders, the so-called 'physical risks' of climate change, which, among other impacts, may be seen in terms of higher temperatures, changes in flooding, drought or limited water availability, and sea level rise.

Regulators, investors and lenders are increasingly aware of the possible implications of physical risks across different parts of the financial system but they are also searching for practical, analytical approaches to guide their decision-making. The Financial Stability Board (FSB)'s Task Force on Climate-related Financial Disclosures (TCFD) has recommended inclusion of physical risk disclosures in organisations' annual filings. In addition, at least 18 regulators and central banks from across Europe, North America and Asia, including the Bank of England, De Nederlandsche Bank and Banque de France have recently drawn attention to the direct risk climate change poses to investors, as well as the potential for contagion to other parts of the finance sector.[1] However, while there is a general perception that this is important, there is still little understanding of how these risks can be assessed, and therefore reported, managed and, ultimately, reduced.

Insurance can play a key role in helping to manage physical risks, especially of the most extreme events. But growing physical risks will also influence the future affordability and availability of insurance protection.

Climate change will influence the likelihood and intensity of extreme weather events, which threaten the interests of investors and lenders in real estate and infrastructure assets in particular. The Intergovernmental Panel on Climate Change (IPCC) reports that climate change will result, for example, in increased frequency and intensity of heatwaves; more heavy precipitation events, leading to a greater risk of flooding at the regional scale; and an increased frequency and intensity of extreme high sea levels, such as those caused by storm surges. The large year-to-year natural climate variability means that, even with further climate change, such events will not take place every year, even in more extreme scenarios. However, early signs of these risks materialising can be seen in more frequent heatwaves in most regions, a global increase in the frequency and intensity of heavy rainfall events and an increased risk of drought in the Mediterranean.[2] These changes pose particular threats to both infrastructure assets – for which global investment needs may exceed US$90 trillion by 2030 – and residential and commercial building stock – which is expected to grow by 13 per cent between 2017 and 2026.[3] For financial institutions lending against real estate and infrastructure assets, increases in the frequency and intensity of extreme weather events might increase the likelihood of defaults due to the increased financial losses borrowers face. For investors in real estate and infrastructure assets, such changes might lead to asset devaluation and reduced yields.

Insurance will likely play an important role in helping investors and lenders manage these increased risks, but insurance should not be used as a reason to ignore them. Insurance can play a key role in helping to manage physical risks, especially of the most extreme events. But growing physical risks will also influence the future affordability and availability of insurance protection. In their first-ever report on climate change, the UK's Prudential Regulation Authority noted that "increasing levels of physical risks could present challenges, both to market-based risk transfer mechanisms and to the underlying assumptions behind general insurance business models".[4] As such, investors and lenders need to be directly empowered to understand how these risks might influence them.

How can investors and lenders better understand physical risks?

This report shows how investors and lenders can use catastrophe modelling tools and associated metrics, refined by the insurance industry over decades, to better assess, manage, report and reduce their exposure to physical risks, particularly those from extreme weather events. Catastrophe models have long been used by the insurance industry to assess and price extreme weather event risk, and hence help them and their clients manage these risks. Recently the Geneva Association, the leading international insurance think tank, recommended that climate science projections should be used within natural catastrophe models to provide more forward-looking forecasts.[5] This report shows how, in practice, outputs from climate models and climate scientists can be used in combination with natural catastrophe models to assess risk under future climate scenarios. Used in this way, the insurance industry's catastrophe models are powerful tools that can be used by investors and lenders within their scenario analysis to help quantify the physical risks of climate change, while recognising the inherent uncertainty surrounding the future incidence of climate events.

Section 3 of the report outlines a four-step process that investors and lenders can follow to use these tools, as set out in Figure 1. Section 4 presents the results of an illustrative example of the process and the preliminary findings.

