CFRF CLIMATE FINANCIAL RISK FORUM

# **FROM RISK TO RESILIENCE:** INTEGRATING ADAPTATION INTO FINANCE

# Table of contents

# 1. Executive summary

In 2024, the Adaptation Working Group (*AWG*) launched a report on Mobilising Adaptation Finance to Build Resilience, making the case for scaling adaptation finance by demonstrating its relevance to financial stability, credit risk, and investment value.

This report builds on this earlier work and reflects how the AWG has transitioned from a high-level strategy to a focus on operational delivery – developing a practical toolkit for the financial services sector to integrate physical climate risks and resilience into financial decision-making across institutions, sectors, and geographies.

This report focuses on informing financial decisions by utilising high-quality data and physical risk assessments to turn risk into opportunity through the integration of data into financial decision making. It provides a cohesive framework for mainstreaming adaptation into the financial system – from granular asset-level assessments to national and institutional strategies.

The content within this report has been organised to provide a comprehensive framework for advancing the integration of climate adaptation into financial decision-making:

- **Chapter 2** sets out updates to the Aim–Build–Contingency (ABC) Framework, including its alignment with the Physical Climate Risk Appraisal Methodology (PCRAM) and a series of case studies demonstrating practical application.
- **Chapter 3** considers the role of adaptation-inclusive transition planning, outlining approaches to embedding resilience into corporate strategies through the use of metrics, targets, and maturity assessments.
- **Chapters 4 through 6** provide practical illustrations of adaptation integration, addressing physical risk in credit modelling, sovereign credit assessments, and UK flood risk management respectively.
- **Chapter 7** then turns to systemic considerations, assessing how financial markets can more effectively price, incentivise, and scale adaptation and resilience through risk assessment, product innovation, and market mechanisms.
- **Chapter 8** highlights the importance of capacity-building by mapping training resources available to support financial institutions in strengthening their capabilities to manage physical climate risks. Collectively, these chapters provide a structured approach to embedding resilience across financial markets and ensuring adaptation is mainstreamed into supervisory and investment practices.

**Key highlights include:**

- **Aim–Build–Contingency (ABC) Framework Update:** The ABC Framework provides technical guidance required by the financial services sector on the 'potential future climate states' to be prepared for in making investment decisions and seeking further resilience investment opportunities. This has now been refined by the AWG to strengthen how financial firms assess physical risks across time horizons. It provides clearer guidance on selecting and applying scenarios, includes practical case studies, and demonstrates linkage with the Physical Climate Risk Appraisal Methodology (PCRAM). The update stresses improving data quality, transparency, and usability, which remain barriers to robust assessments. By embedding the ABC framework into decision-making, financial institutions can better manage uncertainty, support regulatory compliance, and unlock opportunities for resilience finance.
- **Adaptation Inclusive Transition Plans:** The report sets out how firms can systematically integrate adaptation into their transition planning cycle. Building on the recommendations from the Transition Plan Taskforce (TPT) Adaptation Primer, it recommends a four-step process (Identify risks, Set ambition, Plan actions, Implement) which aligns resilience with decarbonisation. Further guidance is provided on developing credible metrics and targets – moving beyond carbon reduction, to resilience indicators such as risk-adjusted losses, supply chain robustness, and adaptation investments. The report also includes case studies to show how firms can embed adaptation into strategies, while benchmarking initiatives highlight the maturity of current practices. This results in clearer pathways for firms to manage climate risks holistically, while positioning adaptation as a core element of strategic planning.
- **Physical Risk & Credit Modelling:** The report demonstrates how physical climate risk assessments can be directly linked to financial outcomes such as default probabilities and loss distributions. Using a synthetic Thai asset portfolio, the analysis reflects how resilience investments reduce expected losses and lower the probability of default, thus strengthening the case that adaptation finance improves creditworthiness. By incorporating hazard data, adaptation pathways, and financial modelling, the framework reflects how climate resilience can be quantified in terms of financial risk reduction. This equips lenders, investors, and regulators with tools to recognise adaptation as both a risk mitigant and a driver of financial stability.
- **Adaptation Focused Sustainable Finance Instruments:** The AWG reviewed how adaptation and resilience can be embedded into financial products and instruments. It examined how sustainability-linked loans, blended finance, and insurance mechanisms can integrate resilience Key Performance Indicators (KPIs) and targets, linking them directly to financing costs or capital flows. The report includes case studies highlighting how support factors and incentive structures can steer investment towards resilience measures and discusses innovations such as resilience bonds and blended finance

platforms. This shows how adaptation finance can be mainstreamed by embedding resilience outcomes into the same tools which are already driving transition finance.

- **Sovereign Credit Assessments:** The growing influence of physical climate risk and adaptation efforts on sovereign creditworthiness is highlighted as empirical evidence reflects how climate-vulnerable countries face downgrades and higher borrowing costs unless adaptation measures are put in place. The report calls for credit rating agencies, investors and policymakers to systematically incorporate adaptation into sovereign risk assessments, recognising resilience investments as a factor that reduces default risk and financing costs. It also stresses the importance of policy frameworks and transparent adaptation plans in shaping investor confidence. By embedding adaptation into sovereign ratings, the financial system can create stronger incentives for governments to invest in resilience early, thus reducing systemic risks and promoting long-term stability.
- **Flood Risk Data in the UK:** Flood risk is one of the UK's largest physical climate exposures, however, there remains a significant need to enhance the quality of its data. The AWG highlights the importance of asset-level forward-looking metrics, including proposals such as Flood Performance Certificates, to capture resilience in property markets. For flood data to be useful for decision making purposes, improved standardisation, greater transparency, and integration of forward-looking hazard modelling are essential. The report's recommendations reflect how higher-quality data could reduce systemic risk, enabling insurers to price risk more accurately, and helps investors identify adaptation needs. Improving UK flood data is regarded as a critical step to mobilise private capital towards resilience investment and strengthen insurability.
- **Climate Training Needs Assessment:** Finally, the AWG conducted a review of climate training for finance professionals, identifying significant gaps in adaptation-focused resources. A survey of practitioners found that while transition and carbon-focused training is growing, practical guidance on physical risk, hazard modelling, and adaptation finance remains limited. The report stresses the need for more hands-on, technical modules that help finance professionals apply physical risk data and resilience metrics in practice. The recommendation is for regulators, training providers, and industry bodies to expand offerings, ensuring that adaptation becomes as embedded in financial training as transition already is. This will help mainstream resilience thinking across the sector and build institutional capacity to act on climate risks. An online searchable database on relevant training can be found as part of the Session 5 guides on the CFRF section of the Bank of England website

The report addresses information gaps, training needs, and analytical frameworks required to support integration and creation of opportunities by providing modelling frameworks and financial mechanisms to incorporate climate resilience into lending, insurance, sovereign risk assessment, alongside corporate transition planning. The outputs demonstrate the financial materiality of adaptation and propose clear approaches to valuation and reward resilience in capital markets, hence addressing barriers to investment in adaptation.

Going forward, the AWG will continue to work on enhancing guidance for financial institutions, integrating the ABC framework into climate scenarios, and seek to provide recommendations to policy makers to catalyse increased flows of adaptation and resilience finance.

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# 2. ABC Framework guidance update

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**Contributors:** Impax (*case study*), Howden (*case study*)

This chapter sets out updates to the ABC Framework developed in the 2024 CFRF AWG report and provides real world applications. The ABC Framework provides a common methodology for financial institutions to develop more consistent and credible climate risk assessments, which support risk-adjusted financial decisions and enable the integration of adaptation into investment planning and supervision. It provides a practical framework for assessing climate physical risks across multiple scenarios and time horizons.

The interim update described below provides case studies that outline how the Framework has been applied by financial institutions and aims to enhance the usability of the ABC. It also provides a step towards alignment with complementary frameworks such as the PCRAM.

During the next 12 months, the guidance will be further revised to align with new regulatory expectations from the Bank of England, updating Supervisory Statement (SS3/19) on Enhancing banks' and insurers' approaches to managing the financial risks from climate change[1]. The intention is that the ABC Framework will also be extended to include the integration of earth system tipping points and cascading and systemic risks.

## 2.1 Scene-setting foreward: unlocking adaptation through data and transparency in UK finance

As physical risks intensify and adaptation becomes a strategic imperative, the ability to access, interpret, and act on high-quality data is essential for financial resilience. Given the nature of physical climate risks, action must follow a structured approach to decision-making under uncertainty. Developed in 2024 and refined in this report, the ABC —Aim, Build and budget, Contingency plan— Framework was developed to enable financial institutions to adopt a consistent and credible approach to assessing physical climate risks across multiple time horizons and emissions pathways.

This approach is not theoretical. It is already being applied in risk assessments, client engagement, and product development across banking, insurance, and asset management. This report provides two examples. It also demonstrates how the ABC Framework can be linked to PCRAM and discusses two new dimensions: tipping points and cascading risks. In doing so, this chapter provides a roadmap for embedding adaptation into financial decision-making.

## 2.2 Overview of ABC Framework

The ABC Framework was devised by a group of technical advisers to the 2024 CFRF AWG – a consortium of the Met Office, University of Leeds, London School of Economics and Oxford University, drawing on the latest scientific evidence from the Intergovernmental Panel on Climate Change (IPCC), risk assessment principles and based on feedback from the CFRF AWG.

It is a simple framework for selecting future climate change scenarios to support decision making across different timescales and comprises the layering of three components – emissions response, climate response, and local hazard response. It was designed with pragmatism in mind, balancing robustness of the approach with ease of use to encourage greater consistency and credibility across the financial sector.

The three scenarios were selected based on review of the scientific literature, comparison between different scenarios sets (including those from the IPCC and the Network for Greening the Financial System (NGFS)) and through discussion with the CFRF AWG members.

- **Aiming for 1.5°C** (a suitable proxy for this is the IPCC's Shared Socioeconomic Pathway 1-1.9 (SSP1-1.9) scenario and taking the median climate response).
- **Building and budgeting for 2°C by 2050** (the best proxy for this is the IPCC's SSP2-4.5 scenario and taking the median climate response).
- **Contingency planning for 2.5°C by 2050** (this is represented by the IPCC's SSP3-7.0 scenario and taking the 95th percentile of the climate response).

The temperatures quoted are the levels of global warming above pre-industrial levels by 2050, which is a timescale most relevant to decision making for most firms. For those interested in a longer-term view, in the period between 2050 and 2100, the 'aim' scenario is expected to stabilise warming, but in 'build' and 'contingency' scenarios, further warming is expected after 2050 and likely beyond 2100.

### 2.2.1 Applying ABC Framework to different timescales

The Task Force on Climate-related Financial Disclosures (TCFD) guidance reflects that, 'organisations should include scenario analysis into strategic planning or enterprise risk management processes', by 'identifying a range of scenarios that provide a reasonable diversity of potential future climate states'. The ABC Framework provides the technical guidance that the finance sector needs on what 'potential future climate states' to be prepared for in making risk management and investment decisions and seeking further resilience investment opportunities, over different timescales. Examples include:

1 Supervisory Statement | SS3/19 - Bank of England

- **For banks**, it can help with assessment of local hazards and weather-related risks already manifesting across mortgage portfolios to better inform risk assessments (over near to medium term – up to 5 years ahead, and up to the lifetime of a typical mortgage, which could now be 35+ years).
- **For asset managers**, it can help inform engagement with portfolio companies in asking whether their transition and adaptation plans, are resilient to A and B and C scenarios. Integrated transition and resilience plans that cover both plans to reduce greenhouse gas emissions and ensure resilience to physical climate risks could be requested from clients and portfolio companies (from near to medium term decision making – up to 5 years ahead and then out to 2050 or beyond).
- **For insurers and infrastructure investment managers**, it can inform how much climate change contingency planning will be needed to build and maintain assets with expected economic lifespans greater than 10 years (i.e. from medium to long term).

It is increasingly expected that regulatory bodies will seek confirmation that firms are assessing and managing their climate risks, including the risks from physical climate change, over a range of timescales.

**The four steps of applying the ABC Framework are outlined below:**

**1**

**Select the asset and its location and decide over which timelines to undertake risk assessment.**
The CFRF AWG has compiled a database of hazard data sources that are appropriate to use Climate Hazard Open Sources | Environmental Change Institute. For the short term (up to 5 years) it is credible to use data that describes the current climate. When looking out beyond ~5 years, applying the ABC Framework is key

**2**

**Apply the emissions uncertainty lens.**
The starting point is the A scenario aiming for a strong mitigation case that could translate to at most around 1.5°C warming globally for a median sensitivity of the climate; B building and budgeting to moderate mitigation action or around 2.0°C for a median sensitivity of the climate by 2050 (in line with current policies); and C contingency planning for a higher scenario to be used with assets with longer lifetimes, such as critical infrastructure.
For adaptation planning, these scenarios next need to be mapped against local climate projections, with additional consideration of both natural weather variability and the uncertainty in climate model response.

**3**

**Apply the climate response uncertainty lens.**
During the 2020s to 2030, because of the lagged response of the climate to changes in emissions, uncertainty in the climate response dominates over uncertainty in the emissions and therefore the range of hazards for which preparation is needed.
For medium-term decision making (5-10 years), it is sufficient to use one emissions scenario. This is because of the inertia in the climate system, which means that scenarios do not diverge during this timescale. We propose Scenario B.

**4**

**Apply the local climate response – hazard data – lens.**
The fourth step, the actual risk assessment, will need to be applied at a physical asset level and focuses on understanding selected local hazard responses.

## 2.3 Real applications of ABC Framework in the financial sector

The case studies below provide examples from across the financial centre of applications of the ABC Framework, alongside guidance for applying the framework in each context.

### 2.3.1 Asset Management case study: Impax Asset Investment – applying ABC Framework to publicly listed UK water utilities

**Background**

Impax Asset Management undertook an analysis of drought-related risks facing publicly listed UK water utilities, combining both historical observations and future climate projections, according to the CFRF's ABC Framework. The study aimed to understand how this climate hazard might evolve over time, to better frame investment decisions and inform engagement relating to these securities.

The assessment demonstrated that UK drought conditions are expected to worsen relative to historical norms, underscoring the need for increased adaptation-related investment in the water sector as part of upcoming infrastructure cycles. This is especially relevant for long-lived assets including water supply networks, where planning must account for a wide range of future climate uncertainties.

| Step | Guide for applying ABC Framework | Impax Analysis process |
|---|---|---|
| 1 | **Select asset and timelines of interest:** Once the asset has been selected for assessment and its location identified, a decision is needed on what timelines over which to undertake risk assessment. | The assets under consideration were publicly listed UK water utilities and the assessment focused on a 20-year window from 2020 to 2039, capturing risks over a relevant horizon both for the company's strategic infrastructure planning and one that overlaps with Impax's average holding period. |
| 2 | **Applying the emissions uncertainty lens:** Review the three climate scenarios set out in the ABC framework, examples are given for potential emissions and warming ranges under each scenario (Strong Mitigation (A), Moderate Action (B) and Backtracking (C). | The analysis used three climate scenarios from the ABC Framework:<br><br>**Aim (Scenario A)** – Strong global mitigation efforts, aiming to limit warming to around 1.5°C (SSP1-1.6). Even under this most optimistic pathway, drought severity was projected to double compared with 2014, **indicating that conditions will deteriorate significantly**.<br><br>**Build (Scenario B)** – Moderate action consistent with about 2°C of warming by 2050 (SSP2-4.5). Under this pathway, drought severity was estimated to rise by 2.2x compared to historical levels—more than twice the increase seen in Scenario A.<br><br>**Contingency (Scenario C)** – A higher-emissions route (SSP3-7.0). Here, average drought stress over a year could be as much as 30 times worse than the historical baseline. This scenario is particularly important for long-lived assets including water supply infrastructure, where planning for extreme outcomes is necessary. Further, comparing the "Contingency" scenario for the time period 2020-2039 against historical values pre-2014 shows an average increase in the average length of a set of consecutive dry days of 15%.<br><br>The next step was to link these scenarios to **local climate projections,** taking into account both natural weather variability and the uncertainty inherent in climate models. |

| | | | |
|---|---|---|---|
| 3 | **Applying the climate response uncertainty lens:**<br>Step 3 requires adding the global climate response variable. For the next 10 years or so, as a result of the lagged response of the climate to changes in emissions, uncertainty in the climate response dominates over uncertainty in the emissions and therefore the range of hazards that need to be prepared for. | Given the window covered by the analysis, climate response uncertainty generally outweighed emissions uncertainty. Asset management investment decisions are typically based on an investment horizon of less than ten years, so Scenario B in theory is sufficient. It was necessary to consider the other scenarios, given the longer-term importance of strategic planning against drought risks out to 2050 for each company and the potential investment opportunity today to mitigate the risks. | |
| 4 | **Applying the local climate response – hazard data – lens:**<br>The fourth step, the actual risk assessment, will need to be applied at a physical asset level and focuses on understanding selected local hazard responses | This analysis focused on local drought hazard projections across each company's watershed (the area of land that drains into a particular river or reservoir). All scenarios indicated a consistent worsening of drought stress as measured by the SPEI[2] significant implications for operational resilience and capital planning.<br><br>These physical risks pose direct challenges to the business model of water utilities, potentially affecting operational and financial performance. As a result, investors and other stakeholders are likely to demand stronger evidence of adaptation planning, greater transparency and regulatory support. Understanding these risks can be essential to the investment case moving forward. | A data point relevant in the context of worsening drought conditions is that OFWAT recently approved "GBP2bn development funding to kickstart GBP50bn investment for the biggest programme of water supply projects in decades", which includes 30 major infrastructure projects to improve and expand water supply in the UK.<br><br>The sector's transparency on physical climate risks is already relatively strong, and this helps to inform and contextualise any comparative analysis. Most companies report comprehensively through TCFD-aligned climate reports and Water Resource Management Plans. Future regulatory alignment, particularly around infrastructure investment and scenario-based drought planning, is expected to support improved sector resilience. |

2 Standardised Precipitation-Evapotranspiration Index

**Reflections:**
For Impax, as an asset manager, analysis underpinned by the ABC Framework can be used to engage portfolio companies when considering their climate resilience. Impax will, for example, continue to engage with UK water companies on managing both current and future drought risks.

**SPEI by company**

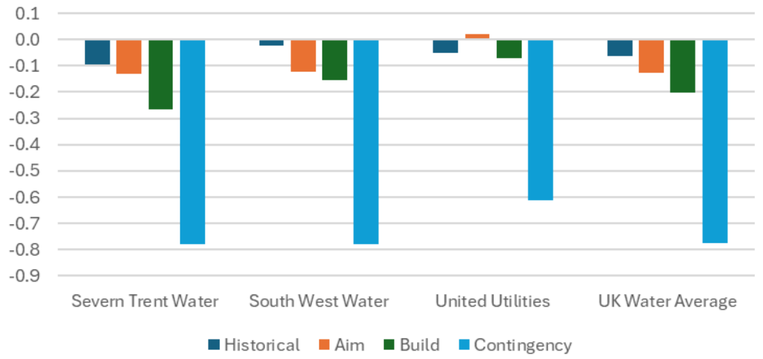


**FIGURE 1: CHANGING DROUGHT STRESS**

The figure above shows the changing drought stress (lower values indicates more severe drought exposure) and the figure below indicates the average increase in the average length of a set of consecutive dry days compared to the UK average for various companies (SVT, Severn Trent Water – PNN, Pennon Group (parent of South West Water) – UU, United Utilities).

**"Contingency" Scenario vs Historical**

**(Average Drought Length in Days)**

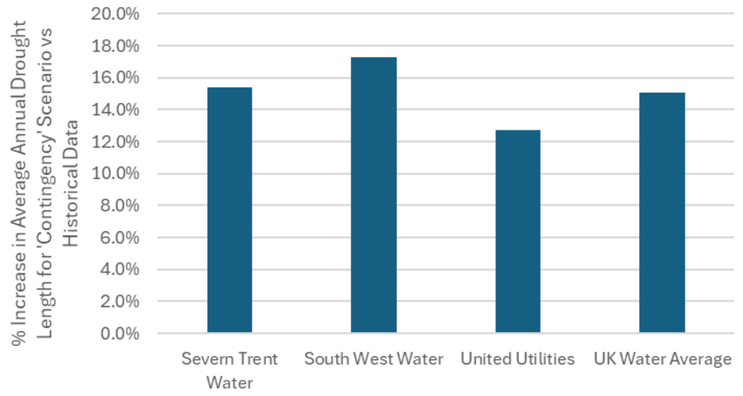


**FIGURE 2: IMPAX: RESULTS OF APPLICATION OF ABC FRAMEWORK**

Impax has run analyses on physical climate risk for individual holdings for several years now, through the lens of several different frameworks and across two generations of the IPCCs model projects, CMIP5 and CMIP6.

The CFRF framework offers an excellent basis for consistent analysis for both project-led climate analyses and systematic approaches, given its accessibility and clear and definitive guidance on key points such as scenario analysis and flexibility on timelines. In the future the framework can be developed to provide further guidance for the application to listed equity investments given their complexity and to mitigate the challenges of relatively lower quality data disclosures.

## 2.3.2 Brokers & risk managers case study: Howden application of ABC Framework[3]

### Background

The Global Risk and Resilience Fellowship is a pioneering program delivered through a partnership between Howden, the Resilient Cities Network and the Sustainable Markets Initiative, the objective of which is to bolster city resilience by collaborating with city leaders to utilise insurance and private sector tools and knowledge to address urban climate change-related challenges.

In 2024, the Greater Manchester Combined Authority and United Utilities worked with Howden to strengthen their understanding of the impacts of flood risk on the city-region's water infrastructure, the cost of this flood exposure and the investment required to reduce it. The initiative convened key stakeholders from the insurance and wider private sector to explore the impacts of United Utilities failing to adapt to flood risk.

The Fellowship identified key vulnerabilities within United Utilities' asset portfolio and quantified the related financial implications, helping to make the business case for adaptation investment. The project supported United Utilities' Climate Adaptation Manager with language to engage with United Utilities' Risk Manager to help build a compelling investment case based on future insurability for future enhancing resilience and

| Step | Guide for applying ABC Framework | Howden GRRF assessment process | |
|---|---|---|---|
| 1 | **Select asset and timelines of interest:** Select assets and its location(s) as either point locations e.g. buildings, linear assets e.g. railways, or larger area assets e.g. agricultural lands. For the GRRF Fellowship, priority assets and point-based locations were selected.<br><br>Select time horizon(s) depending on the type of asset, life of asset, business prioritise and client risk appetite. Considering the recommendations of the ABC Framework for Critical National Infrastructure, the Fellowship considered 2030, 2050 and 2080. | With a portfolio of more than 3,000 assets, Howden applied the following steps to first identify the top five most important facilities for the local authority's water supply:<br>• Mapped the service provider's portfolio of facilities & network, including location, function, facility value, connectivity, network criticality etc.<br>• Developed an understanding of materiality and of the vulnerabilities of the service provider's various facility types, e.g. electrical equipment, presence of staff on-site etc.<br>• Applied a criticality criterion to select the most important facilities to the local authority's water supply.<br><br>To account for the long assets' lifetimes and rationale for considering adoption, the following time horizons were considered: Baseline (present day), 2030 (near-term), 2050 (mid-term), and 2080 (long-term). | |
| 2 | **Applying the emissions uncertainty lens:** As part of scenario analysis, Howden typically use at least two emission scenarios in order to capture the range of potential outcomes. Which emission scenarios are selected typically depend on the client's risk appetite, sector-type, data availability and other factors. Howden typically recommends using the RCP8.5/SSP5 as the 'higher' emission scenario, which is more conservative than the SSP3-7.0 recommended in the ABC Framework. This is often selected due to data limitations, variable client risk appetite and as a 'worse case' scenario. | This assessment was focused solely on physical climate risk. Given data limitations for flood risk datasets, the GRRF Fellowship only considered two emission scenarios:<br><br>(1) RCP4.5/SSP2 corresponding to an 'moderate action' scenario and aligned with current global policies and commitments, and | (2) RCP8.5/SSP5 - a higher scenario which is aimed at Critical National Infrastructure (CNI) and aligned with a worse-case scenario.<br><br>Given data limitations, only median projections were considered. |

3 GRRF Manchester Fellowship Report April 2025

investing in climate adaptation. The methodology developed during the project has been shared with the Cabinet Office and the Ministry of Housing, Communities, and Local Government to inform the framing of insurance for resilience.

| | | | |
|---|---|---|---|
| 3 | **Applying the climate response uncertainty lens:** For medium-term scenario analysis (5 to 10 years), Howden's approach aligns with the recommendations from the ABC Framework to use the SSP2-4.5.<br><br>For the long-term scenario analysis, Howden's approach aligned with the ABC analysis in terms of using more than one emission scenario. | The higher emissions scenario RCP4.5/SSP2 was considered for the 2030 time horizon to align with the current global trajectory as best as possible given data limitations. | Both emission scenarios were considered for 2050s and 2080s time horizon to capture the range of uncertainties. |
| 4 | **Applying the local climate response – hazard data – lens:** Howden's approach typically takes into consideration a range of data sources, to include observational data and climate model data, and a range of percentiles, to include 5th, 50th and 95th.<br><br>To support short-term decision making more local datasets are typically used, combined with an understanding of historical trends and baselining data using met station datasets to take into consideration uncertainty in the climate response.<br><br>For clients with higher risk appetite, a 5th or 95th percentile is typically applied. | A range of data sources were utilised:<br>• High resolution hazard datasets from the latest ensemble of climate models (CMIP6)<br>• Met station data from on-site stations or proxy station to identify historical trends, form a baseline understanding of the climate and to validate the climate data from the models<br>• Flood risk data at a resolution of 5m (JBA Risk Management)<br>• Insurance loss models to quantify expected financial losses from climate perils e.g. Annual Average Loss, a measure of the technical rate or pure premium. | Engagement workshops were used to identify a range of direct, indirect, and cascading risks resulting from flooding of United Utilities' facilities, and these were captured in a risk matrix (Risk Matrix = Likelihood Score x Consequence Score, with results ranging from 'Very Low' to 'Very High'). A cost-benefit analysis across a range of suitable adaptation solutions was carried out (to include engineering-based, nature-based, policy-based, and insurance recommendations). |

**Key outcomes:**
The Fellowship project strengthened the understanding of United Utilities, Greater Manchester Combined Authority and their key partners of the vulnerability of Greater Manchester's water infrastructure to flood, the cost of this exposure, and the investment required to reduce it. Specific outcomes identified for key stakeholders can be summarised as follows:

- **Greater Manchester Combined Authority** has developed a deeper and clearer understanding of the impacts of present day and future flood risk in the city region, which will enable it to build a fuller picture of the costs and impacts of climate change. Additionally, it is more aware of United Utilities' flood risk exposure, United Utilities' capacity to respond, and the related potential impacts on the provision of water services in the region.
- The Fellowship project provided **United Utilities** with a methodology for assessing the impacts of flood on its assets that is informed by insurance data and market recognised risk assessment approaches. This methodology will support United Utilities' existing approach to assessing the impacts of climate risk on its asset portfolio, including potential enhancements to its 2024 Climate Risk Assessment. The Fellowship project showed that for the top five most critical facilities, with a combined total facility value of GBP114.8 million, Average Annual Loss (AAL), a proxy for calculating the cost of insurance premium, was calculated and shown to increase by +23% by 2100 relative to present day across the five facilities. Existing flood protection measures were shown to mitigate the AAL across the top five facilities by ~10%. It was also shown that for fluvial flooding, today's 1 in 1,000-year return period event likelihood becomes a 1 in 509-year event by 2080 (RCP8.5).
- The **Cabinet Office and Ministry of Housing, Communities and Local Government** – both of which were consulted throughout the project – now have a better understanding of the approaches used by the insurance sector to assess the costs of climate risk, as well as the relevance of these approaches for climate risk assessment in cities. The learnings from the project can be drawn on in the development of other municipal resilience plans, as well as any updates to the UK Government Resilience Framework.

**Key reflections:**
The ABC Framework was used as a guiding reference for the GRRF Fellowship project, but it was adapted to suit the specific needs of the client, the scope of the project, and the limitations of available data. Due to constraints in flood risk and loss modelling data, Howden was unable to apply the ABC Framework's recommended SSP3-7.0 scenario and instead used RCP8.5 as a substitute.

Similarly, the time horizons suggested by the ABC Framework, short-term (<5 years), medium-term (5–10 years), and long-term (>10 years), were found to be too restrictive for this project. As a result, Howden adopted alternative time horizons of 2030, 2050, and 2080. This adjustment aligns with the ABC Framework's recommendation to consider longer-term horizons when assessing Critical National Infrastructure.

While the ABC Framework encourages the use of multiple percentiles from model ensembles, data limitations meant that only the median percentile could be used. Typically, Howden's approach incorporates a range of data sources, including meteorological station data and climate model outputs, and considers multiple percentiles (e.g., 5th, 50th, and 95th). However, the constraints of this specific project limited the ability to do so.
The client valued the range of outcomes presented across different scenarios and time horizons, which supported business decision-making and facilitated scenario planning and strategic war-gaming.

## 2.4 Using ABC and PCRAM frameworks together

The ABC Framework helps financial institutions to identify the range of physical risks for which they need to prepare – but the question then becomes how they should respond to these risks.
This section establishes how the ABC Framework can be used in conjunction with PCRAM - a tool for integrating physical climate risks into investment decisions for real assets - that is gaining increasing attention with financial institutions.

The most recent version of PCRAM, which was open for consultation from June – August 2025, PCRAM 2.0, offers a practical guide for understanding and managing the physical climate risks that climate change poses to real assets, appraising the adaptation options and linking it back to asset values, thus making the financial case for investment.

PCRAM provides systematic, objective, and replicable guidelines for integrating physical climate risks into investment decision-making by combining climate science, engineering, and finance to present a robust but adaptable approach to identifying the business case.

Here we discuss how the ABC framing and PCRAM can be used together to achieve this. The PCRAM method consists of 4 steps, shown in Figure 3 below:


Text in blue has been added as part of PCRAM 2.0.

**FIGURE 3: ABC AND PCRAM APPLICABILITY FOR ENHANCED PHYSICAL CLIMATE RISK ASSESSMENTS**

The ABC framework overlaps and thus can help with steps 1 and 2 by bounding the problem and providing information on the range of climate information needed on different time scales (from present day, through a decade or more ahead, out to mid and late 21st century). It can also provide practical questions to help to establish the quality and suitability of climate data sources. In the second step, the ABC Framework provides a practical way of selecting suitable climate scenarios to use, including navigating the different sources of uncertainty that contribute to the spread in physical climate risks. It does so in a way that balances the need to look across the range of future outcomes with the time and complexity of performing a fully comprehensive risk assessment. Conversely, the PCRAM framing provides a wrapper that places the ABC Framework into a wider assessment of materiality and also the role of adaptation in managing risks. Used together, the ABC Framework and PCRAM can help to inform the business case for investing in resilience.

### 2.4.1 Case Study: Maritime Transport on Lake Victoria with adaptive pathways

East Africa Marine Transport (EAMT) was delivered by the Private Infrastructure Development Group (PIDG) through its project development solution, InfraCo, and in partnership with Grindrod Limited (Grindrod), logistics experts. EAMT is a pioneering scheduled roll-on/roll-off freight transport service across Lake Victoria, transporting up to twenty-one fully laden trucks between Port Bell (Kampala, Uganda) and the Port at Mwanza South (Tanzania). The asset was assessed using the PCRAM approach, with analysis shaped by uncertainties across multiple dimensions, including hydropower operating regimes, climate change impacts in the Lake Victoria Basin, and the global trajectory of greenhouse gas emissions.

The ABC framework was applied during the initial scoping, data gathering, and materiality assessment (PCRAM Steps 1 and 2) to guide the selection of assessment time horizons and emission scenarios for the subsequent analysis. Accordingly, 2030 and 2050 were selected as key time horizons, and the analysis was conducted using RCP 2.8, RCP 4.5, and RCP 8.5 emission scenarios.

While most projections of future water levels on Lake Victoria suggest minimal disruption, climate models for East Africa diverge considerably on key variables, such as mean precipitation, resulting in contrasting extremes for upper and lower forecasts of lake levels. Additional uncertainty arises from the

long-term implementation of the current hydropower management regime, with a risk that operations may deviate from the agreed approach. Drawing again on the ABC framework guidance for dealing with uncertainties in decision making, an adaptive pathways approach was developed to provide a flexible, iterative framework for managing decisions under uncertainty. Rather than committing to a single 'optimal' strategy, this approach maps out multiple possible pathways, each defined by trigger points that signal when adjustments or shifts in strategy are needed.

Modelled projections suggest that lake levels are more likely to undergo chronic, multi-year variations than abrupt shocks. These patterns enable proactive planning, where investment decisions can be guided by observed lake conditions and anticipated future trends. Resilience options were modelled using predefined trigger thresholds, which were then used to simulate future scenarios. These simulations integrated climate projections, lake-level forecasts, and financial modelling to assess potential disruption, revenue impacts, and the cost benefit of resilience measures.

This approach provided confidence that - even under more extreme future scenarios - investment in resilience would not undermine investor returns. It also established a robust basis to model and test multiple future scenarios in an automated, systematic, and efficient manner, enabling sensitivity testing and creating a flexible framework to support future asset planning and decision-making

### 2.4.2 How could the ABC Framework have helped these PCRAM applications?

How ABC could help this type of study: adaptation pathways approaches can benefit from bounding the range of outcomes, as well as identifying the most likely future climate pathway. The first helps to constrain the range of adaptation options that need to be kept available on different time horizons and can be informed by the Contingency (C) pathway in the ABC framework. The second can help to plan the near-term response and provide a scenario against which deviations can be assessed with observations. It can be informed by the build (B) scenario in the ABC Framework. The ABC Framework can also provide tools to help assess the suitability of model projections.

## 2.5 Potential future developments of the ABC Framework

The ABC framework provides a starting point for scenario analysis and the assessment of risk using climate model data driven by global climate models for policy relevant emission scenarios, such as those produced for the IPCC assessments; combined with PCRAM it can create the investment case for resilience. A number of extensions are suggested by the CFRF AWG to further enhance the framework and give a more complete quantification of risk. This section provides insights in three areas:

- factoring in tipping points;
- factoring in more complex risks;
- guidance on how to incorporate with regulatory scenarios, including the NGFS scenarios.

### 2.5.1 Incorporating tipping points

Tipping points are thresholds in the climate system, which if crossed can lead to large-scale irreversible and/or abrupt changes[4]. Tipping points of particular concern are shown in Figure 4 below, and are found in the ocean, cryosphere and on land.

Examples of cryosphere tipping points involve the deglaciation of the Greenland and West Antarctic icesheets moving into an irreversible state of acceleration so that their contribution to sea-level rise increases over coming decades and centuries with consequences for flooding.

Ocean tipping points include the "collapse" of the Atlantic Ocean meridional circulation (AMOC), which would lead to major ocean currents, including the gulf stream, being disrupted. This would impact the transport of heat northward from the tropics with major implications for northern hemisphere weather and climate, including much colder winter temperatures and sea-level rise. Tipping points on the land include a more rapid and irreversible die-back of the Amazon forest, which would lead to the loss of a major natural sink of carbon from the atmosphere, amplifying the warming the global climate experiences. At present, the IPCC view is that the chance of crossing a tipping point in the 21st century remains low and but uncertain. Studies that estimate the thresholds have been compiled but represent a compilation of studies of opportunity rather than a carefully controlled set of experiments of consistent design[5]. It is not clear whether all the models used are sufficient to represent the physics of the processes that govern the tipping point, and most are not constrained by real world observations. There is evidence that the likelihood of triggering a tipping point increases as global temperatures rise, but there is disagreement between researchers on whether the likelihood of some tipping points occurring might be higher than anticipated in the last IPCC assessment.

Tipping points are expected to develop and their consequences felt over a range of different timescales

4 Glossary — IPCC

5 Exceeding 1.5°C global warming could trigger multiple climate tipping points | Science

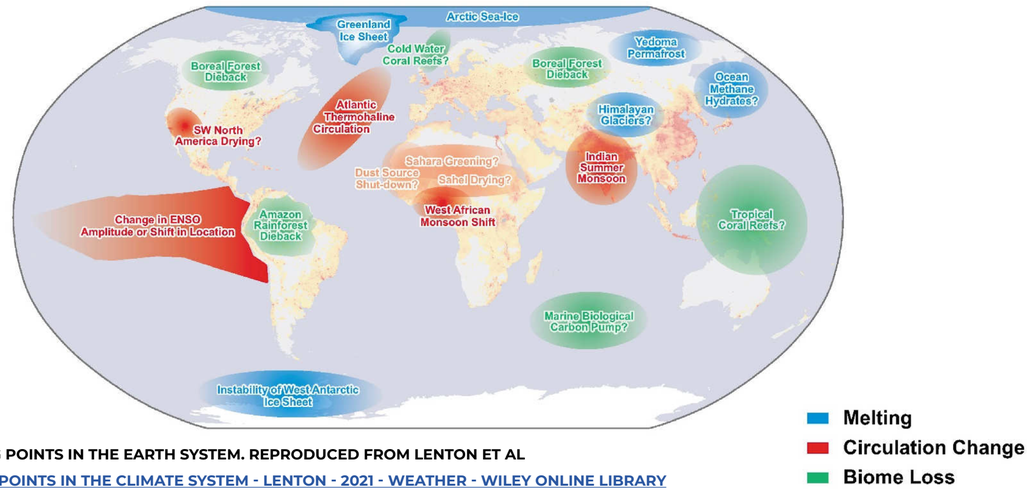


**FIGURE 4: TIPPING POINTS IN THE EARTH SYSTEM. REPRODUCED FROM LENTON ET AL**
**SOURCE:** TIPPING POINTS IN THE CLIMATE SYSTEM - LENTON - 2021 - WEATHER - WILEY ONLINE LIBRARY

from a few years to decades to centuries for others. Furthermore, there is evidence that the climate conditions might need to be sustained beyond a tipping point for an extended period of time in some cases for the tipping point to be triggered, suggesting a degree of temporary resilience if global temperature follow an overshoot pathway, which is relevant to decision making on adaptation responses.[6]

A further consideration is the potential for markets to accelerate the risk and uncertainty of major earth system tipping points into asset valuations and wider financial and economic activity. These so called 'Minsky Moments' could occur, for example, if the evidence for one, or more, tipping points breaching reached a level that triggered investors to re-assess risk over different time horizons – leading potentially to widespread uncertainty in markets.

Tipping points therefore represent an uncertain and potentially existential societal threat. As such the question around how to incorporate them into a risk mitigation and adaptation framework is challenging, requiring careful consideration of the trade-offs involved. For example, whilst it may be sub optimal at this stage to attempt to plan adaptation on the basis of an assumed path for tipping point evolution, the scale of the potential implications are such that beginning considerations around possible playbooks may well be considered a sensible investment of time.

It is important to note that while there is often focus on major global tipping points, the probability of local tipping points in ecological and human systems is also important to consider and can be happen over much shorter timescales. For examples, tipping points in the degradation of soils and water availability locally can have major (and more localised) impacts on agriculture and industry. Such tipping points are already observed, for example, changes water cycles in Brazil linked to climate and land-use change that are impacting agriculture and energy systems. It is equally important for financial institutions to be accounting for such local tipping points in physical risk pricing to build resilience.

Depending on the time horizon of risk assessment and investment decision making, and the level of lock-in inherent in these decisions, it could be appropriate to consider such tipping points within the 'C' scenario. Given the deep uncertainty, the guidance from the IPCC and others is to take adaptive pathways approaches, where the evidence is regularly reviewed, and flexibility is built into plans to ensure they are adaptable over time. An example of this is the Thames Estuary 2100 project, which was designed in a way to be flexible to the potential for higher increases in sea level rise due to potential low-probability, very high-impact changes in ice sheets over the lifetime of the Thames Barrier[7]

### 2.5.2 Interactions between hazards and the treatment of complex risks

Alongside the consideration of tipping points, there is also a recognised need to consider complex risks, for instance those involving compound hazards and both hazard and risk cascades. These can amplify the risks and impacts beyond initial estimates and thought needs to be given to how to factor them into future updates to the ABC Framework.