- First, investors and lenders need to collect data on the physical assets ('exposure') they are concerned about. As a minimum, this should include their geographic locations and some information on asset class, such as whether they are residential or non-residential property. The more detailed that property-level information can be – in terms of construction type and year, roof type, number of floors, occupancy and square footage – the more robust the associated results will be.
- Second, they need to decide which natural catastrophe model(s) to use for their analysis. A number of factors will play into this choice. A critical one will be whether the modelling will be undertaken in house or sub-contracted to a commercial model vendor. The former would require use of an open source model. This may allow for more bespoke analysis to be undertaken and provide greater understanding of what drives any results, but these models may not have received as much investment and will also require reasonable technical skills to be confident that the work is being undertaken accurately. The advantages and disadvantages reverse for vendor models. For models supplied by vendors, the extent and transparency of model documentation is another important factor, since this will enable investors and lenders to understand and review the assumptions that have been made in the modelling.
- The third stage involves choosing the climate scenarios to model and defining how those climate scenarios might influence the probability and severity of extreme weather events. In order to account for uncertainty about the extent of global action on reducing emissions, scenarios chosen should cover a wide range of plausible futures. The scope of potential ranges in temperature increases, typically expressed in terms of temperature increases by 2100 above a pre-industrial baseline, might range from 1.5°C, the temperature target 'aimed for' in the Paris Agreement, to 4°C or more, which broadly reflects the temperature increases that would be expected given the current trajectory of emissions. The relationship between these temperature changes and the severity and frequency of disaster events within a region should incorporate the latest peer-reviewed developments in climate science and acknowledge/account for the uncertainty around these relationships. Some models already include effects of climate change on the frequency and intensity of the perils within their models; otherwise, collaborations with academics or specialist climate change impact modellers may need to be sought out in consultation with the model developer. As climate models continue to develop, for example in their geographic fidelity, these developments can be incorporated into this stage of the analysis.
- The final stage is model execution and interpretation of the associated results. Catastrophe models can provide a wide range of different results of interest. Two of the most common outputs are Average Annual Loss (AAL) – the average losses from property damage experienced by a portfolio per year – and annual probability of occurrence – the probability that, over the period of one year, a given asset experiences an event of a given magnitude. Any results should be compared against a 'present day' climate scenario baseline and, where possible, these baseline results should be compared with and scrutinised against historical loss data. Forward-looking results should also be benchmarked against those from comparable studies, where available. When there is confidence that these results are robust, investors and lenders then have the option to convert the changes in expected losses into potential changes in asset values. They can also use the natural catastrophe model(s) to analyse how adaptation measures might reduce losses and asset value impacts.

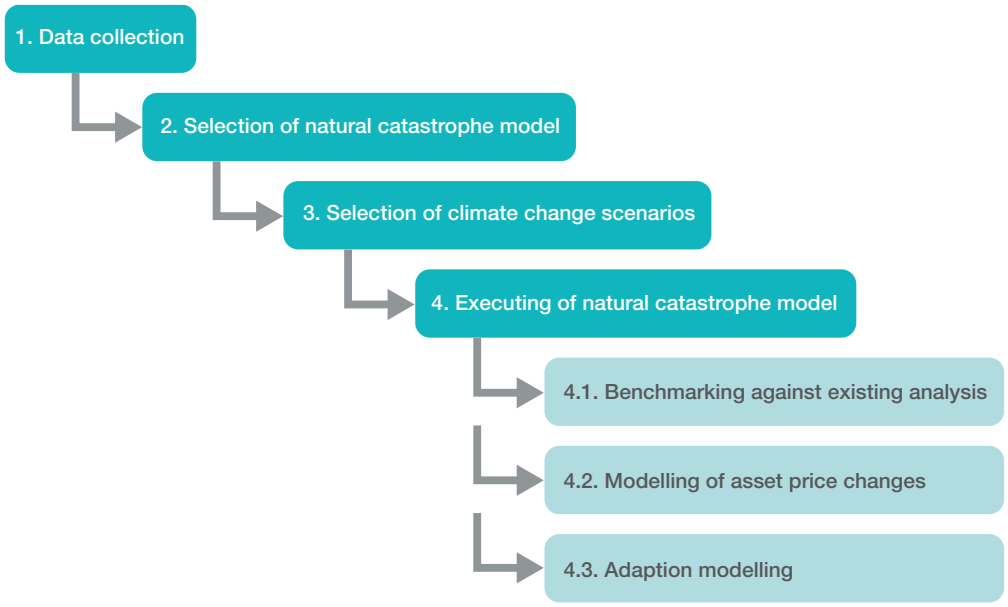


Figure 1. Key steps for investors and lenders to follow in modelling the physical risks of climate change