Evaluating the consequences of climate change is not simply a matter of estimating the change in risk, multiplying by the cost of a typical event, and adding up. Whilst this approach is analytically appealing, it fails to consider the damage that climate change may do to the wider infrastructure; economic and social structures that underpin the recovery from, and costings of, multiple individual events.

A more holistic consideration of the way risks can cascade through the economy, and wider society, is therefore required, recognising that comprehensive analytical techniques are currently challenging in this space. For example, typical hazard models give very granular analysis, however, they are typically limited to the direct damages to property or company operations. Whereas typical macro-

6 Ritchie et al, 2024. See Here

7 Ranger et al, 2013. See Here

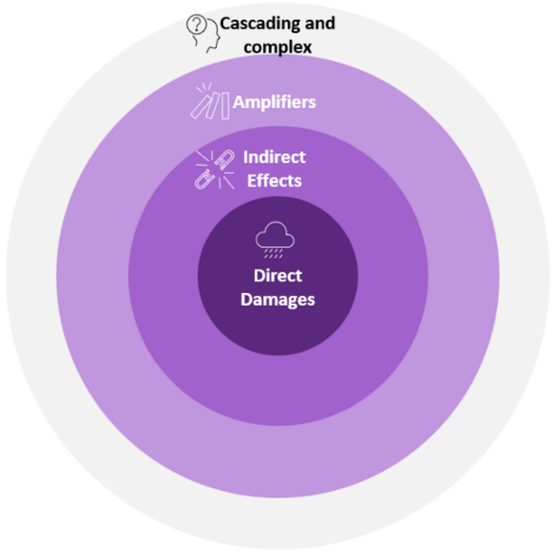


**FIGURE 5: CASCADING RISKS**

economic damage functions consider only simple mathematical relationships between average temperature, chronic risks and general economic output – without giving insights as to the drivers of the risks (and with well recognised challenges and limitations around how these should be calibrated given the non-stationary nature of climate risks).

Recognising this, one technique to facilitate a comprehensive risk analysis in the first instance, is to differentiate between 'layers' of risk (as shown in Figure 5 below). Whilst this is a simplification, and the boundaries between the layers are necessarily blurred, it can support the identification of risks that are potentially within the management of an individual institution, from those that are systemic, and so inform overall resilience considerations.

- **'Direct damages'** capture the immediate physical impacts, including damages, occurring directly on properties and factors of production (for example physical destruction of property, land, labour or capital). These are typically where analytical techniques are most achievable.
- **'Cascading effects'** (often referred to as 'indirect effects') capture the secondary consequences of direct damages that affect interconnected relationships between economies or sectors and agents within the economy (for example aggregate impacts on local valuations, disruption to infrastructure and labour availability, disruption to supply chains and trade relationships etc). Data is typically challenging in this space, and conceptually it can be assessed analytically at an individual exposure level or using more aggregate or storyline methods.
- **'Contagion'** (often referred to as 'amplification') captures the factors or mechanisms that can intensifying the magnitude of these direct and cascading effects on the economy, and which have the potential to cause further disruptions or instability for a sustained time-period (for example insurance market disruption, asset repricing and stranding, inflationary pressures, deterioration in public finances, wider financial market instability etc). These would likely have to be considered system wide, leveraging an appropriate scenario narrative describing the contagion mechanisms being explored.
- **'Cascading and Complex'** captures the broadest consequences of climate change that have significant social, environmental, and humanitarian implications and will cascade back through the economy in complex and non-linear ways (for example food and water scarcity, mass migration, human health, war etc). These represent the most significant aggregate risks from climate change but also the most challenging to incorporate appropriately into the analysis.

### 2.5.3 Alignment with developments in NGFS scenarios

Another useful future development of the ABC Framework will be to revisit and **increase the consistency with the latest NGFS scenarios**[8]. The assessment of physical risks typically involves the need for spatial detailed climate model simulations. The NGFS scenarios, which continue to be important reference scenarios for the financial sector, are limited in the level of spatial granularity around physical risks that they provide. While some of that granularity is available in the IPCC assessments, these are not necessarily easily accessible to financial firms, nor is it easy to judge which IPCC scenario aligns best with which NGFS scenario. In the original ABC Framework specification, a table was provided to map between the IPCC and NGFS scenarios. Consideration should be given to whether this mapping can be improved and updated in light of the most recent developments of the NGFS scenarios.

Enhancing data quality for physical risk assessments using the ABC Framework forms a strong foundation for companies, institutional investors, and financial institutions to improve their recognition of the main exposures impacting their portfolios. By assessing transition risks alongside physical risk, a firm can integrate their strategies together and, where required, prioritise high risk exposures. The next chapter defines how Adaptation-Inclusive Transition Plans can develop the maturity of a company's understanding of climate risk and applicable mitigation responses and how to apply material metrics, KPIs and targets to enhance resilience throughout their operations.

8 NGFS Scenarios Portal

# 3. Integrating resilience into decision-making using adaptation- inclusive transition plans as a framework for thinking

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**Contributors:** *Workshop*: Ira Poensgen (ITPN), Paul Smith (UN PRB), Edd Denbee (GFANZ), Paul Pritchard/Daan van deer Wekken/ Mark Manning (ISO/BSI), Roberto Spacey Martin (Resilience Planet/University of Oxford)

The 2024 CFRF AWG developed a framework outlining actions to integrate adaptation into the Transition Plan Taskforce (TPT) Transition Planning Cycle. This chapter builds on this work to enhance the effectiveness of Adaptation Inclusive Transitions by selection of KPIs and metrics into transition planning. The chapter outlines various approaches to metric selection for different institutions and their applicability, while highlighting the role of enhancing metric maturity and adaptation target setting as a tool to derisk an institution's operations.

## 3.1 Introduction

Adaptation-inclusive transition plans have the potential to be a useful tool for managing climate-related risks systematically across financial and real economy firms and building societal resilience. Many transition plans typically focus on increasing capital flows into decarbonisation but often do not account for the increasing risk exposure and average annual losses (AALs) incurred from the physical impacts of climate change. Effective physical risk assessment and management helps to avoid losses otherwise baked into economic activities under current and future environmental changes, therefore making transition plans more realistic and achievable.

An important method for financial institutions to reduce their physical risk exposure is through engagement to encourage the companies / assets they invest to become more resilient, (which can be supported through various financial mechanisms as covered in Chapter 7). For real economy companies enhancing resilience at an asset or portfolio level can be implemented using a similar template to transition planning, where risks are mitigated and opportunities identified through decarbonisation investment. While it remains essential to build resilience through both direct operations and the wider value chain it is advantageous to develop an integrated approach to managing both physical and transition risk simultaneously.

Effective corporate planning in these areas (including clarity about plans for capital expenditure) is a pre-condition for increasing capital flows into both decarbonisation and adaptation - although it should be assessed alongside dependencies against other factors in an institutional context it should demonstrate a cross-cutting approach.

The extent to which resilience has already been embedded into transition planning is hard to quantify. One of the key recommendations made by the Transition Plan Taskforce Adaptation Primer is to publish a stand-alone Adaptation Plan as a result of an adaptation-inclusive transition planning process, yet evidence shows few organisations have published such a document[9]. In this same vein, the statistics for the first wave of European Sustainability Reporting Standards (ESRS) disclosures show that only 67% of non-financial companies consider climate adaptation to be a material topic, compared to 97% for climate mitigation[10]. A more detailed analysis into the disclosures of S&P 250 companies reveals that, from a comprehensive set of adaptation and resilience decision-useful datapoints, only 20% are covered in current disclosures on average (Spacey Martín et al 2025). These points all suggest a need for further guidance on how to develop adaptation-inclusive transition plans.

To plug this gap, the 2024 CFRF AWG Report developed four broad actions to integrate adaptation into the TPT Transition Planning Cycle (see Table 1).

The review proposed 12 specific adaptation action areas into the TPT framework, highlighting how adaptation considerations can be effectively integrated into transition planning efforts.

9 Climate costs are rising, but few companies have an adaptation plan | S&P Global (spglobal.com)

10 EFRAG - ESRS Reporting Insights

**Table 1: CFRF AWG Adaptation Inclusive Transition Planning Actions**

| Step | Action | How to: |
|---|---|---|
| 1 | **Identify, assess, and prioritise physical-related risks and adaptation** | Screen assets and business plan.<br>Create physical risk assessment (ABC Framework can be used as a starting point) |
| 2 | **Set the ambition** | Create high level objectives and ambitions in relation to adaptation. |
| 3 | **Plan Your Actions** | Construct a plan ideally informed by scenario modelling. |
| 4 | **Implement the Plan** | Action the strategy to inform investment/ lending/underwriting decisions within the planning cycle and begin integrating adaptation into business planning and operations. |

Since then, further market guidance regarding how resilience should be embedded into transition planning has emerged directed at business leaders in the real economy (WBCSD), insurance companies (UNEP FI PRI), commercial banks (UNEP FI PRB), and investors (IIPGCC) more broadly[11]. Simultaneously, policymakers have also published materials highlighting recommended actions on the subject which incorporate similar principles. For example, the NGFS use the same 5 pillars as elements recommended by the CFRF AWG in their recent report on Adaptation Inclusive Transition Plans[12].

Applying this guidance for identifying physical risk exposure and integration across the planning cycle may be a multi-stepped approach which develops over time while simultaneously enhancing resilience. This section aims to address the following:

- Assessing institutional approaches to integrating adaptation into transition planning to recommend best practices.
- Selection of KPIs and metrics that are most applicable to a firm's operations to ensure a strategy is impactful.
- Developing the maturity (i.e., enhancing the effectiveness of a strategy to build resilience) of KPIs and metrics within the adaptation inclusive transition plan.
- Setting Adaptation focused targets.

## 3.2 Approaches to integrating adaptation into transition planning

To create a guidance for implementing Adaptation Inclusive Transition Plans, the CFRF AWG held a workshop in July 2025 aiming to evaluate the position of various institutions' approach to adaptation evaluation and integration into transition planning, with speakers from the ITPN, GFANZ, UN PRB, IIGCC, ISO and experts from the CFRF AWG. Speakers noted various assessment methodologies for integrating adaptation into transition planning and on the emerging acceptance that transition planning needs to move beyond decarbonisation alone and consider a variety of key issues such as adaptation (also nature and social concerns. A key example was presented by ISO who have embedded physical scenario modelling into their upcoming standard for Net zero transition planning for financial institutions[13]. ISO/DIS 32212 is a global standard for Financial Sector Transition Planning that focuses on internal planning processes and places them within a global quality infrastructure. The standard integrates adaptation across its requirements including an assessment of exposure to physical climate risks associated with owned buildings and operations as well as through its financing activities. In doing so it recommends assessing the adaptive capacity of assets and how connected actions leading to deforestation, conversion of natural ecosystems, soil erosion or over extraction of water could lead to increased risks faced by others. The

11 Spacey Martin et al, 2025. See Here

12 NGFS: Adaptation Inclusive Transition Plans

13 ISO/DIS 32212 - Sustainable finance — Net zero transition planning for financial institutions

standard acknowledges that financial institutions can exert leverage in facilitating adaptation, for example by screening their own customer portfolios for physical climate risk and encouraging adaptation in those customers that are heavily exposed.

The workshop concluded with attendees and speakers acknowledging there was an underlying consistent approach of using the elements and planning cycle defined by the CFRF AWG with ongoing collaboration existing between the guest speakers and institutions represented within the AWG. Instead of enhancing the planning cycle, the workshop therefore focused on defining recommendations for best practice to define adaptation KPIs and the maturity of these KPIs for users. To avoid confusion, it should be noted that some forms of metrics may be applicable across different elements of the planning cycle, (e.g., % of assets which have undergone a physical risk assessment for Step 1 or number of clients engaged on resilience for Step 4), to enhance the maturity level within the elements.

This may benefit the overall cycle by highlighting areas of lacking information or inaction across a portfolio that need to be addressed. This aims to support a firm in developing appropriate metrics within these elements that can subsequently improve their overall institutional resilience. In a similar manner, adaptation target setting may be developed as a standalone strategy, it is beneficial to create a synergistic approach with transition financing to avoid future tradeoffs and reduce potential losses as discussed in the TPT's report on Building Climate Ready Transition Plans[14]. The outcome of the workshop highlighted the need for a tailored approach, depending on the nature of an institution's business activities, through relying on the Transition Planning Cycle (and its elements) to form an integrated adaptation plan.

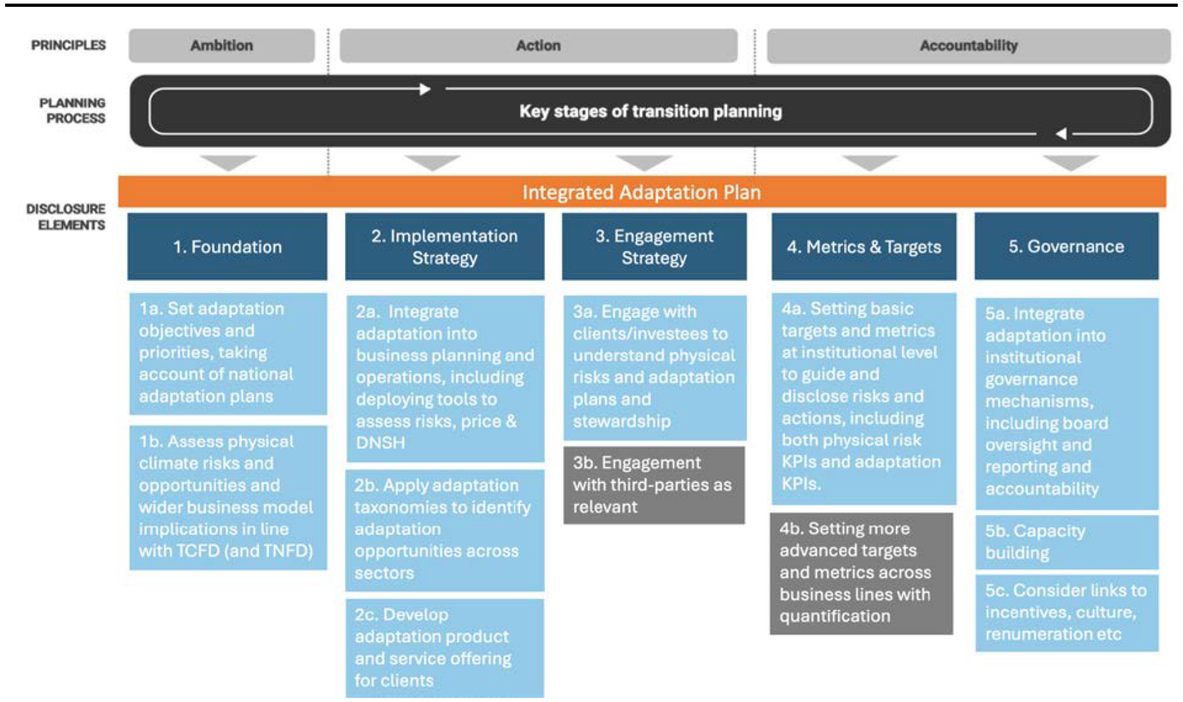


**FIGURE 6: CFRF AWG ELEMENTS OF ADAPTATION FRAMEWORK FOR FIRMS**

14 ITPN: Building Climate Ready Transition Plans

## 3.3 The context for developing adaptation- and resilience-focused metrics

Transition planning for adaptation and resilience does not revolve around a singular metric, as is the case with GHG emissions reduction for decarbonisation. The use of $CO_2$ e-based metrics globally is underpinned by two qualities: universal applicability and uniform effect.[15] The former means $CO_2$ reduction metrics are relevant in all contexts and geographies, while the latter means that benefits are equally distributed irrespective of locations or economies of scale. The certainty between action and outcome is much less clear with adaptation and resilience, due to the multitude of hazards, socio-economic contexts and possible responses. Instead, a set of principles can be followed to ensure metrics track whether actions are aligned with adaptation and resilience, such as building on risk assessment, doing no significant harm to society and nature, aligning with external adaptation plans and measuring a positive contribution to resilience.[16]

To gain a comprehensive insight into the maturity and implementation of resilience planning, multiple types of metrics are therefore needed, including input-, output-, and outcome-based metrics. Input- (or process-) based metrics can be used to monitor the extent to which an organisation has taken measures internally to ensure actions taken yield societal resilience benefits. Output-based metrics, on the other hand, give insight into the quantity of resilience actions an organisation has taken. These metrics could include, for example, capital invested into adaptation solutions, proportion of supply chain engaged on climate-related risk, or wastewater recycled. Outcome- (or impact-) based metrics focus on the quality of resilience actions and are therefore often more resource-intensive to measure. These could include residual risk profiles following resilience actions or water pollution at key sites. A database of adaptation and resilience metrics already used in existing frameworks can be found in Bernhofen et al 2024.

Different metrics can help monitor different elements of adaptation-inclusive transition planning and therefore serve different use cases. When undertaking their own transition planning, financial institutions can define and monitor tailored input- and output-based resilience metrics with relative ease. However, monitoring outcome-based resilience metrics relies on the effective disclosure of other organisations in the value chain.
While integral to transition planning, metrics and targets in adaptation-inclusive transition plans therefore serve two inter-related purposes:

1) consolidate and track one's own strategy to prepare for and contribute to a resilient transition, and
2) inform the progress of adaptation-inclusive transition planning of others (e.g. financial institutions relying on their counterparties, regulators relying on financial institutions, etc.).

**Selecting KPIs**
Market engagement by CFRF indicates there is currently no one-size fits all approach to selecting KPIs as the market is still experimenting and best practice developing. Universal metrics are likely not applicable given the variance in physical risk exposures but the forming an underlying methodology can support resilience development. Inherently, integration of adaptation into transition planning is a tool for risk reduction, avoidance, transfer or in some cases loss – KPIs should reflect and measure this.

Table 2 below outlines generalized examples of KPIs and metrics which can be applied across the elements to support a firm enhance the overall effectiveness of their integrated strategy – where focusing on improving a metric within one element can subsequently improve the outcome of another. For example, increasing the percentage of assets assessed may identify areas of concentrated risk that allow a firm to gain further insight on estimated losses they could be exposure to and lead to improve engagement to inform and act on these exposures. This can then create a reporting cycle that monitors ongoing risk events and associated mitigation strategies in the local context (i.e., improving the foundation step can highlight the need for greater action across the remaining elements).

The format of the table is separated into company focused (such as a real economy firm assessing its asset base) and institution focused (such as a capital provider or asset manager assessing their lending or mortgage portfolios). The rows show examples of KPIs and metrics within each element of the Adaptation Framework in the transition planning cycle (see Figure 6), while the columns show each stage of that adaptation framework from left to right. The table is intended to show that the approach to metric selection is similar but follows slightly different methodological approaches based on the type of company (i.e., increased maturity within the columns indicates an overall higher effectiveness across the planning cycle). It is key to ensure the applicability of selected metrics KPIs to align with an institution's operations (e.g., engagement being a key metric for an asset manager but not as material for an insurer) to enable the maximum derisking potential of an integrated strategy.

15 Leiter, 2022. See Here

16 Climate-Resilient Finance And Investment: Framing Paper: Mullan And Ranger

**Table 2: Assessment of adaptation KPIs across elements of the adaptation framework for transition planning**

| Recommendations for Assessment | Maturity | Kpis linked elements of adaptation framework for transition planning | | | | |
|---|---|---|---|---|---|---|
| | | Foundation | Implementation Strategy | Engagement Strategy | Metrics & Targets | Governance |
| **Company (asset) focused** | Low (starting point) | Implementing risk assessment for key assets | Expanding asset coverage under assessment and improving data quality (e.g., engagement with data providers) | Identify and discuss strategies with assets in high risk ratings or high value assets | Define key hazards and improv data quality | Annual assessments (linked to regulatory or voluntary requirements) |
| | Medium | High % assets covered by risk assessment | Damage assessment of assets and identification of key sites (Implementing ABC) | Identify key resilience strategies or insurance solutions or % CapEx allocated to resilience | Install resilience metrics to derisk assets | Annual assessment of exposure and impact / adequacy of resilience |
| | High (sophisticated approach) | % assets and value chains assessed | Diversification of supply chain from key risk areas | Defined resilience strategy and/or insurance coverage for critical assets – Value chain resilience enhancement (e.g., supplier certifications) | % of assets and resilience with resilience measures embedded in operations | Annual monitoring of suppliers and informing diversification across value chain |

| Recommendations for Assessment | Maturity | KPIs linked Elements of Adaptation Framework for Transition Planning | | | | |
|---|---|---|---|---|---|---|
| | | Foundation | Implementation Strategy | Engagement Strategy | Metrics & Targets | Governance |
| **Institution (portfolio) focused** | Low | Portfolio level risk assessment (exposure basis) | Enhance asset coverage and identify high risk clients | Engage with clients to improve data coverage (% engaged) | Minimum regulatory requirement for % portfolio assessed | Measure and report methodology and ECLs |
| | Medium | Detailed physical risk assessment of portfolio and assets / companies within | Full ABC scenario implementation | Design/offer Adaptation focused financial products (see Chapter 7) | Adaptation focused products tailored to specific hazards client engagement | Annual refresh of climate risk assessment to inform risk prioritisation |
| | High | Full coverage physical risk assessment | Client by client risk assessment with exposure details with estimated ECLs | Offering tailored financial products or advisory based on client adaptation maturity | High risk exposure engagement, adaptation and resilience business strategy with relevant targets (e.g., # clients, revenue generated) | Adaptation finance team, internal frameworks, tailored risk assessments, integrated physical risk assessment |

## 3.4 Assessing the applicability of adaptation metrics and maturity for implementation

As shown above, metrics are needed along every step of the adaption-inclusive transition planning process, especially when addressing issues such as data gaps or inconsistent physical risk assessment methodologies. A maturity scale is inherent to metric selection, which underlies a firm's progress over time. For example, if a metric aims to improve the percentage of a portfolio analysed by physical risk assessment, future metrics should include resilience requirements relevant to the findings of that assessment (e.g., an asset has high risk exposure to flooding, while all supply chains are susceptible to drought/heatwave/wildfire and hence future metrics and implementation should highlight concentrated supply chain risk and transfer through diversification or supplier engagement).

Importantly, the role of these metrics should be complementary with other environmental objectives contained in transition plans, and should incorporate synergistic benefits (e.g., supplier diversification with applicable sustainable certifications). The IIGCC's Climate Resilience Investment Framework (CRIF), for example, is designed to complement the Net Zero Investment Framework, while being informed by the Physical Climate Risk Appraisal Methodology (PCRAM). CRIF and NZIF feature similar guiding principles allowing a firm to incorporate a single approach to integrating physical and transition risk assessments, (i.e., dual use of the frameworks enable co-management and integration of climate risks). Metric and KPI selection should aim to enhance performance in line with regulatory reporting standards and applicability of physical risk exposures. The maturity of a set of metrics should therefore be based on applicability as well as relevance of targets alongside their impact. The following case studies define the benchmarking methodology for measuring companies on adaptation and resilience based on their metric reporting which can guide metric selection.

### 3.4.1 Case study: developing metrics to assess companies on adaptation and resilience

Unlike with decarbonisation, no benchmarking methodologies exist for resilience which facilitate the comparison of companies and portfolios. Researchers from London School of Economics and Political Science, with the support from ClimateArc, have developed the first corporate benchmarking methodology for resilience - ResilienceArc. The framework comprises 5 high-level metrics, 16 sub-metrics and over 75 indicators, drawing on a mixture of asset-level data and corporate disclosures to assess how aligned a company is with resilience.

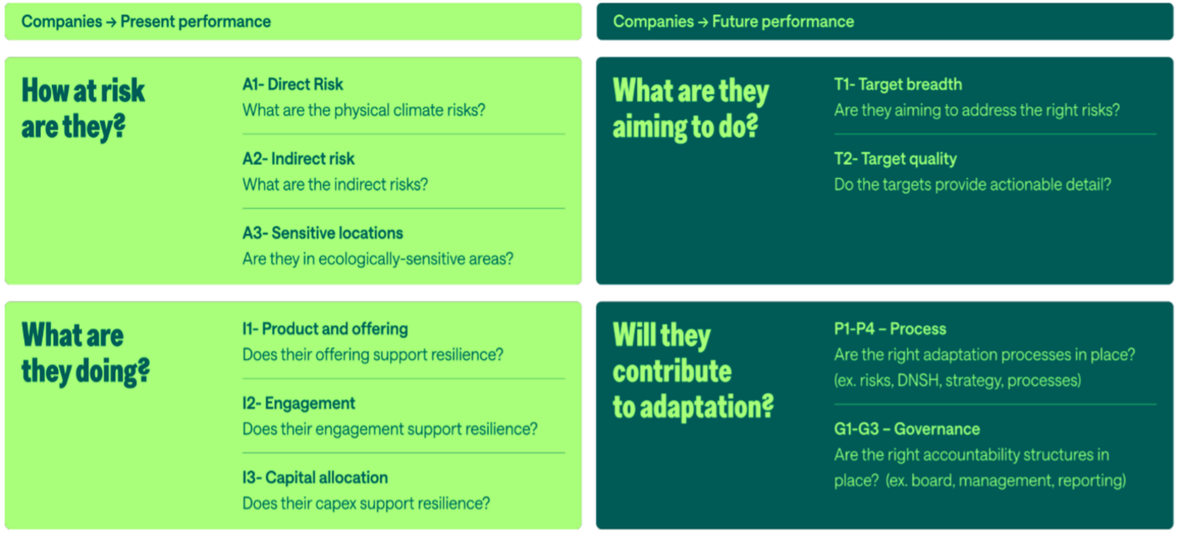


FIGURE 7: OVERVIEW OF RESILIENCEARC ASSESSMENT

To guide metric selection, the assessment builds on the enhanced adaptation-inclusive TPT framework presented in the 2024 CFRF AWG report, other resilience-related frameworks (including TCFD, TNFD, ACT Adaptation), as well as the resilience-aligned principles for finance set out in Mullan and Ranger (2022). The methodology includes both process-based and output-based metrics, but not outcome-based metrics to facilitate comparison and avoid making normative judgements on acceptable levels of risk. Metrics have undergone expert review and will undergo further review by prospective users of the assessment tool to ensure applicability for financial decision-making. As such, the benchmark provides initial insights into how information found in adaptation-inclusive transition plans can guide financial decision-making.

In combining asset-level data and corporate disclosures, ResilienceArc promises to deliver the next generation of climate-related risk assessments at the company level. The data produced will enable users to identify where a company is materially exposed to risk, while at the same time understanding what actions, targets and processes the company has undertaken to address these. These datapoints could be combined to develop aggregated residual risk profiles or bespoke analytics to inform financial decision-making across risk assessment, client engagement and capital allocation.

## 3.5 Setting effective adaptation-related targets

As is the case with metric selection, defining relevant adaptation targets is also an iterative part of the transition planning process. In transition planning, targets are set to define an organisation's intended decarbonisation trajectory. Effective targets allow an organisation to account for its progress, while also highlighting the steps taken to achieve these and the challenges encountered.

Adaptation targets, like metrics, can follow a maturity scale. For example, the latest UNEP FI PRB adaptation guidance (2025) differentiates between three levels of maturity, informed in part by whether an organisation's targets focus on its practices or its impacts. Practice targets use process- or output-based metrics to capture organisational activity with regards to adaptation, while impact targets use outcome-based metrics to capture how an organisation is contributing to societal resilience.

Across all sets of adaptation targets, a common set of principles can further guide their definition. Targets should be Specific, Measurable, Achievable, Relevant and Time-bound (SMART). In the context of adaptation, this means that targets should reflect a company's business activities as well as the specific climate-related risks and opportunities it has identified. They are underpinned by appropriate metrics, which are partly driven by what an organisation can realistically measure at a given point in its transition planning journey – the assumption being that data quality and available information increases over transition planning iterations. Practice targets may also be complemented by metrics that ensure actions taken by an organisation do not lead to maladaptation in its direct operations or cause significant harm to others across society.

Once an organisation defines its adaptation targets, their suitability can be assessed internally and by others in the value chain. Adherence to the principles above informs this assessment. Further credibility can be given to an organisation's adaptation targets if these are approved by senior leadership or the Board. In many instances, evaluating the extent of an organisation's ambition on adaptation, encapsulated by its targets, requires normative assumptions about risk appetite or appropriate contributions to societal resilience. Organisations may therefore refer to external national, subnational or sector-based adaptation plans to further legitimise the suitability of their targets.

These points have important implications for the extent of adaptation information financial institutions need from their clients or counterparties. For example, when setting portfolio-level risk-based targets, an investor needs to be able to define to which perils its portfolio will be resilient, at what hazard intensities (e.g. expressed in return periods), in what geographies, and at what timeframes. To track performance against these targets, portfolio companies must therefore report their adaptation targets with information on the perils, assets, geographies, and hazard intensities covered, as well as the timeframes the portfolio company seeks to achieve these. As a result, financial institutions, through their exposure to a wide set of firms across the economy, are well-positioned to drive improved data quality in their value chains as part of their adaptation target-setting journey and broader transition planning iterations.

**Summary**

Adaptation-inclusive transition plans are essential to ensure that resilience is systematically embedded alongside decarbonisation. Developing appropriate metrics and targets helps institutions integrate physical risk considerations into strategy, investment, and disclosure. The priority next step is to refine metrics and targets, strengthen disclosure practices, and align transition planning frameworks so that resilience becomes a standard component of financial and corporate decision-making.

Building on the guidance herein, the CFRF AWG aims to expand on metric selection to create tailored guidance for different institutions. This will focus on specific examples through expansion of the KPIs and metrics within the planning cycle and highlighting the value of governance to ensure compliance with emerging mandatory reporting standards that should be used to address material physical risk exposure and enhance overall resilience.

# 4. Getting practical #1: integrating physical risk into credit modelling to support adaptation-focused investment

**Writers:** Holly Roberts-Harry, Mark Bernhofen, Alex Kennedy, Peter Delaney, Tammy Tan, Michael Harmon, Anne Chataigne
**Contributors:** Stafford *(PCRAM case study)*

This chapter outlines how physical climate risks, and the benefits of resilience investments can be quantified and embedded into forward-looking credit risk modelling. By linking physical risk to expected credit losses and probability of default, a pathway is offered for banks and insurers to more accurately price climate-related financial risks and recognise the value of adaptation. This foundational work supports the mobilisation of capital by showing how resilience strengthens borrower credit quality and reduces portfolio-level risk.

## 4.1 Introduction

Companies with assets exposed to extreme physical risk are more vulnerable to financial losses and estimates show that without resilience investment, these will cost firms an average of 3.3% per annum of asset value (and up to 28%).[17] Research indicates that the economic benefit per dollar invested in resilience ranges between USD2- USD20 with larger impacts expected to be felt in emerging markets with typically higher sensitivities.[18] Financial losses caused by physical risk hazards – both acute and chronic - can materially impact a company's balance sheet[19] through disruption to direct operations, supply chains and productivity losses,[20] and drive up the cost of insurance or limit access to insurance entirely.

Annual loss estimates are often informed by the occurrence of an event, creating awareness that resilience measures against specific risks are required. Generally, information on the installation of forward-looking resilience planning isn't incorporated into project pricing unless generic considerations are built into the project development plan (at an asset level), and resilience requirements may be considered during a 'Do No Significant Harm' (DNSH) assessment or Climate Change Risk Assessment (CCRA), e.g., a financial institution may advise a project on resilience needs if they are an Equator Principal signatory.

In practice, companies often believe that the additional cost to enhance resilience is not deemed essential – or at least is a cost that can be deferred to some future date - which results in lacklustre investment in resilience measures and the 'bare minimum' being incorporated. This is in contrast to well documented risks, as seen in countries with frequent seismic activity, companies typically implement foundational resilience measures which allow for risk transfer solutions to be developed.

For example, residential insurance coverage has materially increased under the Taiwan Residential Earthquake Insurance Fund (TREIF) since the 1999 Chi Chi earthquake, with 37.85% of households owning policies in 2023 compared to 1% in 2002. Taiwan has also updated building regulations nationally and monitors requirements every 3-5 years while implementing enhanced assessment methodologies[21]. These examples of resilience investment were triggered by the occurrence of an event that had a catastrophic impact and hence implemented to minimise the impact of future events, rather than proactively assessing potential impacts for worsening risks or 'shocks' that may not be considered. Proactive and considered planning for Expected Credit Losses (ECL) should be prioritized.

For banks in the UK, the PRA has proposed expectations for bank to have the necessary practices and policies to identify climate-related risk drivers of ECL so they can recognise climate-related risks within ECL in accordance with applicable accounting standards (including where they inform economic scenarios and weightings). Firms should also consider processes needed to allow for utilisation and enable the challenge of the ECL calculation and to inform post-model adjustments, to allow for modifications to financial models, primarily to account for novel risks, data limitations, or model inaccuracies that the primary model cannot capture (in this case to capture the benefits of resilience). This enables the identification of controls needed to enable reviewing and monitoring of how climate-related risk drivers have been incorporated into ECL calculations.[22]

For insurers (subject to the relevant obligations), the PRA has proposed an updated methodology to ensure that an insurer's Own Risk and Solvency Assessment (ORSA) sufficiently incorporates the potential impact of climate-related risks to the sufficient 'depth and granularity' that is expected. The proposal aims to ensure Solvency Capital Requirements (SCR) are not under-estimating the impact of climate-related risks that insurance companies may be vulnerable to through their underwriting and investment activities. Furthermore, the proposal expects a clearer link between climate risk analysis and business decision-making for both investment and underwriting activities. Hence, the proposed changes may also encourage insurers to look more closely at how they can incentivise and reward the implementation of resilience measures that reduce the Probable Maximum Loss (PML)

17 Quantifying the financial costs of climate change physical risks for companies | S&P Global

18 SCB - The Adaptation Economy

19 Physical Risk Scores and Financial Impact Methodology Guide

20 ITPN - Adaptation Primer

21 Chi Chi Earthquake 25th Anniversary (guycarp.com)

22 CP10/25 – Enhancing banks' and insurers' approaches to managing climate-related risks – Update to SS3/19 | Bank of England

and Average Annual Loss (AAL) metrics used in underwriting calculations, and maintain or increase creditworthiness of investment assets.

Given limitations in data availability, there is no consistent, universal methodology available for assessing asset- or portfolio-level losses due to increasing physical risks. The work of the CFRF AWG has focused on the development of a generalised proprietary tool, using accessible models, that can be modified for asset- or company-specific requirements. The open-source framework for quantifying the financial impacts of acute physical climate risks, published by Kerkhofs et al. (2025),[23] is an example of an approach that simulates the losses from extreme events due to direct damages and business disruption. The framework uses an integrated discounted cash flow (DCF) model which incorporates physical losses on free cash flow (FCF) leading to change in probability of default (PD). For this report, the framework was modified to incorporate the impact of asset-level resilience measures.

This analysis is for illustrative purposes only. The CFRF AWG has considered the following hypothetical examples to show how the integration of physical risk losses may be assessed. Figure 8 shows the high-level methodology applied to a synthetic portfolio of assets, mirroring a banking portfolio, exposed to flooding in Thailand. This approach could be modified for other risks, markets, or sectors.

## 4.2 Illustrative assessment of physical risk losses for a banking portfolio exposed to flooding in Thailand

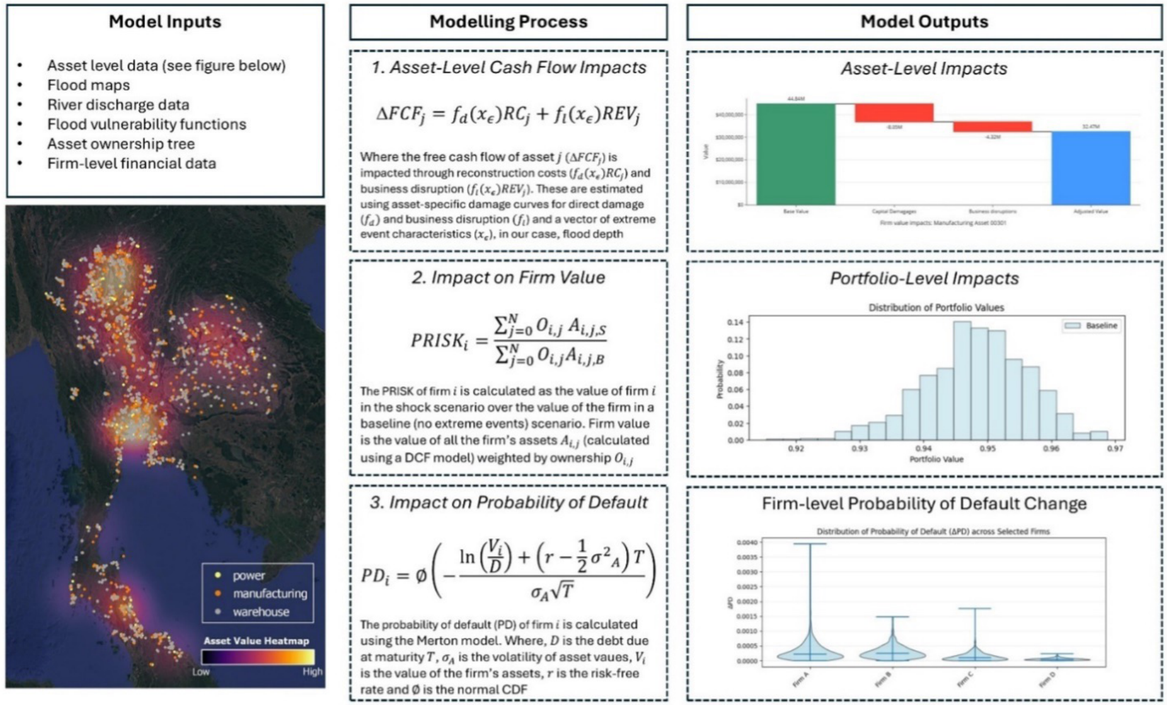


FIGURE 8: OVERVIEW OF THE ASSET-LEVEL FINANCIAL RISK METHODOLOGY APPLIED TO A SYNTHETIC PORTFOLIO OF ASSETS IN THAILAND

The model was applied to a synthetic portfolio comprising 1,750 assets distributed across 60 hypothetical companies operating in Thailand. The portfolio of assets consisted of power plants, manufacturing facilities, and warehouse assets. Each asset was assigned a plausible location and characteristics, ownership of assets was assigned to companies, and financial data was generated for each company to mimic a hypothetical bank portfolio.

Impacts were assessed at the asset-level, using flood hazard maps and asset-specific damage functions. Losses were aggregated to the firm-level and an equally weighted portfolio of all 1,750 assets using Monte-Carlo simulation. Two scenarios were considered: a baseline scenario where asset-level flood protection was assumed to be equal to the existing level of flood-protection in the sub-national region the asset was located; and an adaptation scenario, where 15 companies (421 total assets) increase flood protection of their assets to protect against a 100-year flood.

The results from both simulations are shown in figures below. Figure 9 shows distribution of values for a portfolio of all 1,750 assets in Thailand. The rightwards shift of the distribution captures the impact of the adaptation investments for 24% of the assets. In the baseline scenario, the average portfolio value change (relative to the portfolio value assuming no extreme events) due to flooding is 5.2%. In the adaptation scenario, this value is reduced to 4.3%. The 99% Value at Risk (VaR) for the portfolio in the baseline scenario is 7.2%, reducing to 6.2% in the adaptation scenario.