While an understanding of climate impacts on property portfolios represents one important implication from climate change, there are many other implications from climate change on lives and livelihoods, especially among developing countries, that are not captured in this approach.

What results emerge from an illustrative application of this methodology?

The report provides an illustration of how investors and lenders can follow this four-step process. In terms of data, this application analyses 12 real estate asset portfolios, consisting of assets in the UK, Europe, North America, South America and Asia. Seven of these portfolios consist of UK residential mortgage assets held by large UK retail banks and building societies, whilst five are real estate investment portfolios held by ClimateWise members. The latter portfolios mostly comprise offices and shopping centres, with assets across Europe, North America, South America and Asia. The analysis compares present day losses of the portfolios from extreme weather events to their expected losses in the 2050s. Financial institutions with long-term investments, including banks and building societies providing new 35-year mortgages today, will have exposure to risks in this time period.

The results derive from two natural catastrophe models that are characteristic of those used in the insurance industry. The application uses CLIMADA, an open source model developed by ETH Zurich, to explore European winter wind storm and tropical cyclone risks. A strong attraction of CLIMADA is that it is an open source model, which means that all assumptions behind the model are visible and, with modifications to the source code, can be adapted by advanced users. However, the sophistication of the modelling does not match that of the commercial vendors. The application also uses Future Flood Explorer (FFE), developed by an international team of academics and experts, to explore UK flood risk. The FFE was previously used as part of the 2017 Climate Change Risk Assessment for the UK government's Committee on Climate Change.

Financial institutions with long-term investments, including banks and building societies providing new 35-year mortgages today, will have exposure to risks in this time period.

The application explores expected losses in the 2050s in two climate change scenarios (acknowledging that this is just a sample of possible future climate change scenarios):

- The first scenario is consistent with 4°C of global warming by the end of the century, an outcome in line with the warming implied by current trajectories of climate action.
- The second scenario reflects the possibility that aggressive mitigation action and technological innovation leads to rapidly decreasing emissions levels and the global temperature rise being limited to 2°C by the end of the century.

The illustrative analysis uses results from climate models to map these changes in global average temperature increases into expected changes in the frequency and severity of floods and storms. It is recognised that this is an area subject to ongoing scientific enquiry, with the effects of climate change better understood for some extreme weather events such as UK flood, than others such as European wind storms. Furthermore, the changes in these events represent just a subset of future climate impacts.

The results show that, for these particular portfolios, climate change could have large impacts on the losses that investors and lenders face from floods in the UK and tropical cyclones in North America and the Pacific Rim, but that their increases in losses from European winter wind storms are likely to be lower. Under a 4°C warming scenario, the modelling suggests the AAL caused by UK floods to residential mortgage assets could increase by 130 per cent. It also suggests a 40 per cent increase in the number of residential properties exposed to significant flood risk (defined as a 1.3 per cent or 1 in 75 annual probability of flooding or above), equivalent to 180,000 properties within the portfolios examined. These results are for large, geographically well-diversified portfolios; more regionally concentrated lenders may see larger increases. For investment portfolios, in a 4°C warming scenario, the increase in AAL from flood risk across four UK portfolios is modelled to be 70 per cent higher in the 2050s than today. Across the two portfolios with assets in North America and the Pacific Rim, the analysis based on best evidence suggests that the equivalent expected increase from tropical cyclone risk is 80 per cent. The portfolios examined face much smaller increases in risk from European winter wind storms.