23 Kerkhofs et al, 2025. See Here

### Distribution of Portfolio Values

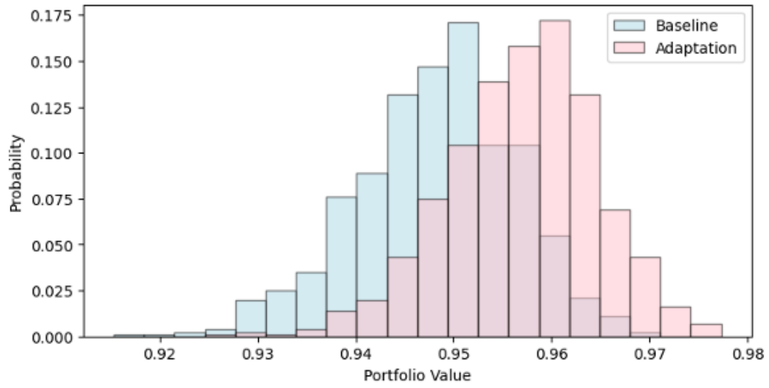


**FIGURE 9: DISTRIBUTION OF PORTFOLIO VALUES IN THE BASELINE AND ADAPTATION SCENARIO**

The model also shows how adaptation investments can reduce the Probability of Default (PD) of firms. Figure 10, below, shows the distribution of PD values for "Thailand Holdings Company 027" for both the baseline and the adaptation scenario. The figure shows that the adaptation intervention significantly reduces the firm's PD. The average change in PD for "Thai Holdings 027" under the baseline scenario was 10 basis points. This reduced to 1 basis point in the adaptation scenario. Tail (99th percentile) PD values were reduced significantly by adaptation, from 78 basis points in the baseline scenario to 16 basis points in the adaptation scenario.

### Thai Holdings 027

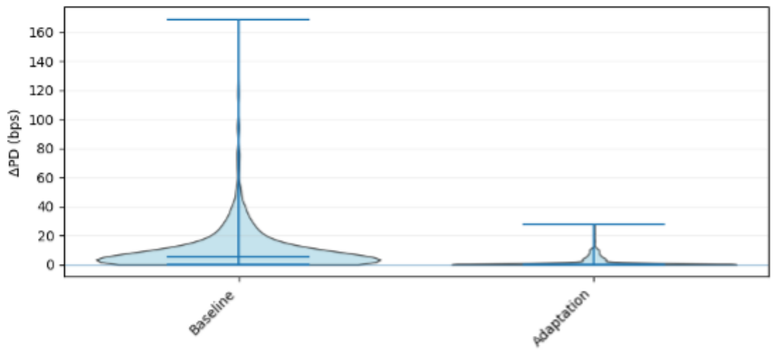


**FIGURE 10: CHANGE IN THE PROBABILITY OF DEFAULT (ΔPD) DISTRIBUTION FOR COMPANY "THAI HOLDINGS 027" FOR BASELINE AND ADAPTATION SCENARIO**

At the asset level, investments in resilience can reduce both direct damages and business disruption. In Figure 11, the loss-exceedance curve is plotted for "Warehouse Asset 01085" for both the baseline and adaptation scenario. This specific asset had no baseline flood protection, and in the adaptation scenario, the design protection was increased to protect against a 1-in-100-year flood. This plot shows that adaptation reduces the Average Annual Loss (AAL) of the asset from USD19,724, in the baseline scenario, to USD11,612, representing a nearly 92% decrease.

### Warehouse Asset 01085 Loss-Exceedance Curve (Baseline vs Adaptation)

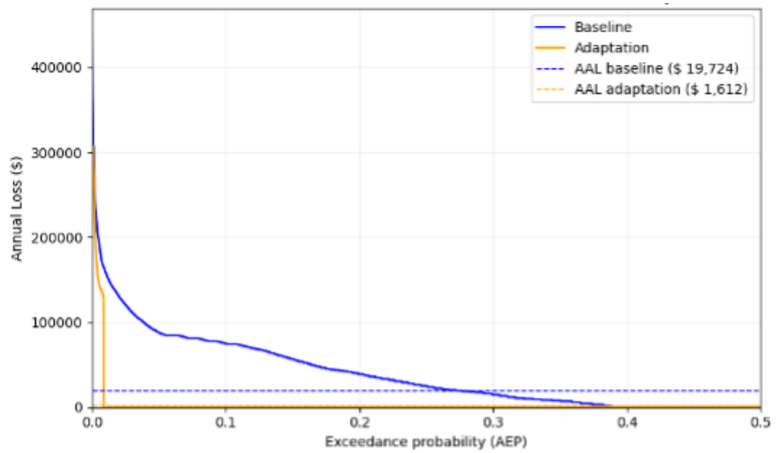


**FIGURE 11: BASELINE AND ADAPTATION SCENARIO LOSS-EXCEEDANCE CURVES FOR WAREHOUSE ASSET 01077**

This reduction of estimated Average Annual Losses (AAL), achieved by investing in resilience measures, should in theory lead to an improvement in insurance terms over the lifespan of the project. While there are case studies that point to the relationship between resilience investment and an improvement in insurance terms, there is more work to be done to evidence this link.

Applicability of resilience measures to these models show that investment in adaptation reduces the loss probability dramatically, not only retaining financial returns but also protecting access to capital for future developments and loan repayments. For a credit provider, where possible given the granularity of a portfolio assessment, the losses should be minimised either through client level risk assessment or in a similar manner to protected vs unprotected flood assessments. Application of these measures are limited by data availability – an example of enhancing this quality may be through regulatory requirements.

### Common resilience metrics for financial decision-making

Reductions in PD and AAL resulting from resilience measures could be integrated into a common set of resilience metrics for use across the financial sector. Establishing such metrics would help standardise how risk-reducing investments are assessed and valued by financial actors, supporting more consistent and transparent decision-making. This could form a component of work for future CFRF AWG cohorts, helping to build the evidence base and drive alignment across credit, insurance, deal flow and investment practices.

### 4.2.1 Case study: PCRAM

The PCRAM 2.0 case studies (Howden, IIGCC 2025), demonstrate the potential to reduce the vulnerability of investments in real assets to physical climate risks by incorporating resilience measures, that could lead to improved access to capital and improve affordability of insurance.

Stafford, through its direct investment platform Theia, actively manages renewable energy assets in its SISF II and SISF IV funds, with physical climate risk being an important element of its risk management strategy. The development, by the IIGCC, of PCRAM offered Theia a chance to enhance its investment risk management approach and contribute to a broader industry initiative aimed at improving climate resilience in infrastructure portfolios.

As part of the PCRAM 2.0 case study, Theia selected a PV plant in Northern Italy to apply PCRAM's gated methodology. The study identified acute hailstorms and chronic heat stress as key risks and evaluated resilience measures such as misting systems and polymer coatings. These measures were assessed for their cost-effectiveness and impact on asset performance. PCRAM proved valuable in linking climate risks to financial outcomes, supporting Stafford's and Theia's integration of the tool into its due diligence and portfolio monitoring practices.

However, we also concluded that some methodological limitations for investors remain, such as the partial integration of insurance considerations and the potential misalignment between resilience benefits and fund lifecycle constraints. The study also highlighted the need for broader market recognition of resilience value, suggesting that insurers and lenders could play a key role in driving adoption and valuation of climate-resilient assets. The CFRF AWG will expand on this next year with a focused working group.

### Summary

Physical climate risks have clear financial impacts, and traditional credit models underestimate them when they fail to account for resilience. Integrating adaptation into credit modelling shows that resilience investments can reduce losses, improve credit quality, and strengthen financial stability. Further work is needed to develop common resilience metrics, improve data availability, and encourage regulatory alignment so that adaptation benefits are consistently valued in credit risk assessments.

# 5. Getting practical #2: integrating adaptation into sovereign credit assessments

**Writers:** Valentina Ramirez, Swenja Surminski, Mark Bernhofen, Tammy Tan, Peter Delaney, Matt Burke, Camila Cristancho, Chandra Gopinathan, Hamish Stewart, Anne Chataigne, Alex Kennedy, Nicola Ranger
**Interviewees:** *ADB, Aberdeen Investments, AP7, ASCOR, BP Pension Trustees, FIL, Fitch Ratings, RCLM: Moody's Ratings, MunichRe, NGFS, NinetyOne, PGIM, PIMCO, PKA, S&P Global Ratings, Saltmarsh Economics*

This Chapter examines how national adaptation efforts influence sovereign creditworthiness, borrowing costs, and access to international finance. It presents empirical evidence and modelling that physical climate risk is already impacting sovereign spreads and ratings—particularly in vulnerable economies—while adaptation remains under-recognised. Addressing this gap is essential to enabling fiscally constrained countries to attract investment for resilience and ensure financial markets support, rather than penalise, early adaptation action.

## 5.1 Climate–aware sovereigns: considering physical climate risk and adaptation

A country's credit quality (i.e., the creditworthiness of the sovereign) determines its cost of borrowing (i.e., the yield of its sovereign bonds), which in turn influences the borrowing costs of the private sector. A growing body of research underscores the compelling economic case for early investment in adaptation and resilience.

Reports consistently suggest that every dollar spent today can yield significant returns in the future, ranging from USD2 to USD43 in avoided losses and recovery costs, depending on the market and sector[24]. A recent analysis focused on the UK, estimates benefit-cost ratios of 2:1 to 10:1, meaning each GBP1 invested could generate GBP2 to GBP10 in economic gains.[25]

In interviews held between June and August 2025 by the paper authors with a broad range of stakeholders including institutional investors, Credit Rating Agencies (CRAs), data providers, banks, insurers, and multilateral development banks, there is **broad consensus that physical climate risks are increasingly influencing sovereign credit assessments, particularly for highly vulnerable countries**. Most stakeholders, however, emphasised that short-term climate risk forecasting remains constrained by data and modelling gaps, while long-term assessments are complicated by uncertainty around global warming trajectories.

At the same time, **despite clear evidence that large-scale adaptation efforts can significantly reduce vulnerability and prevent future losses[26], their economic impact is still not sufficiently reflected in sovereign credit assessments**.

This suggests that financial markets are currently mispricing both climate-related risks and the value of adaptation efforts that build resilience and reduce vulnerability. Adaptation and resilience investments can reduce sensitivity by altering the inherent characteristics of an economy that make it vulnerable, for example, by upgrading infrastructure, diversifying crops, or improving health systems. Adaptation and resilience investments can also enhance adaptive capacity, increasing the country's ability to adjust, respond, and recover, for example through early warning systems, institutional strengthening across critical sectors, or access to climate finance. While these measures do not reduce exposure or the hazard itself, they significantly improve the country's ability to cope with and adapt to climate change impacts.

Crucially, if investors, insurers, and finance providers focus solely on reducing short- and medium-term exposure to physical climate risks, they risk exacerbating systemic vulnerability over the long term. This, in turn, constrains a country's ability and capacity to invest in essential adaptation measures. Thus, it is critical that credit assessments recognise the value of early resilience-building efforts to help direct capital to countries where it is most needed.

## 5.2 Entry points and green shoots

Most stakeholders continue to prioritise near-term concerns, with limited recognition of tail risks such as the potential impacts of climate tipping points, and insufficient attention and support for strengthening adaptive capacity and or reducing sensitivity to reduce vulnerability and avoid future economic and social losses. Encouragingly, progress in data quality, interdisciplinary collaboration, and the growing sophistication of climate risk analysis is deepening our understanding of adaptive capacity and enabling more informed, forward-looking decision-making, with momentum continuing to grow by the presence of adaptation and resilience taxonomies.[27] This is evident in the issuance of green and resilience bonds at corporate and country levels with more proceeds flowing to adaptation. Equally, subnational and regional action is becoming more common as assessments highlight the increasing complexity of global challenges. These are partially driven by growing investor and market pressure which support financial institutions and policymakers to make more informed decisions in response to escalating climate risks. Collaboration between disciplines and stakeholders demonstrated that resilience investments (e.g., PCRAM case studies)[28], can enhance value.

24 Building resilience through climate adaptation (jpmorgan.com)

25 See Watkiss, P (2022), Here.

26 Bernhofen et al, 2024. See Here

27 Taxonomies Database | Environmental Change Institute

28 PCRAM in Practice: Outputs and insights from climate resilience in action (iigcc.org)

## 5.3 Empirical evidence: the impact of physical climate risk and adaptation on sovereign credit risk assessments

Sovereign credit assessments are constantly run by market participants, whose views are reflected in market signals such as bond yields (the price of debt), default spreads (the difference in yield between a particular sovereign and 'risk-free' or highest quality bonds), and Credit Default Swaps (the price of insurance against default). They are also conducted by CRAs, whose job is to evaluate an issuer's ability to repay its debt in the near term.

### 5.3.1 Physical climate risk affects the credit quality of the most vulnerable countries

**Physical climate risks pose a material risk to government finances through both macroeconomic and contingent liability channels** (Volz et al, 2020).[29] The increasing frequency and severity of extreme events inhibits economic growth, which can impact government revenues. At the same time, the fiscal costs of climate-related disasters are significant as governments have to pay for reconstruction and recovery and will often act as insurers of last resort. The costs of physical climate risks can negatively impact a country's debt sustainability, and as a result their creditworthiness (Zenios, S., 2022).[30] For example, following the 2022 floods in Pakistan that affected 33 million people and led to economic losses and damages of USD30 billion, Fitch downgraded Pakistan's credit rating from B- to CCC+ citing deteriorating external liquidity and falling exchange reserves, worsened by the fiscal impacts of the flooding (Fitch, 2022).[31]

Research suggests that countries highly exposed to physical climate risks face higher costs of debt. In an econometric analysis of 46 countries, Kling et al (2018)[32] found that the most climate-vulnerable countries pay a risk premium on their debt. Similarly, Bingler et al (2022)[33] found that the long-term bond yields of lower rated countries' (AA- and below) increased with climate risk exposure, while Beirne et al (2021),[34] found a similar "climate risk premium" on sovereign debt in Southeast Asian countries. **These studies suggest that physical climate risk is starting to be priced into some sovereign debt markets.** This risk premium reflects market expectations that climate-vulnerable countries may face greater fiscal stress and higher default probabilities. In a study of 116 countries between 1995-2017, Cevik and Jalles (2021)[35] confirmed this relationship empirically, finding that countries with greater climate risks had measurably higher default probabilities, with the effect being most pronounced in low-income countries.

**Empirical evidence suggests that climate risk exposure has had a downward effect on a country's credit rating, particularly for developing countries and those with lower ratings** (Sun et al, 2023,[36] Cevik and Jalles, 2020).[37] The sovereign rating impacts of climate change could get worse in the future. When combining future climate-change macroeconomic loss projections with an empirically derived sovereign rating model, Klusak et al (2023)[38] find that 59 countries could face downgrades as early as 2030 (0.68 notch average), rising to 81 countries (2.18 notch average) by 2100.[39]

### 5.3.2 Credit risk sensitivity to adaptation varies widely across countries

**Research connecting a country's adaptative capacity to its credit risk assessment remains limited and faces some challenges for researchers.** Resilience of a country to climate change and it being considered creditworthy may both be outcomes of similar economic and institutional processes. To evaluate readiness (i.e., a country's ability to leverage investments and convert them into effective climate adaptation actions), the Notre Dame Global Adaptation Index (ND-GAIN) data relies on similar variables that have been shown to already be meaningful for credit risk assessment (De Moor et al, 2018).[40] This observation drives some of the empirical challenges underpinning this work.

Despite this, researchers that have variously applied the ND-GAIN data in this context to evaluate resilience and adaptive capacity (see Cappiello et al, 2024;[41] Ferrazzi et al, 2021 and Cevik & Jalles, 2022)[42] find that adaptive capacity is important for credit outcomes. Other work relies upon underlying macroeconomic models that incorporate adaptation as an intrinsic component in their model (Klusak et al, 2023).[43] This body of work connects deviations of temperature and precipitation to macroeconomic fundamentals, where it is deviations from a baseline that drive economic consequences. The principle behind this idea is that economies will naturally adapt over a medium-term horizon. For example, in a fast adaptation scenario, the economy is sensitive to deviations from a twenty-year average temperature baseline. A slower adaptation scenario may consider windows of up to 40 years (see Mohaddes & Raissi, (2024)[44] and Kahn et al, (2021)[45] for a discussion on this class of models).

**Research shows that credit risk outcomes are sensitive to these adaptation assumptions and, the difference in the credit impact between slow and fast adaptation is much larger for some countries than it is for others** (Klusak et al, 2023; Bernhofen et al. 2024).[46]

Examples of recent work that deviate from both of these approaches include Bernhofen et al (2024).[47] This work constructs a bespoke climate flood risk assessment for Thailand, uses the IMF's DIGNAD model to evaluate the impact on the economy and finally, uses the same credit risk model in Klusak et al (2023) to establish credit risk impacts. This work avoids the empirical challenges described above and incorporates adaptation directly, as described in Section 4.2.

29 Volz et al, 2020. See Here.
30 Zenios, S., 2022. See Here.
31 Fitch, 2022. See Here.
32 Kling et al, 2018, See Here.
33 Bingler et al, 2022. See Here.
34 Beirne et al, 2021. See Here.
35 Cevik and Jalles, 2020. See Here.
36 Sun et al, 2023. See Here.
37 Cevik and Jalles, 2020. See Here.
38 Klusak et al, 2023. See Here.
39 This is assuming the most extreme, RCP 8.5, emissions scenario
40 De Moor et al, 2018. See Here.
41 Cappiello et al, 2024. See Here.
42 Cevik & Jalles, 2022. See Here.
43 Klusak et al, 2023. See Here.
44 Mohaddes & Raissi, 2024. See Here.
45 Kahn et al, 2021. See Here.
46 Klusak et al, 2023. See Here.
47 Bernhofen et al, 2024. See Here.

In summary, the empirical evidence suggests that physical climate risks are increasingly reflected in sovereign credit markets, especially for vulnerable countries, while the role of adaptation in shaping creditworthiness remains uneven and under-integrated.

### 5.3.3. Finance and insurance providers are starting to assess country's adaptation efforts

**Despite the strong economic rationale for large-scale adaptation efforts to reduce vulnerability and avoid future losses,[48] the financial case in the short term remains underappreciated**. Although finance and insurance providers are starting to assess country's adaptation efforts and support resilience investment to some degree, **most stakeholders continue to focus primarily on risk mitigation**. Improving understanding of the economic benefits of adaptation and strengthening the financial case for near-term investment in adaptation and resilience is essential to unlock further private investment, especially in emerging and developing economies.

#### 5.3.3.1 Institutional Investors

**Institutional Investors** (pension funds and asset managers) **are at different stages in assessing both physical climate risks and adaptation efforts of sovereign bonds issuers**. When assessing risk, investors often report struggles with scenarios analysis that are granular enough to be decision useful, but there is consensus that data and modelling is rapidly improving. Some pointed out that short-term climate risk forecasting remains constrained by data and modelling gaps, while long-term assessments are complicated by perennial uncertainty around current global warming trajectories. Those who are more climate change aware are carefully assessing both physical and transition climate risks, as well as adaptation and mitigation plans in tandem with a country's fiscal capacity to implement them, appreciating that lower-income countries face significant budgetary constraints. From a portfolio management perspective, investors are concerned not only with a country's credit profile in the long run, but also with market directionality—that is, how risks are currently priced by the market and the likelihood of those risks being re-priced over a 1–2 year horizon.

**Institutional investors are increasingly recognising opportunities to channel funds into climate** adaptation and resilience **at both national and subnational levels, notably through the bond market.** Some expect further growth, supported by adaptation and resilience taxonomies, such as the Climate Bonds Resilience Taxonomy,[49] which provide clear guidance on what qualifies as a resilient investment. For example, jurisdictions like Hong Kong have begun integrating climate adaptation into the use of proceeds for green bonds, directing funds toward infrastructure upgrades to withstand events like typhoons.

Lastly, investors also noted that **subnational entities are becoming important entry points for channelling finance into climate adaptation and resilience.** Some are increasingly engaging with these issuers, requesting detailed adaptation plans and fiscal risk assessments, often supported by consultancies that help quantify the costs of inaction. While this kind of dialogue is emerging at the sub-sovereign level, similar practices are still largely absent in the sovereign bond space, suggesting a missed opportunity for broader systemic impact.

#### 5.3.3.2 Commercial banks

Commercial banks are becoming increasingly sophisticated in their approach, assessing both risk and adaptive capacity to shape overall strategy, support internal decision-making, and guide government lending activities. For example, Standard Chartered uses a set of Physical and Transition Risk rankings to identify the markets most vulnerable and least ready to adapt and mitigate climate-related Physical and Transition Risks. These rankings are used as qualitative and quantitative inputs to internal Country Risk management process spanning annual sovereign credit grades and limits reviews, inputs to climate-related scenario analysis, and Risk Appetite.[50]

As a key source of funding for national governments, adaptation and resilience investments represent a massive win-win opportunity for banks and financial institutions: not only do they open avenues for expanding lending, but they also enhance the creditworthiness of recipient countries by reducing climate-related fiscal risks. Standard Chartered's Adaptation Economy Report examines the need for adaptation investment in 10 developing markets (Bangladesh, China, Egypt, India, Indonesia, Kenya, Nigeria, Pakistan, the UAE and Vietnam).[51] For the 10 markets in this study, failure to invest an estimated 30.4 billion this decade – the minimum projected level to adapt to climate damages as they occur – could lead to a cost of USD376.6 billion in damages and lost growth by the end of 2030 (in a 1.5°C warming scenario).

#### 5.3.3.3 Multilateral Development Banks (MDBs)

**For concessional funders like multilateral development banks, credit quality assessments typically have a short to medium term horizon**, limiting visibility of long-term impacts from climate resilience or adaptation efforts. However, adaptation costs and benefits are increasingly being quantified, based on estimated losses and adjusted for fiscal capacity.

The *Triple Resilience Dividend*[52] concept provides a compelling framework for evaluating climate adaptation investments, especially for entities with a dual mandate –both developmental and financial. It highlights three layers of benefits: reduced losses from climate impacts, increased economic activity, and wider co-benefits such as improved

48 Bernhofen, M.V., et al (2024). See Here.

49 Climate Bonds | Climate Bonds Resilience Taxonomy

50 Annual Report 2024 | Standard Chartered (sc.com)

51 Adaptation economy | Standard Chartered (sc.com)

52 Tanner et al, 2015. See Here

health, social cohesion, and ecosystem services. This approach underscores the case for early and strategic investment in resilience, especially in developing markets.

MDBs have pioneered the issuance of adaptation and resilience bonds to scale climate adaptation finance. In 2019, the European Bank for Reconstruction and Development (EBRD) issued the world's first dedicated climate resilience bond, raising USD700 million to fund projects aligned with the Climate Resilience Principles[53]. These bonds support investments that strengthen the ability of infrastructure, communities, and ecosystems to withstand climate shocks. The Asian Development Bank (ADB) also issued a bond in 2019 which featured adaptation and resilience activities. through its Green, Social, Sustainable, and Other Labelled (GSS+) Bonds Initiative, aims to catalyse over USD1 billion in sustainable bond issuances by 2025, including resilience bonds, to finance climate investments and strengthen resilience across Southeast Asia. The ADB has supported the issuance of sustainable bonds—including resilience-focused instruments—across ASEAN+3 markets, contributing to a total outstanding volume of USD 917.6 billion by year-end.[54] These instruments mark a shift toward proactive, systems-level investment in resilience, particularly critical for regions most exposed to climate impacts.

Since the early 2010s, the IDBG has embedded climate considerations into its strategic framework, setting ambitious targets, including mobilising USD25 billion USD in adaptation between 2024 and 2030, and actively supporting the incorporation of resilience measures into national and regional long-term strategies.[55] The Bank enhances institutional capacity by assisting governments in developing resilient policies, establishing robust regulatory frameworks, and fostering private sector engagement. In addition, IDB CLIMA rewards borrowers for achieving nature and climate objectives, providing a 5% grant on the loan amount. With a groundbreaking set of debt conversions backed by IDB and partners, countries are freeing up fiscal savings that are channelled into investments in water security for its population and biodiversity conservation projects.[56]

#### 5.3.3.4 Insurers

With regards to asset side of the balance sheet (i.e., insurers as investors) sovereign credit assessments do integrate physical climate risk, but often indirectly through ratings used by the investment teams. Location-specific risk intelligence is not consistently applied, and analysis does not explicitly reflect vulnerability assessments.

In their liability side of the balance sheet (as insurance underwriters) they use a stochastic model approach for different hazards, which hugely differ from NFGS' Integrated Assessment Models. There is also a big difference between developed and developing and emerging market, where protection gaps are much wider, leading to higher net risk and less appetite or higher costs for underwriting insurance. A major challenge in developing and emerging market regions is the lack of granular data—especially on vulnerability and tax income distribution—which makes sovereign risk modelling more difficult. To assess adaptive capacity, insurers rely on data such as National Adaptation Plans (NAPs), GDP distribution, land use maps, sectoral exposure, insurance coverage, and hazard-specific resilience infrastructure.

Engagement with governments remains fragmented. There is no centralised unit for sovereign engagement, but insurers typically interact through industry associations, local initiatives (such as Morocco's agricultural fund or Mexico's earthquake pool), and development agencies seeking risk assessments in data-poor regions. These efforts aim to improve climate resilience and close protection gaps, particularly in vulnerable economies.

Advanced tools including catastrophe models (CAT models) enable insurers to estimate potential losses from extreme events and guide decisions on public insurance schemes, financial reserves, and infrastructure investment.

53 World's first dedicated climate resilience bond, for US$ 700m, is issued by EBRD DevelopmentAid

54 Asia Bond Monitor – March 2025 | Asian Development Bank (adb.org)

55 IDB | IDB to Scale Annual Climate Financing to $11.3 Billion by 2030, Accelerating Impact (iadb.org)

56 IDB | IDB CLIMA (iadb.org)

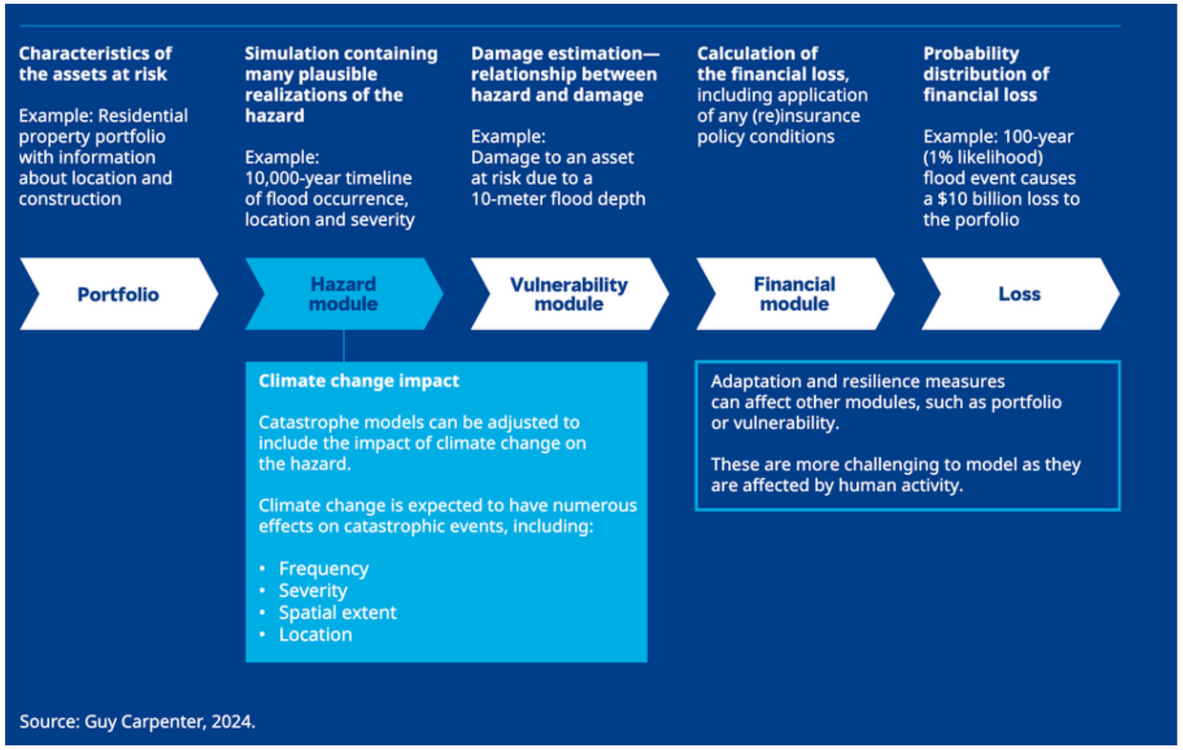


**FIGURE 12: CLIMATE CHANGE IMPACT ASSESSMENT**[57]

Catastrophe models can also be leveraged to guide investment in infrastructure and community development projects[58]. For example, reinsurance broker Guy Carpenter has extensive experience using, evaluating, adjusting and building catastrophe models, with teams of scientists and engineers. To support risk analysis in regions where full probabilistic catastrophe models do not exist, Guy Carpenter has developed a suite of GCAT Risk Ratings. The Risk Ratings cover multiple perils, including pluvial and fluvial flood, which go beyond standard hazard maps, which only display physical risk for a peril at a location. By combining hazard maps with peril and building-specific vulnerability curves, along with climate change models, the maps converting hazard into annual average damage ratios. This metric allows direct comparison between countries, regions and perils for a baseline and future climate - making it possible to quantify the impact of changing climate on loss cost.

The sector also promotes risk layering—a strategic approach to combining financial instruments to manage climate risks effectively. By helping quantify and address the insurance protection gap, especially in low-income countries, insurers are supporting more resilient economies and encouraging proactive public finance strategies that reduce systemic risk and promote sustainable development.

As governments, insurers, and development institutions seek ways to transfer disaster risk to capital markets, issuance volumes of **CAT bonds (catastrophe bonds) have seen a notable surge in recent years**[59], driven by growing awareness of climate risks and the need for innovative financial instruments to manage them. CAT bonds are structured so that investors lose part or all of their principal if a predefined catastrophe occurs. The yield (or spread) investors demand reflects their perceived risk of that event happening. By analysing the pricing of CAT bonds market participants can infer the implied probability of the triggering event. As new data (e.g. climate models, disaster forecasts, or actual events) emerge, CAT bond prices adjust, offering a real-time reflection of changing risk perceptions. A promising innovation are resilience bonds linked to cat cover: In 2025 Guy Carpenter placed a USD600 million resilience bond for the North Carolina Insurance Underwriting Association (NCIUA), with the aim to unlock funding for risk mitigation – in this case the roof fortification efforts in the face of rising windstorm risks.[60]

### 5.3.4 Credit Rating Agencies (CRAs)

**CRAs have been increasingly acknowledging the potential impact of climate change on sovereign credit profiles,** reflecting both the rising frequency and severity of climate-related events and growing regulatory attention[61]. The big three rating agencies -S&P Global Ratings, Moody's Ratings, and Fitch Ratings- have published reports explaining the

57 How a Holistic Risk Approach Increases Resilience in the Face of a Changing Climate | Marsh McLennan

58 How a holistic risk approach increases resilience (marshmclennan.com)

59 Catastrophe bonds & ILS issued and outstanding by year - Artemis.bm

60 NCIUA's recent catastrophe bond included integrated disaster-resilience feature - Artemis.bm

61 ESMA 2019 Guideliness: CRAs and Sustainability (europa.eu)

channels through which climate risk can affect sovereign creditworthiness, and which countries are most at risk (see Fitch, 2025[62]; S&P, 2023[63]; Moody's 2016[64]).

Consistent with their primary mandate to assess probability of a borrower's default on its debt obligations, **they state that their analysis is focused on whether climate-related events visibly and measurably impact a sovereign's ability to service debt.** In other words, for most CRAs, physical climate risks are considered only to the extent that they are immediately material to a country's fiscal and socioeconomic conditions. This is consistent with a recent study by Andersen et al, 2025[65], which finds no evidence that climate risk systematically affects ratings or that its influence has evolved over time reflecting CRAs short- to medium-term focus on economic fundamentals rather than on long-term climate risks.

**When assessing physical climate risks, CRAs explain that they draw on a range of models, data sources, and scoring systems, applying expert and qualitative judgment** to evaluate how climate hazards affect a country's vulnerability and its broader economic and social dynamics. Most reported that these assessments inform in-country engagements and consultations. These assessments vary in sophistication; some use heat maps or scoring frameworks, yet these are not granular enough to calculate precise probabilities, partly due to underlying uncertainties in climate projections and persistent data limitations.

**CRAs acknowledge that adaptation and resilience efforts can significantly shape a country's macroeconomic trajectory for the better.** In the short term, they may boost output through public investment and help stabilise prices by reducing disruption from climate events. Over the longer term, effective adaptation and resilience enhances productivity, moderates inflation volatility, and supports fiscal sustainability by lowering recovery costs and economic losses.

When it comes to factoring adaptation and resilience efforts in their analysis, CRAs have recognised that **national adaptation investments**, such as large-scale resilient infrastructure, or desalination projects, can reduce climate vulnerability and help stabilise credit ratings. However, their **influence on ratings depends heavily on the credibility and governance of the investment plans, their near-term fiscal relevance, and the likelihood of implementation.** For example, developed economies like the Netherlands face significant sea level rise risks but have a long history of investing in coastal defence. In contrast, emerging and developing economies often struggle with limited data, severe fiscal constraints, and implementation uncertainty, which hinders the systematic integration of adaptation measures into credit ratings.[66] **Some mentioned that adaptation and resilience investments are more likely to prevent rating downgrades, than to trigger upgrades.**

While credit ratings are widely used by regulators and investors, their rating decisions often lag market signals such as bond spreads and CDS prices, which often reflect deteriorating credit conditions more quickly.[67] Yet, because ratings influence regulatory capital requirements and portfolio construction and lending decisions, the way CRAs assess climate adaptation efforts has a significant impact on capital flows. **As adaptation metrics continue to evolve, and transparency around the performance of adaptation and resilience investments increases, it is important for CRAs to continue to incorporate additional data-points and articulate how these efforts are integrated into sovereign credit assessments.** CRAs have an opportunity to further support financial market participants' decision-making processes by more intentionally and visibly embedding adaptation and resilience considerations into their methodologies and rating reports. Doing so could **enable markets to appropriately price these efforts and potentially reward countries that invest in long-term climate preparedness.** The latter is particularly important for EMDEs where investment needs are larger.

62 Fitch, 2025. See Here.

63 S&P, 2023. See Here.

64 Moody's, 2016. See Here.

65 Andersen et al, 2025. See Here.

66 Belize's experience highlights how fiscal reforms drive credit rating improvements more so than environmental factors. In 2017, S&P downgraded Belize to Selective Default due to missed debt payments and economic challenges following Hurricane Earl. The rating was alter upgraded to B- with a stable outlook after a fiscal restructuring. Environmental factors had minimal to no influence on these subsequent changes

67 See Jongsub Lee, et al. 2021, Here.

## Box [2] - Emerging and developing economies (EMDEs)

**Despite contributing less to historical emissions, EMDEs face a disproportionate share of climate impacts,** as highlighted by the IPCC and other global assessments.[68] Applying uniform risk assessments across markets can misrepresent the true investment potential of these regions, especially when local resilience efforts and sector-specific opportunities are overlooked. This creates a clear tension between how risk is assessed and where investment is needed the most.[69] **While some investors recognise this tension, integrating it systematically remains challenging partly due to starker data gaps, higher costs involved, and prevailing interpretations of fiduciary duty that favour short-term risk avoidance over long-term resilience.**[70]

**The gap between EMDEs with regards to the availability of climate-related data and the capacity of emerging market treasuries to engage with it, remains significant.** While investors can access extensive datasets from niche providers for sovereign bond analysis for DM countries, data is much more limited for EM countries and some finance ministries in developing countries have less resources to discuss climate adaptation and resilience plans and investment needs in meaningful detail. This is not universally true, however, with some emerging markets leading with example (e.g., India, Chile).

**Another key difference between DMs and EMs lies in the role of private insurance in absorbing climate-related financial shocks and the fiscal burden it puts on governments.** In developed economies, private insurance and reinsurance often cushion the fiscal impact of climate events, though coverage gaps and affordability issues remain. In contrast, emerging markets typically lack such coverage, leaving governments more exposed to immediate fiscal pressures. With property protection gaps exceeding 90% in many EM regions, compared to 30–40% in high-income countries, climate events can have a greater fiscal impact on public balance sheets, and can result in GDP losses up to 4x higher.[71]

**To address some of these issues, there is growing momentum to review domestic and international financial regulations to ensure they are applied proportionately and do not disadvantage developing countries in accessing climate finance.** Improving data offering, clarifying standards, building senior-level capacity, and strengthening the offer of emerging market benchmarks, are also essential to better understand and price the financial materiality of underinvestment in A&R. These can help direct capital toward efforts that reduce systemic risk and support long-term climate and economic stability.

68 See Hannes Boehm, 2022, Here.

69 See Imperial Business School, Here.

70 IEEFA | Systemic Risk Reduction Funds June 2025

71 Climate change and emerging markets: The property protection gap challenge | Peak Re (peak-re.com)

## 5.4 Tools to assess physical climate risk and country adaptive capacity

**The table below highlights some frequently mentioned tools to assess physical climate risk and country adaptive capacity that are freely available. Utilisation of this data set can and should be used to address data quality and availability concerns.** Commercial data providers, not included in this list, have also been substantially and continuously improving their offering responding to growing investor demand. Benchmarks and knowledge portals assess adaptive capacity in different but complementary ways. Benchmarks provide scores or rankings across countries and use standardised indicators to compare adaptive capacity. For example, the ND-GAIN (Notre Dame Global Adaptation Initiative) Country Index uses 45 indicators to assess a country's vulnerability and readiness for climate change. These indicators are grouped into vulnerability and readiness components, which are further broken down into critical sectors including food, water and infrastructure. The index helps governments, businesses and communities prioritise adaptation efforts.

Multiple knowledge portals provide extensive datasets that can be used for research and policy design, as well as informing decision making. For example, the UNEP Adaptation Gap Report provides an annual assessment of global progress on climate change adaptation, focusing on planning, financing, and implementation. It has found that progress in adaptation financing is not fast enough to close the enormous gap between needs and flows, which contributes to a continued lag in adaptation planning and implementation efforts[72].

NGFS climate scenarios are primarily used by central banks and financial supervisors, but some market participants use them to assess physical risk at country or regional level. These offer a structured way to explore plausible climate futures by combining climate risks with macro-financial effects. Damage functions are used to estimate the economic impact of various hazards such as GDP losses, crop yield reductions, and declines in labour productivity. Due to limited economic data availability, many emerging market countries are not yet modelled individually, although an upcoming update aims to improve regional representation.