The analysis also suggests that losses faced by investors and lenders are lower, but still substantial, if global efforts to reduce emissions are successful. For the UK residential portfolios, AAL from floods would increase by only half the amount of a 4°C scenario, while the modelling suggests that the number of properties within the portfolios at risk of significant flooding (1.3 per cent or 1 in 75 annual probability or above) might only increase by 25 per cent. For investment portfolios in the UK, the increase in AAL is 40 per cent, which is similar to the potential increase in AAL from tropical cyclone risk. Table 1 summarises. These results reinforce that it is paramount for governments, business and society to try and keep warming as low as possible, as underlined by the most recent IPCC analysis.[2]

Peril	Asset type	Risk metric	2°C warming by end of century	4°C warming by end of century
UK flood risk	Residential mortgages	% increase in AAL by 2050s	61%	130%
		% increase in number of properties at significant risk of flooding (annual probability of 1.3% or above)	25%	40%
UK flood risk	Investment portfolios	% increase in AAL by 2050s	40%	70%
North America and Pacific Rim tropical cyclones	Investment portfolios	% increase in AAL by 2050s	43%	80%
European winter wind storms	Investment portfolios	% increase in AAL by 2050s	6.3%	3.6%

Table 1. Modelling shows increased losses are expected across all perils, but they are lower if global efforts to reduce emissions are successful

These findings align with those from earlier studies, including those from the insurance sector. For instance, JBA found a 25–30 per cent increase in AAL for UK residential properties in the 2040s,[6] while the UK's Climate Change Risk Assessment,[7] also using the Future Flood Explorer as in this analysis, found a 30–62 per cent increase in AAL in the 2050s for UK residential properties. The smaller increases in AAL found in these previous analyses are likely to reflect differences in assumptions around community-based adaptation and in the portfolios examined, while in the case of the JBA analysis, also differences in model set-up and time horizon. Similarly, the relatively modest increases in AAL from wind storms match the findings of research carried out on behalf of the Association of British Insurers (ABI) regarding the effect of climate change on wind storm losses to UK assets.[8] The ABI modelling exercise found the AAL from UK wind storms was expected to increase 11 per cent by the end of the century under a 1.5°C scenario and 25 per cent by the end of the century under a 4.5°C scenario. It is likely that differences to our analysis are largely attributable to the different time horizon and scenarios considered, as well as some differences in the model set-up and the underlying climate models used to drive the results.

What are the potential implications for investors and lenders, insurers and policymakers?

The potential increases in risk, especially in a 4°C scenario, raise important questions for investors, lenders, insurers and policymakers as to how they can be managed in the most cost-effective manner.

- In cases where commercially provided insurance policies are held in relation to these perils, policyholders might expect to see, on average, increases in premiums and insurance companies would need to purchase substantially more reinsurance to ensure solvency and in line with any increases in modelled uncertainty. For assets that have no insurance cover (such as some commercial properties), all of any increase in risk will be faced by investors and/or lenders.
- This also has important implications for the strategy of organisations set up to help address the insurance protection gap. In the specific case of the UK residential mortgage market, this applies particularly to Flood Re, whose role is to provide an affordable market for home insurance for properties built before 2009 that are at risk of flooding. It achieves this by offering fixed premiums according to council tax banding, with the funding gap between the premiums it charges and the risk-based price for insurance met through a levy imposed on the insurance industry (and, ultimately, its policyholders). This analysis suggests its funding gap could increase, reinforcing previous concerns about the sustainability of these arrangements. For example, although a formal assessment of when insurance availability for residential properties through normal market arrangements may become challenging has not been undertaken, a typical rule of thumb is that it can be challenging to provide affordable insurance in cases where the annual probability of flooding is 1.3 per cent or above. The modelling shows that, in a 4°C warming scenario, by the 2050s, the number of residential properties falling into this category could increase by 40 per cent to 180,000 properties across the portfolios examined. Scaled to the UK mortgage portfolio as a whole this could amount to an additional 250,000 properties, and compares with approximately who were benefiting from the Flood Re scheme during the most recently reported financial year.[a] Moreover, Flood Re is, by statute, to transition the UK residential market back to risk-reflective pricing, meaning that after 2039 premiums and excesses should, as well as being risk-reflective, remain affordable without the benefit of the levy: careful investigation will be required of whether and how Flood Re can achieve this in light of the projected increased risks arising from climate change.
- In the absence of Flood Re or for UK residential properties excluded from Flood Re (those built after 2009), the implications for both homeowners and mortgage providers could be more profound. It is possible that, in some cases, this increase in risk will mean that buildings insurance for residential properties may no longer be available for some homes at an affordable price (recognising that what is seen as an affordable premium can vary by household). A lack of access to affordable insurance would have adverse implications for homeowners living in those properties who may find that their properties suffer significant decreases in value, potentially leaving them in negative equity and either unable to sell their homes and/or unable to re-mortgage. This could have significant personal costs, as well as disrupting the liquidity and efficiency of the housing and mortgage markets. In turn, lenders may need to consider the increased risk of mortgage default, which is likely to be geographically concentrated, and ensure that their business strategies are robust to this risk.

A crucial next step from this work should be for national regulators to explore in more detail the interlinkages between flood risk, insurance availability and the residential property market – with a particular focus on how these interlinkages could evolve over time. In the UK, this would build on the concern expressed by the Bank of England regarding the possible crystallisation of financial risks from greater flood risk to the UK residential mortgage market if flood insurance would become unaffordable[9].

While there is expected to be a substantial overall elevation in physical risks in a 4°C scenario, not all lenders and investors are likely to be equally exposed. Especially in a 4°C warming scenario, the modelling finds significant differences in the risk of different portfolios of mortgage and investor assets. Under a 4°C warming scenario, the range of increase in expected losses across the seven UK residential mortgage portfolios varies between 108 per cent and 132 per cent. For the two portfolios of assets at risk of tropical cyclones in North America and the Pacific Rim, the range in the increase in losses is 17 percentage points, with much of this difference driven by the location of just a small number of assets. The modelling suggests that the spread in risk across different portfolios is substantially smaller if emission reductions are successful in moving the world onto a 2°C warming trajectory.

The potential increases in risk, especially in a 4°C scenario, raise important questions for investors, lenders, insurers and policymakers.

[a] It is recognised that the number of properties that Flood Re currently supports, 150,000 during the most recently reported financial year,[10] is significantly lower than the number of properties in the portfolios examined facing an annual probability of flooding of 1.3 per cent or higher, 445,000. Flood Re reports that: "benign weather and the decisions taken by insurers on which properties to cede have meant that the number of properties benefiting from the Scheme is below our expectations. As views of flood risk vary across the market and are reflected in ceding patterns, we have invested significantly in our understanding and modelling of flood risk to help us optimise the design of the Scheme and as a result benefit insurers and their customers."[11]

This implies that one of the most important ways that investors and lenders can influence their risk is through both strategic location investment decisions (which region/country/continent) and local asset-siting decisions; although any such changes should be done carefully, in a phased, managed way. Capital providers to investors and lenders will likely want to understand how such location decisions, intermediated by insurance availability (discussed above) and adaptation action (discussed below), are taking account of the physical risks of climate change. To the extent that investors and lenders do alter location decisions, it will be much less disruptive to the real economy if this happens over a long period of time rather than as an abrupt response to one or a series of particular events.

Property-level adaptation measures can materially reduce climate change induced losses, and this is most effective when combined with global efforts to reduce emissions. The increase in losses identified above assumes relatively limited efforts to adapt to the impacts of climate change. In the UK, the modelling suggests that, under a 2°C scenario, around two thirds of the additional losses might be offset if half of at-risk households install flood protection measures. This includes measures to prevent flood ingress and measures to reduce damage if flood water does ingress, such as resilient flooring. Further reductions in losses, and a reduction in the number of properties at significant risk of floods (annual probability of flooding above 1.3 per cent), could be secured by increased community-level flood adaptation measures.[b] The analysis of tropical cyclone risk suggests that, in a 2°C temperature scenario, roof upgrades to properties at risk of tropical cyclones might offset around half of the increase in AAL. However, adaptation measures offset a smaller proportion of the increases in losses in higher temperature scenarios, when extreme weather events are expected to be more severe.[c] In other words, rather than considering adaptation as an alternative to efforts to reduce emissions, it is best thought as a complement to these efforts.