Despite continuous improvements, NGFS scenarios are inherently limited when projecting outcomes in uncharted territory, especially where non-linear effects of tipping points and compounding effects are considered. There is growing recognition of the need for more qualitative insights and consideration of broader societal risks like inflation, migration, and geopolitical instability. Herein, the ABC Framework outlines a methodology for utilising outputs of climate scenarios to inform

**Data sources, scores, benchmarks**

| # | Name | In a nutshell |
|---|---|---|
| 1 | **ND-GAIN Country Index** | Measures a country's vulnerability to climate change and its readiness to improve resilience. |
| 2 | **INFORM Climate Change Risk Index** | Developed by the EU and UN, it assesses disaster risk using climate projections and demographic forecasts to estimate long-term future risks at country level. It incorporates exposure, vulnerability, and adaptive capacity metrics. |
| 3 | **WB, Climate Change Knowledge Portal** | Provides historical and projected climate data, as well as sectoral risk profiles for countries. |
| 4 | **WB, Adaptation and Resilience Readiness Data** | Provides a whole-of-economy framework to evaluate a country's progress in adaptation and resilience actions and capacity development, identify gaps, and support design of effective adaptation and resilience policies and strategies. |
| 5 | **German Watch, Country risk index** | Analyses to what extent countries and regions have been affected by impacts of weather-related loss events (storms, floods, heat waves etc). Exclusive focus on historical physical climate impacts (observed damages). |
| 6 | **WB, Global Facility for Disaster Reduction and Recovery (GFDRR) – ThinkHazard!** | Provides hazard-specific risk information to support disaster risk-informed development. |

72 Adaptation Gap Report 2024 | UNEP - UN Environment Programme

| | | |
|---|---|---|
| 7 | **Global Systemic Risk Assessment Tool (G-SRAT) (Resilient Planet Data Hub)** | The University of Oxford (OPSIS/ECI) with partners including the insurance development forum, the World Bank and UNDRR developed the G-SRAT, an advanced global open risk assessment tool covering multiple hazards and asset types. The technology assists countries identify 'hotspots' across major infrastructure networks including energy, water and transport that are most vulnerable to climate risk, to ensure effective investment. |
| 8 | **CDRI Global Infrastructure Risk Model & Resilience Index (GIRI)** | GIRI is a fully probabilistic global risk assessment of infrastructure assets across key sectors, including power, telecommunications, transport, water, energy, and essential services like health and education. It quantifies risks posed by geological and climate-related hazards—earthquakes, tsunamis, landslides, floods, cyclones, and droughts—across every country and territory. |
| 9 | **Columbia Univ, Climate Finance (CliF) Vulnerability Index** | Designed to provide a comprehensive understanding of climate vulnerability for nation states to improve the targeting and provision of climate change adaptation financing. |
| 10 | **UNEP Adaptation Gap Report** | Offers global assessments of progress on adaptation, including investment needs and implementation gaps. While not country-specific, they offer input on global trends, adaptation finance, and governance. |
| 11 | **EIB, A global index of climate risk for countries** | A 2025 publication with a comprehensive index assessing climate risk for over 170 countries, distinguishing between physical and transition risks while accounting for adaptation and mitigation capacities. |

**Note that this is a non-exhaustive list and does not include offerings from commercial data vendors.**

decision making across all markets. Next year's CFRF AWG work on the integration of the ABC Framework into NGFS scenarios will outline how to apply the framework to assess and minimise damage functions.

Adaptation measures are currently not integrated into NGFS climate scenarios. Conventional climate impact models (CIMs) and integrated assessment models (IAMs) used by NGFS often treat adaptation simplistically, typically as either full or no adaptation, without accounting for the varied adaptive capacities across countries. As adaptation and resilience metrics evolve, shared socioeconomic pathways (SSPs) can be used to better represent adaptive capacity. This integration could help identify key investment areas.

**To support better understanding and management of climate-related risks at the macroeconomic level, and foster further investment flows, UNDRR, Howden, FCDO, and other partners have launched a new initiative bringing** together experts from diverse disciplines and sectors to develop globally applicable metrics for systemic resilience. The goal is to translate technical risk indicators, such as Average Annual Loss (AAL) and Probable Maximum Loss (PML), into decision-useful metrics for governments, financial institutions, and investors. By integrating these risk metrics with economic indicators like GDP impact, sectoral revenues, and financial performance, the initiative aims to create a global framework for quantifying climate risk. This framework seeks to help mobilise capital for adaptation and resilience.

**As a crucial current source of information, National Adaptation Plans (NAPs), Nationally Determined Contributions (NDCs), and Long-Term Low Emission Development Strategies (LT-LEDS)** often outline national-level adaptation goals and strategies. However, these documents vary widely in format and content, with limited standardisation across countries. They are more commonly available for developing countries, exacerbating the uneven landscape of information. Importantly, while these documents present plans and intentions, they do not always indicate the extent to which these strategies will be or are being implemented, making it difficult to assess actual progress on adaptation.

### 5.4.1 High-level recommendations for policy makers and regulators

To unlock much-needed private investment in climate adaptation and resilience, that would support credit risk profiles of both sovereigns and corporates within them, governments and regulators can take a series of measures to a) enhance the understanding of physical climate risk and the economic benefits of adaptation through improved information and disclosure, and b) strengthen the financial case for near-term investment in A&R through smart regulation and targeted incentives.

**Enhancing information and disclosure**

1. **Make risk information a public good (universally accessible, high quality data).**
2. **Clarify the definition of resilience investments.**
3. **Support the Global Goal on Adaptation (GGA) and the development of adaptation indicators.**
4. **Strengthen communication and long-term planning for adaptation investment**
5. **Strengthen mandatory climate risk disclosure and accounting standards. Improving incentives to strengthen the financial case for adaptation and resilience investment**
6. **Strengthen climate-resilient procurement standards.**
7. **Implement levies and repurpose harmful subsidies to expand fiscal space** and correct market signals for adaptation and resilience.
8. **Design smart regulation and targeted fiscal incentives to strengthen the short-term financial case for resilience investment.**
9. **Deploy market-shaping policies and tools to unlock private finance.**
    a. **Deploy pull finance mechanisms**
        i. **Advance market commitments,**
        ii. **Public-private risk sharing mechanisms**
        iii. **Outcome-based contracts**
    b. **Support pilots for innovative resilience finance instruments.**
10. **Review prudential regulations to unlock climate resilience investment.**
11. **Support pre-arranged financing tools particularly in emerging markets and vulnerable economies.**
    a. **Insurance-Linked Securities (ILS)**, such as catastrophe bonds (CAT-Bonds)
    b. **Contingent Credit Lines and Guarantee Facilities** offer pre-approved financing
    c. **Parametric Insurance** triggers payouts based on measurable parameters

**Box [3] - Initiatives advancing the enabling conditions for climate adaptation investment**

Several initiatives across the UK and EU are working to create enabling environments for climate adaptation investment, with a shared focus on mobilising finance, supporting local authorities, and overcoming barriers to resilience planning and implementation.

- **ATTENUATE** (UK): A collaborative project led by the Grantham Research Institute, aiming to unlock private finance for adaptation by generating economic evidence, improving public sector investment strategies, and addressing behavioural and governance barriers.
- **MIP4Adapt** (EU): Supports regional and local authorities in developing adaptation plans, accessing finance, and engaging communities through technical assistance and a Community of Practice.
- **Pathways2Resilience** (EU): Helps over 150 regions and communities understand climate risks, develop resilience pathways, and deploy innovative solutions aligned with the EU Adaptation Strategy.

## 5.5 Summary and areas for further work

**Adaptation and resilience investments are essential for strengthening national capacity to manage climate impacts.** As exposure to climate hazards increases, these investments reduce sensitivity and enhance adaptive capacity, improving a country's ability to cope and recover to the effects of climate change. While they don't eliminate exposure, adaptation and resilience efforts can significantly improve macroeconomic performance by boosting short-term output and supporting long-term growth and fiscal stability.

Physical climate risks already influence sovereign credit, yet the value of national adaptation efforts is not consistently reflected in market assessments. Recognising resilience can strengthen fiscal stability and improve access to finance, particularly for vulnerable economies.

Despite growing awareness and evidence of the impact of physical climate risks on sovereign credit assessments –and of the economic benefits of national adaptation efforts— most stakeholders continue to prioritise near-term concerns, with limited recognition of tail risks such as the potential impacts of climate tipping points, and insufficient attention and support for strengthening adaptive capacity and or reducing sensitivity to reduce vulnerability and avoid future economic and social losses.

Assessing adaptive capacity requires tailored, context-specific tools, as adaptation is dynamic, highly context-specific, and cannot be captured by a single metric. While data limitations persist, a growing suite of publicly available benchmarks and portals (many adapted from disaster risk frameworks) are helping stakeholders evaluate resilience and guide targeted investment and policy decisions. Encouragingly, progress in data availability and quality, interdisciplinary collaboration, and the growing sophistication of climate risk analysis is deepening our understanding of adaptive capacity and enabling more informed, forward-looking decision-making. These advances, alongside emerging taxonomies and subnational initiatives, are unlocking capital for resilience and building momentum for adaptation-focused financial instruments across sovereign and corporate markets.

As adaptation metrics continue to evolve, CRAs and other stakeholders have an opportunity to further support market participants' decision making processes by visibly incorporating adaptation and resilience efforts into sovereign credit assessments. This would help markets price these efforts accordingly and reward sovereigns and sub-sovereigns that invest in long-term climate preparedness.

To unlock further public and private investment in climate adaptation and resilience, critical for strengthening sovereign and corporate credit profiles, governments and regulators must improve climate risk information and disclosure, clarify resilience investment definitions, and support long-term planning and adaptation indicators. At the same time, smart regulation, targeted fiscal incentives, and market-shaping tools such as outcome-based contracts and risk-sharing mechanisms can strengthen the financial case for near-term investment. Reviewing prudential frameworks and supporting innovative finance instruments will further enable capital mobilisation, especially in vulnerable economies, aligning financial systems with long-term resilience goals.

# 6. Getting practical #3: improving flood risk management in the UK

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**Contributors:** Flood Re (Jonathan Kassian), NatWest (Doug Baird and Paul Cross), Marsh (Callum Ellis), Environment Agency (Yannick Pape)

This Chapter considers the challenges facing the financial sector in relation to flood risk in the UK, drawing on insights from finance firms, Government and the Environment Agency. Recommendations are included to address these challenges, setting out how the industry can develop decision-useful data, by improving the transparency and consistency of data, and creating forward looking assessments which address the current lag in data updates. Finally, this chapter sets out how Flood Performance Certificates could be leveraged using more accurate and forward-looking risk data can enhance insurability, improve financial system stability, and drive targeted adaptation investment.

## 6.1 Introduction and background

Flood risk data is an area of focus as the finance industry faces challenges which make lending decisions and insurance pricing difficult. There is also a UK-wide concern around outdated flood maps, which do not reflect either the current weather hazard or the current state of defence, and associated difficulty in making lending decisions. This requires a regulatory push for timely updates in order to address these issues. This should involve collaboration between financial regulators and the Environment Agency. There have been improvements in the data through improved modelling methodologies and use of technology. The National Flood Risk Assessment 2 (NAFRA2)[73] has increased the profile of flood risk as it has increased the visibility of surface water risk. However, challenges still remain with property-level flood risk data and converting flood hazard data into £-based risk in a consistent way across the financial sector.

If the data does not accurately capture the underlying physical risk, then this is difficult for insurers to accurately price policies and for lenders to assess credit risk. This challenge is compounded by the fact that insurers and lenders each use different data sets and there is uncertainty around the quality of the different data sets and the different ways the data has been processed by providers.

An important consideration when considering flood risk in the UK is the approach to removal of Flood Re and the post Flood Re situation[74]. Flood Re is a joint initiative between the insurance industry (with over 50 participating insurers)[75] and the government, established to ensure affordable flood risk insurance is available to homeowners and provide guidance for enhancing resilience[76]. It was established as part of the Water Act 2014, launched in 2016, and due to be in place until 2039. To date, it has benefited over 500,000 homes since inception by enhancing insurability, providing subsidies for flood damages and mechanisms for building resilience[77].

This has challenges from many aspects including governance, regulation and data. It will be important to minimise situations where no insurance coverage is available.

This CFRF Adaptation Working Group focused on what the key challenges facing the finance industry were in relation to flood risk in the UK and what good would look like for flood risk data, with a focus on:

1. What this means for policy / regulation
2. What this means for data / tools
3. What this means for industry processes / behaviour.

## 6.2 Towards decision-useful data

### Transparency & consistency of data

At present there are many challenges associated with the use of flood data flood data in risk assessment and management. The first concern is the **lack of sharing of flood risk data between and across the insurance industry and mortgage providers.** The consequence is that different estimates of risk are likely being made, leading to inconsistent decisions and inefficiencies.

Secondly, flood risk data that is used is often produced by, so called, “black box” methodologies, which are poorly defined by providers of this data. This includes a **lack of information along the entire calculation chain** from the source meteorological and hydrological data, the framing of uncertainty, the choice of vulnerability and exposure data, approach to inundation modelling, the treatment of flood defences and the method for considering spatial correlations in risk. Ultimately it leads to a lack of understanding of the quality of flood data from different providers.

#### 6.2.1.1 Towards standardisation and accreditation of data providers

One approach to improving access to good quality data is to develop a quality standard for flood data, including how climate information is incorporated. It would also be useful for this to include information on vulnerability, protection measures and their

73 National Flood Risk Assessment 2 Update (NaFRA2) (aegaea.com)

74 FloodRe is a joint initiative between the insurance industry (with over 50 participating insurers) and the government, established to ensure affordable flood risk insurance is available to homeowners and provide guidance for enhancing resilience . It was established as part of the Water Act 2014, launched in 2016, and due to be in place until 2039. To date, it has benefited over 500,000 homes since inception by enhancing insurability, providing subsidies for flood damages and mechanisms for building resilience.

75 Participating Flood Re Insurers | View Our Insurers List | Flood Re

76 What is Flood Re? | About The Flood Re Scheme

77 Resilience to flooding (parliament.uk)

evolution over time. Standards aimed at guiding good practice exist in many regulated industries[78] and cover both methodologies and data, and they can be either voluntary or statutory.

There are several approaches that could help improve the quality assurance of flood data, and these vary in the ease in which they could be implemented. Firstly, one could assist the user of data by equipping them with questions to ask of their data providers. These questions, and the answers expected for good data, could be developed in a transparent dialogue involving current users (especially those advanced users who are already able to distinguish between good and poor flood data), academia and those responsible data providers who wish to see the standards of the industry raised. An extension to this approach could be to include quantitative metrics of performance in this process, such as asking providers to show results for a hypothetical exposure and vulnerability dataset and baselining an acceptable level of performance. A step towards this is being made in the CFRF Resilience Working Group report 2025, which is comparing a range of model vendors for the same portfolio of assets. An extra necessary step is deciding on a baseline of minimum quality, and it will need to take account the uncertainty ranges in data products not just the most likely outcome.

A second approach is to focus on the providers of flood risk data, recommending that those professionals who work in these sectors are accredited as having training and a clear demonstration of the skill set and understanding needed to produce the high-quality data needed for assessing flood risk. Such accreditation is common in many disciplines, and an analogy would be the chartered status for engineers. There are a range of organisations that could provide this, including the Royal Meteorological Society. This approach could be applied on its own, but it doesn't guarantee good quality data and so it perhaps best implemented as an addition to the other ideas presented.

A more extensive approach would be to set a standard, for instance through a body such as the BSI or ISO to provide a more formalised standard, which has the potential to have a major impact on the quality of climate information and the methods applied to climate data for the finance sector. A first step would be to systematically itemise the current standards that are directly applicable to firms in the finance sector, but also those that relate to adaptation of underlying assets. On the former an initiative by the WMO and the EU funded Climate Europe 2 project is exploring the potential of an international climate service standard and is seeking input from the finance sector. On the later there are many existing standards, including Eurocodes standards and the ISO14090 series that are relevant to climate data. A new BSI PAS is currently in development that will focus on adaptation pathways, with a focus on infrastructure.

An important aspect of the regulatory landscape for banks and insurers in the UK comes from the Bank of England through the PRA and FCA. In particular, SS3/19 goes some way towards setting the ground rules for the regulatory supervision of climate risk management, offering a roadmap for institutions to follow as they begin to normalise the challenges of climate change. The consultation CP10/25 aims to build on this with more explicit consideration of climate physical risk and will likely lead to updated supervisory requirements. The CFRFG AWG will update the ABC Framework guidance to reflect this.

#### 6.2.1.2 Who will improve data relevant to flooding?

There is a low percentage of private sector funding in efforts to improve flood risk data. The recent focus has been on the Government and what steps they can take to ensure good quality data is produced and shared; this has been largely done through funding of climate projection initiatives such as (United Kingdom Climate Projections) UKCP[79], through work by the Environment Agency on flood mapping and through the Flood Re program. However private sector input is required to set up what this will look like post Flood Re in 2039. Public funding pressures will also increase the need for private sector adaptation to flood risk. The first step could be an exercise with data users to understand the critical information they require in order to assess the quality of the data or to ensure consistency between providers.

#### 6.2.1.3 Recommendations

- Survey and report on current guidelines and standards relevant to the finance industry and the assets in which they invest.
- Convene a discussion with finance firms and key regulators and standards bodies to explore the gaps in regulation that might impact on quality and develop plans of how to address the gaps around regulation.
- Engage with ongoing activities, such as that in Climate Europe2, which are already considering improved standards.
- Where data gaps are evident, provide information to government and research funders (private and public sectors) and data providers on future research and data needs.

78 Bank of England and FCA response to DSC recommendations

79 UK Climate Projections (UKCP18) - Met Office

## 6.2.2 Creating forward-looking assessments

### 6.2.2.1 The lag in data updates

Despite improvements in modelling methodologies and the introduction of tools such as NAFRA2, which has enhanced the visibility of surface water risk, the underlying datasets remain insufficiently dynamic. Many currently available flood risk models often fail to incorporate recent investments in flood defences or changes in asset-level resilience. For example, if a local authority invests in upgrading a flood barrier or improving drainage infrastructure, these changes may not be reflected in national datasets for some time. This delay undermines the ability of insurers to price risk accurately and of lenders to assess long-term exposure, particularly for longer-term mortgage products.

### 6.2.2.2 The need for forward-looking risk assessment

Flood risk is inherently dynamic. It is shaped not only by climate variables such as precipitation and sea level rise, but also by human interventions. The Bank of England's 2025 staff working paper.[80]

For example, a town that installs a new flood wall may successfully prevent flooding during moderate rainfall events. However, if an extreme weather event overwhelms that defence—such as a once-in-a-century storm—the flood wall may fail or be overtopped. In such cases, the economic consequences (e.g. damage to homes, disruption to businesses, infrastructure repair costs) can still be severe.

This distinction is critical for financial institutions. While adaptation measures may lower the probability of claims or defaults, they do not eliminate financial exposure entirely. A mortgage lender, for instance, may still face losses if a property is damaged and the borrower cannot repay, even if that property was previously considered protected by local flood defences.

These effects are not isolated. They can propagate through supply chains and financial systems, amplifying the overall economic impact. For financial institutions, this means increased credit risk (e.g. businesses unable to repay loans), asset devaluation (e.g. properties or infrastructure losing value).

This underscores the importance of forward-looking risk models that incorporate both the probability and severity of extreme weather events. Financial institutions must be able to assess not only the likelihood of flooding but also the broader economic consequences of climate shocks.

A key historical limitation of models is their reliance on historical data which does not reflect future conditions. Recent improvements by the Environment Agency, included Met Office projections in their models for the first time, led to a 43% increase (from previous estimates) in the estimated number of homes at risk of flooding[81]. This was reported to be mainly due to improved datasets and modelling techniques, highlighting the value of future-oriented approaches.

Therefore, forward-looking risk models must account for both the reduction in flood probability due to adaptation and the residual risk of economic loss if those measures are exceeded or fail. They must also be capable of capturing the growing volatility introduced by climate extremes using information from climate model projections of future weather and climate extremes.

### 6.2.2.3 Scenario-based and real-time data needs

There is a growing need across the financial sector for data that supports both scenario-based analysis and real-time decision-making. Flood risk is not static, as such, financial institutions require data that reflects both current resilience and plausible future states.

However, current models face several limitations. They are often not updated frequently enough to reflect real-time changes in risk exposure, such as newly installed flood defences or shifts in land use. Moreover, from engagement with CFRF Adaptation Working Group members, we noted many models struggle to assign meaningful probabilities to outcomes or to integrate multiple hazards across geographies and asset classes. As noted in the Bank of England's CP10/25 consultation paper on enhancing climate risk management, effective risk assessment requires timely, high-quality data that can inform both strategic planning and day-to-day risk decisions.