[b] The analysis assumes spending on construction and maintenance of river and coastal defences continues to be implemented as effectively as experienced in the recent past.

[c] As discussed in Section 3.4.3, adaptation measures provide only limited resilience against the most extreme events.

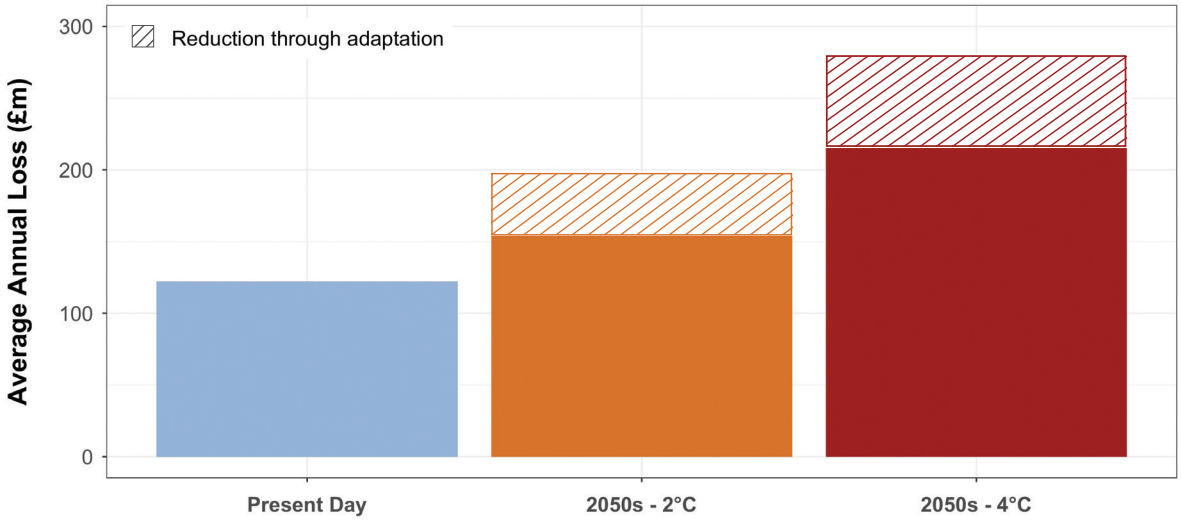


Figure 2. The modelling suggests that adaptation measures help reduce the Average Annual Loss from floods to properties in UK mortgage portfolios
Source: Vivid Economics, based on FFE

This illustrative analysis indicates there is a powerful opportunity for investors, lenders, the insurance industry and policymakers to target the uptake of adaptation measures in the most beneficial areas. Although it allows for rapid repricing of risk, the short time horizons created by the insurance industry's practice of one-year insurance contracts limits the ability for insurers to incentivise adaptation measures. However, investors and lenders, combined with policymakers, may find it easier to take a longer-term perspective. They could work in concert with insurers to encourage the uptake of adaptation measures, for instance, by making both loans and insurance contingent on the installation of relevant adaptation measures. These efforts could help overcome 'first-mover risks' whereby households may be unwilling to introduce adaptation measures that similar households do not have, for fear that their abnormality, and the signal that the property may be exposed to physical risks, might reduce the value of the property.

Advisory Group List

ClimateWise Insurance Advisory Council (2018)

Dominic Christian	Chair of ClimateWise and Global Chairman, Reinsurance Solutions at Aon
Jon Dye	CEO, Allianz UK
Stephen Catlin	Special Advisor to XL's Chief Executive Officer, XL Group plc
Charles Franks	Group CEO, Tokio Marine Kiln
Patrick Tiernan	Managing Director, Aviva Global Corporate & Specialty
William McDonnell	Chief Risk Officer, RSA Insurance Group
Rowan Douglas	CEO for Capital, Science and Policy Practice, Willis Research Network, Willis Group
Alex Hindson	Chief Risk Officer, Argo Group International Holdings, Ltd
Huw Evans	Director General, Association of British Insurers (ABI)
John Parry	Chief Financial Officer, Lloyds
Martyn Parker	Chairman Global Partnerships, Swiss Re
John Scott	Chief Risk Officer, Zurich Insurance plc
Simon Beale	CEO, MS Amlin
Ricard Wennerklint	Deputy CEO, If P&C
Steve Weinstein	Group General Counsel and Chief Compliance Officer, RenaissanceRe

With thanks to previous representatives of the ClimateWise Insurance Advisory Council:

Maurice Tulloch	Chair of ClimateWise (2015-2017), CEO International Insurance, Aviva
Scott Egan	Chief Financial Officer, RSA
Charles Philipps	previously CEO, MS Amlin

ClimateWise Physical Risk Advisory Panel

Elizabeth Cannizzo	Actuarial Analyst, Bank of England
Juan Duan	Risk Specialist – Catastrophe Risk, General Insurance Risk Specialists, Prudential Regulation Authority, Bank of England
Giorgis Hadzilacos	Technical Specialist – Catastrophe & Climate Risk
	General Insurance Risk Specialists, Insurance Division Bank of England
David Rochester	Head of Underwriting, Lloyds Banking Group
Jonathon Gascoigne	Senior Risk Adviser, Capital, Science & Policy Practice, Willis Towers Watson
Matthew Jupp	Principle, Mortgages, UK Finance
Miroslav Petkov	Director, S&P Global Ratings
Daniel Byrne	Chief Risk Officer, Flood Re
Dickie Whitaker	Chief Executive, Oasis Loss Modelling

Advisory Group Supportive Statements

"Flood Re welcomes this analysis which highlights the potential impacts of climate change on UK flood risk. Increasing the understanding of the potential climate change impact on future UK flood risk is an area of ongoing investigation. The direction of travel indicated by this analysis is clear, as is the corresponding threat to Flood Re's public purpose of transitioning to an affordable risk reflective home insurance market for those households most at risk of flood. Research and analysis, such as this report, will feed into Flood Re's medium and long-term plans, in particular the steps we are taking to assess and facilitate the take-up of adaptation measures.

Responding to the consequences of climate change and particularly the increased risk of flooding in the UK requires collaboration and action from a broad range of public and private stakeholders, including Government, insurers, mortgage providers, rating agencies and regulators. Flood Re therefore supports the the ClimateWise Principles and its work to draw together these various stakeholders, and looks forward to participating in future research and analysis to better understand and plan for the shifting landscape of UK flood risk."

Flood Re

"Lloyds Banking Group welcomes this research into the possible impact of climate change on properties in the UK. As a key mortgage lender, commercial lender, and home insurer, Lloyds has a significant interest in this issue from both a commercial and a customer point of view. Understanding the effects of climate change on UK homes, and responding to those consequences, is very important to us and to our customers. The key observation of this report – that we need to focus on both the mitigation of climate change, as well as adaptation to its effects – and that if we do both, we can maintain affordable insurance, is a positive message and one that Lloyds very much supports."

David Rochester, Lloyds Banking Group

"It's important that we keep pushing the boundaries of our understanding of a changing climate across a wide user base seeking answers to important questions. This study, which we are pleased to co-fund, provides an important step in demonstrating how metrics, historically mostly used by the (re)insurance market, have wider application across financial services. Work being pioneered by the (re)insurance industry on interoperability in models and data will further help bring new models and techniques to a wider audience at lower cost, helping society make more informed judgements on key risks."

Dickie Whitaker, Oasis

1. Glossary

Annual exceedance probability curve: a graph which shows the probability that a given threshold of losses will be exceeded in any one year. Average Annual Losses can be derived from an exceedance probability curve.

Annual probability of occurrence: this measures the probability that, over the period of one year, a given asset experiences an event of a given magnitude. For example, an asset might face a 1 per cent chance of flooding at a depth of one metre or more in any given year.

Average Annual Loss (AAL): the average losses from property damage experienced by a portfolio per year.

Coastal flood: flooding from the sea when tidal surge, wave action or a combination overflows the shoreline boundary.

European winter wind storm: wind storms caused by extra-tropical cyclones, most commonly affecting countries in Northern Europe.

Exposure: physical assets exposed to extreme weather events.

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

Natural catastrophe model: a sophisticated computer model used to estimate the risk of financial losses to portfolios of assets.

Protection gap: the difference between the amount of insurance that is economically beneficial and what is actually purchased.

Replacement cost: the cost of fully reinstating an asset after total damage.

Return period: a way of describing the magnitude of an extreme weather event. A flood with a 100-year return period has a 1 per cent chance of being exceeded by a higher magnitude event in any year.

Surface water flood: flooding from a rainfall event prior to the generated run-off reaching an established river or drainage channel.

Tropical cyclone: intense circular storm originating over warm tropical oceans. Known as hurricanes when forming in the Atlantic Ocean and typhoons in the Pacific Ocean.

2. References

[1] Network for Greening the Financial System (NGFS). (2018). NGFS First Progress Report.

[2] Intergovernmental Panel on Climate Change (IPCC). (2018). Global Warming of 1.5°C.

[3] Navigant Research. (2018). Global Building Stock Database.

[4] Bank of England. (2015). The impact of climate change on the UK insurance sector – A Climate Change Adaptation Report by the Prudential Regulation Authority. Prudential Regulation Authority, 1–87.

[5] The Geneva Association. (2018). Managing Physical Climate Risk: Leveraging Innovations in Catastrophe Risk Modelling.

[6] JBA Risk. (2018). New UK Climate Change Model.

[7] Sayers, P. (2015). Climate Change Risk Assessment: Projections of future flood risk in the UK. Appendix G, Validity of present day and future risks.

[8] Association of British Insurers. (2013). Revised Statement of Principles on the Provision of Flood Insurance, 55–60.

[9] Bank of England. (2018). Transition in thinking: The impact of climate change on the UK banking sector.

[10] Flood Re. (2018). *Annual Report and Financial Statements*.

[11] Rollins, J., & Kinghorn, J. (2013). *Improving Wind Mitigation Incentives*.

UNIVERSITY OF CAMBRIDGE
INSTITUTE FOR SUSTAINABILITY LEADERSHIP

Cambridge insight, policy influence, business impact

The University of Cambridge Institute for Sustainability Leadership (CISL) brings together business, government and academia to find solutions to critical sustainability challenges.

Capitalising on the world-class, multidisciplinary strengths of the University of Cambridge, CISL deepens leaders' insight and understanding through its executive programmes; builds deep, strategic engagement with leadership companies; and creates opportunities for collaborative enquiry and action through its leadership groups.

Over the past 30 years we have built up a leadership network of over 8,000 senior leaders and practitioners from business, government and civil society, who have an impact in every sector and on every continent. Their experience and insights shape our work, which is further underpinned by multidisciplinary academic research.

HRH The Prince of Wales is the Royal Founding Patron of CISL and has inspired and supported many of our initiatives.

Head Office
1 Trumpington Street
Cambridge,
CB2 1QA,UK
T: +44 (0)1223 768850
E: info@cisl.cam.ac.uk

EU Office
The Periclès Building
Rue de la Science 23
B-1040 Brussels, Belgium
T: +32 (0)2 894 93 19
E: info.eu@cisl.cam.ac.uk

South Africa
PO Box 313
Cape Town 8000,
South Africa
T: +27 (0)82 829 6852
E: info.sa@cisl.cam.ac.uk

Design and cover: adrenalinecreative.co.uk

Printed on Revive 100% recycled silk art paper.

www.cisl.cam.ac.uk/climatewise | **@ClimateWise**