### 6.2.2.4 Recommendations

To address the challenges outlined in this section, the following actions are considered to improve the financial sector's ability to assess and respond to flood risk:

- Regular updates to national flood maps: Timely revisions are essential to ensure that flood hazard data reflects current physical risks and adaptation measures.
- Integration of forward-looking data: Financial institutions should incorporate dynamic, scenario-based data into lending, underwriting, and investment decisions to better account for long-term flood risk.
- Clearer guidance on adaptation modelling: Agree frameworks for how adaptation measures—such as flood defences or property-level resilience—should be reflected in risk models.
- Real-time data infrastructure: There is a need for data feeds that capture updates on infrastructure investments, asset-level adaptation, and environmental conditions as they occur.
- Standardised hazard definitions and formats: Harmonised terminology and data structures will support interoperability across institutions and regulatory bodies.

80 Bank of England Staff Working Paper No. 1,120

81 One in four properties may be at risk of flooding by 2050 - report - BBC News

## 6.3 Flood resilience metrics

For flood risk there is a clear gap around property level data, and there was much discussion at the flood risk workshop on the potential use of flood performance certificates. These could, of course, be extended to wide weather and climate hazard risk certificates. As outlined below, the Flood Performance Certification (FPC) forms a similar approach to a property's Energy Performance Certificate (EPC) but outlines a potentially higher necessity, in effect it wouldn't matter how efficient a property may be if it will be destroyed by a single or serious of flood events. FPCs were first trailed and reported by Flood Re in 2020 in conjunction with WPI Economics[82]. The report outlined the strategy and provided practical recommendations for implementation, such as using open-source data which has been improved upon by the UK government for measuring flood zones. In January 2025, approximately 5 years after the inception of the FPC plan, the Department for Environment, Food & Rural Affairs (DEFRA) wrote to the committee of public accounts on the seventh report of session 2023-24 (Resilience to flooding) to understand the implications of closing Flood Re in 2039 and where flood risk must get to. Within this document, Flood Re's transition and spending plan is detailed alongside current ongoing regulatory actions.

There is a risk that an FPC scheme could take significant time to set up, Australia has a similar metric for wildfires however this took 8 years to be completed. In order to accelerate the roll out of an FPC, areas which are at higher risk of flooding should be mandated first so that the most at risk areas are prioritised. Additional issues lie with the actual completion and payment of the assessments, as well as responsibility. These will need to be completed in the same manner as EPC at household level and there may be pushback against additional incurred costs or government stipends to cover the actual assessment. The below section outlines a practical approach to enhance resilience against key exposures in the UK.

### Leveraging data using FPCs to stimulate investment

Despite large public investment, there isn't currently a universal process to recognize flood adaptation and resilience in risk calculations or regulatory requirements for reporting of specific resilience metrics. A FPC would help to ensure adaptation is adequately included in decision making and increased awareness of flood risk is not penalised. As part of Flood Re's Quinquennial Review[83] in 2024, Flood Re has released a FPC roadmap[84] to measure the effectiveness of resilience investment at a property level. Fundamentally, FPCs operate with a similar rating system to an EPC aggregating various metrics to create an overall efficiency rating. Core to this rating is the identification, measurement and installation of Property Flood Resilience (PFR), which are intrinsic features of a property that enables risk and damage reduction and may be defined based on area or proximity to a body of water.

PFR can be split into two main activities, flood resistance and flood recoverability. Resistance refers to limiting water access to a property through seepage or openings and may offer low-cost solutions to reduce impacts (such as non-return valves, barriers or pumps). Flood recoverability accounts for the remediation of flood occurrence and considers home design features such as ceramic tiling rather than wooden materials (reducing seepage/easier drying) or elevating sockets[85]. A combination of the two metrics is required to create an overall level of flood protection and offset financial losses posed by flood risks, while the launch of FPCs has cross-cutting benefits between homeowners, insurers, lenders and government.

Thus, implementation of a FPC allows for evaluation of resilience readiness for a given property and allows insurers, buyers and lenders to properly assess a property. The first step for a FPC is measuring a property's vulnerability to floods based on location. Flood risk assessments (FRA)[86] are currently required in the UK for all developments with a high probability (>1%) of a flood event occurring annually (or in areas of low risk (>0.1%) with an area > 1 hectare)[87]. A flaw with FRAs is they may highlight exposure to flooding which may increase insurance costs, with the UK insurance industry expected to pay over GBP 2bn in repair costs over the next five years and premiums expected to increase. These assessments may then be combined with the PFR to develop the FPC rating for resilience vs exposure where FPCs highlight actions taking to enhance resilience. If scaled implementation is achieved cascading benefits may also exist for enabling the ability to track adaptation measures improving a wider understanding of flood risk and access to increased private investment. Currently, ~90% flood and coastal erosion risk management capital has been paid for by central government[88] with an additional GBP 8 billion of government funding for flood defences announced in July 2025[89]. However, FPC ratings may incentivise mechanisms from lenders in a similar manner to green mortgages for properties with EPC ratings of A or B, where buyers could access a cheaper rate and/ properties may retain future value for resilient properties[90] or enable large scale resilience investment through blended finance structures.

While FPCs have been proposed there is no timeline for implementation. A FPC would help to ensure adaptation is adequately included in decision making and increased awareness of flood risk is not penalised. The development of FRAs in the UK means there is a plan for risk exposure which may be combined with financial metrics

82 Flood Performance Certificates.pdf (floodre.co.uk)

83 Flood Re | The Quinquennial Review | July 2024

84 Flood Performance Certificates Roadmap

85 Preparing Your Property - CIWEM

86 Flood risk assessments: applying for planning permission - GOV.UK

87 Flood Map for Planning - Flood Zones

88 Investment in flood defences, UK - Office for National Statistics

89 Hundreds of thousands of homes and businesses to benefit from largest flood defence investment programme in history - GOV.UK

90 Are Green Mortgages Worth It In 2025? - HomeOwners Alliance Are Green Mortgages Worth It In 2025? - HomeOwners Alliance

such as insurance costs and create a feedback loop to incentivise subsidiaries. If coupled, with a FPC's quantification of the impact of recoverability and resilience measures (and the associated cost of these measures) may allow for an accurate assessment for risk evaluation – for example, property A with value £X has estimated annual losses of Y% and will incur increasing insurance costs due to risk exposure or historical risk data. Investing £Z in resilience measure boosts an FPC value up one band and reduces the estimated annual losses and insurance premiums by a certain percentage.

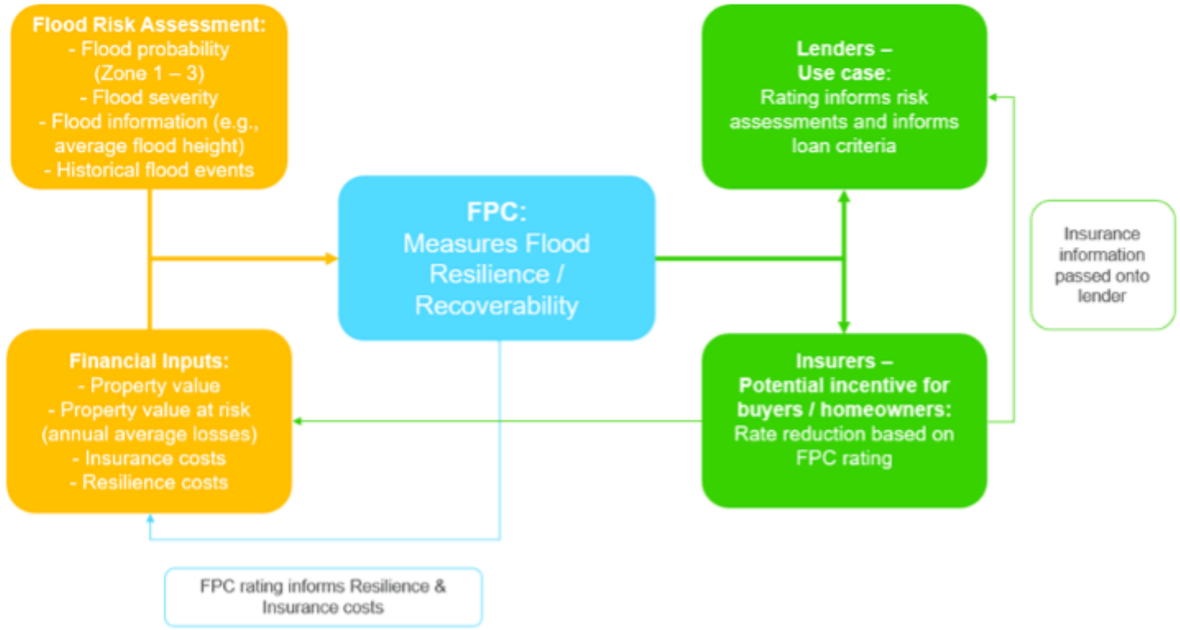


**FIGURE 13: FLOOD PERFORMANCE CERTIFICATE INPUTS AND IMPACTS**

**Recommendations:**

- FPCs should be implemented to evaluate individual property resilience against flooding. This can encourage investment in resilience measures, leading to reduced losses and lower insurance premiums.
- FPC should be kept as up to date as possible so that when homeowners make adjustments to manage flood risk, these are reflected in the FPC rating.
- Property Flood Resilience (PFR) should cover flood resistance and flood recoverability; this will enable risk and damage reduction.

## 6.4 Summary and CFRF recommendations

To address the challenges identified, this chapter proposes a suite of practical solutions:

- **Regulatory bodies should consider how to address the need for standardisation and accreditation** of data providers and their methodologies;
- **Regulatory bodies should consider how to work with standard setting organisations to develop methodologies for how to improve data quality, analysis and pointing to standards being developed by BSI and ISO on what good resilience looks like;**
- Regulatory bodies should consider how to encourage training providers to deliver training on how to apply the ABC framework and understand hazard and climate risk better, and training providers should be made more aware of the gaps in knowledge and the opportunities for filling these gaps.
- **Policy makers in government and regulators should consider practical steps to encourage and incentivise mechanisms such as FPCs** to quantify resilience at the property level;
- **Providers of hazard databases** should consider how to make their data open source and to provide scenario-aligned modelling guidance;
- **Policy makers and regulators should consider how to provide real-time data on infrastructure** to reflect adaptation investments and evolving risks.
- **There is a particular concern around how the removal of Flood Re will impact the financing of flood risks.** Addressing this is a priority that will require policy makers, regulators and finance firms to work together.

These recommendations are grounded in extensive market and regulator consultation.

# 7. Tipping the scales for adaptation and resilience through financial mechanisms

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**Contributors:** University of Oxford and the Resilient Planet Finance Lab (*Thailand case study*), Howden (*EU agriculture case study*), IIGCC/Howden (*PCRAM case study*)

This chapter outlines how to embed resilience in credit risk modelling and insurance pricing, working towards climate adjusted pricing methodologies. It does this by highlighting existing financial instruments and mechanisms that financial institutions can utilise to build resilience whilst then making the case for newer mechanisms that could reflect the value of risk-reducing resilience measures in improved credit or insurance conditions.

## 7.1 Introduction

The risks associated with physical climate change are now clearly visible, yet financial flows for adaptation are still vastly below needs. Economic losses resulting from natural hazard events in 2024 are estimated to be USD 320 billion[91], underscoring the urgent need for scaled investment in resilience. For the UK alone, an estimated GBP 5 – 10 billion per year needs to be invested.

The need is particularly acute in emerging markets and developing economies, where risk perceptions and capacity constraints limit private capital mobilisation. International public adaptation finance flows to developing countries increased from USD 22 billion in 2021 to USD 28 billion in 2022 - progress aligned with the Glasgow Climate Pact made at COP26, which urged developed nations to at least double adaptation finance to developing countries from 2019 levels by 2025. However, even achieving this commitment would only narrow the adaptation finance gap, which is estimated at USD 187-359 billion per year, by approximately 5 per cent.[92] Meanwhile, climate impacts are intensifying: 25 countries, home to one-quarter of the global population, face extremely high-water stress annually, and around 4 billion people experience water scarcity issues[93].

Banks, insurers and investors, as central actors in capital allocation, are uniquely positioned to bridge the adaptation finance gap. By designing targeted incentives, leveraging risk management frameworks, and aligning strategies with long-term sustainability goals, they can unlock new opportunities for value creation while contributing to global resilience.

Given the improvements to creditworthiness and reduction in asset vulnerability from incorporating resilience measures – banks and insurers should reflect the value of these risk-reducing measures in improved credit or insurance conditions.

Investments in climate resilience and adaptation — such as hardened infrastructure, climate-smart agriculture, water security infrastructure, or early warning systems — are not only socially and environmentally beneficial but also financially prudent. These measures directly reduce the vulnerability of systems, assets, and communities to physical risk exposure. As such, investing in adaptation and resilience should be recognised as a **strategic priority for risk management**. Resilient investments reduce the likelihood and severity of climate-related losses, enhancing operational borrower stability, collateral integrity, and cash flow predictability. This has significant implications for creditworthiness over time, particularly in climate-vulnerable regions where unmanaged physical risks could deteriorate credit profiles across sovereigns, municipalities, and private sector borrowers.

## 7.2 “Look-through” to credit risk

Traditional credit and insurance models often rely on retrospective data and fail to account for how future risks are mitigated by proactive resilience measures. This disconnect – combined with the growing recognition that climate-related risks are not yet fully integrated into credit quality assessments – can result in mispricing of risk. For example, investments that materially reduce the probability of default, such as a city strengthening coastal flood defences, may not yet be adequately reflected in improved credit terms, ratings or insurance premiums. The absence of a robust “look-through” from resilience investments to credit risk results in:

- Underinvestment in adaptation: due to the financial value of risk reduction not being priced in.
- Inflated credit spreads: for borrowers who have significantly enhanced their resilience.
- Mis-calibrated guarantee and insurance instruments: based on overestimated underlying risk.

To bridge this gap, financial institutions, insurers, credit rating agencies, and development finance actors need to:

- Incorporate scenario-based stress testing that reflects reduced loss outcomes due to adaptation investments.

91 Climate change is showing its claws: The world is getting hotter, resulting in severe hurricanes, thunderstorms and floods | Munich Re

92 Adaptation Gap Report 2024 | UNEP - UN Environment Programme

93 25 Countries Face Extremely High Water Stress | World Resources Institute

- Adjust credit models to account for adaptation actions, such as improved infrastructure durability or business continuity under stress.
- Develop aligned metrics and disclosures that quantify how resilience investments impact risk trajectories over time.

## 7.3 Mainstreaming insurance risk quantification

While banks typically focus on PD and Loss Given Default (LGD) metrics to calculate credit quality, the insurance industry utilises Average Annual Losses and Probable Maximum Losses to calculate technical insurance premiums for Natural Catastrophe risk. When considering climate-related risks, insurance modelling techniques can provide losses for climate events which combine the likelihood of an event (hazard) occurring, the exposure that an asset has to that event, and the asset's vulnerability (quantified through both insurance and financial metrics). This ground up approach could also be used to re-base asset valuations and quantify the expected reduction in risk as a result of resilience interventions.

To date, there are limited examples where this approach to climate risk quantification is systematically integrated into asset valuations or credit assessments, however adverse weather events and large-scale impairments to assets demonstrate the necessity of this approach. As outlined in this report, by considering both insurance and financial metrics, there is scope to demonstrate the value of investing in adaptation and resilience and develop innovative financial instruments that prioritise capital allocation towards adaptation and resilience as defined in the below case studies.

### **7.3.1 Case study:** Link REIT – property sector (Hong Kong)

Link REIT owns and manages a diversified portfolio of retail facilities, car parks, offices and logistics assets across Hong Kong, Mainland China, Australia, Singapore, and the UK.

Link REIT's work on 'resilience as a competitive advantage' demonstrated that the **use of physical risk assessments and asset enhancements could lower insurance premiums.**

Across the company's Hong Kong portfolio, floods were identified as one of the risks to the portfolio. Link REIT assessed flood risk across the portfolio and as a result proactively instituted flood gates and better drainage systems. It conducted an ESG roadshow with insurance companies demonstrating the reduced risks, and in particular how these measures could lower potential losses by 10 to 20%, **resulting in the company cutting its insurance premium by 11.7% from 2024 to 2025.**

This is a remarkable demonstration of physical risk analysis, adaptation and responding to increased climate risks. It has resulted in significant cost savings and enhanced asset protection, while also showcasing the company's proactive approach to climate resilience and its commitment to sustainable practices

### **7.3.2 Case study:** adaptation and sovereign credit ratings – Thailand

Using data from the Resilient Planet Data Hub (RPDH, 2024) and a sovereign credit rating model developed by Klusak et al. (2023)[94], researchers at the University of Oxford and the London School of Economics and Political Science (LSE) explored the impact of extreme events on Thailand's sovereign credit rating. Scenarios were developed for flood and tropical cyclone (TC) events, considering direct damages to built-up areas and indirect impacts (transport disruption for flooding and power disruption for TCs). Three different scenarios were considered:

1. Risk from a 1-in-500-year event in today's climate
2. Risk from a 1-in-500-year event in 2050 under a high emissions (RCP 8.5) scenario
3. Risk from a 1-in-500-year event in 2050 under a high emissions (RCP 8.5) scenario with additional investments in adaptation (improved building codes and infrastructure resilience, and increased insurance penetration).

94 Rising Temperatures, Falling Ratings: The Effect of Climate Change on Sovereign Creditworthiness | Management Science

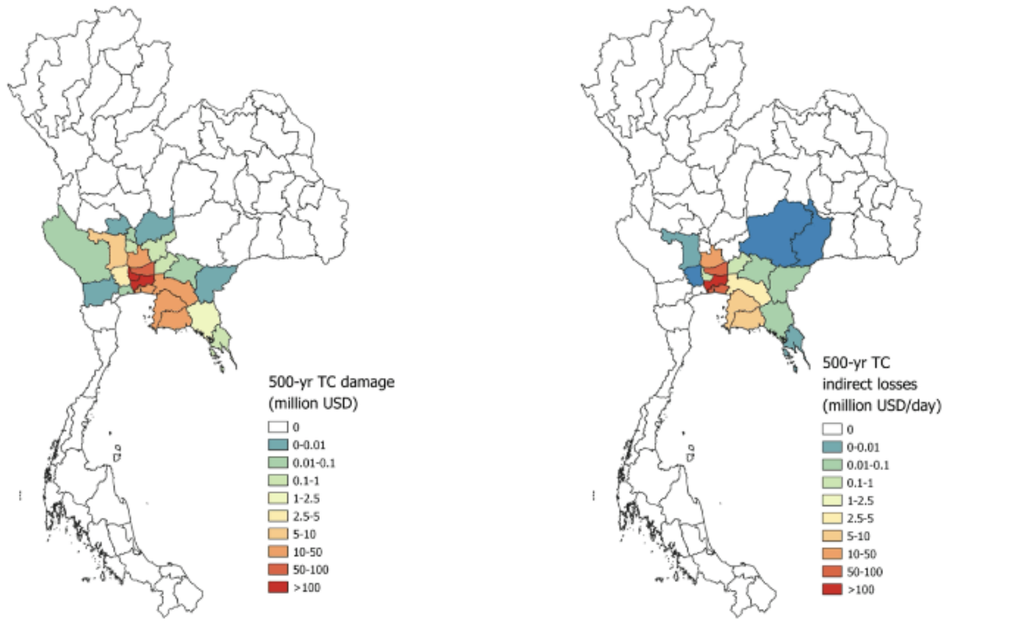



**FIGURE 14: THE DIRECT (LEFT) AND INDIRECT (RIGHT) IMPACT OF A 1-IN-500 TROPICAL CYCLONE (TC) EVENT IN TODAY'S CLIMATE.**

By incorporating loss and damage estimates from these acute risks into a sovereign credit rating model, the potential sovereign credit rating downgrade and associated increase in probability of default and increased cost of debt could be calculated. A 1-in-500-year flood in today's climate could lead to a one notch downgrade in the credit rating. The same event in 2050, under a high emission (RCP 8.5) scenario, could lead to a downgrade of three notches resulting in Thailand's falling from investment to sub-investment grade. This analysis demonstrates that investing in adaptation today can significantly reduce future losses and economic impacts of extreme events.

## Sovereign ratings

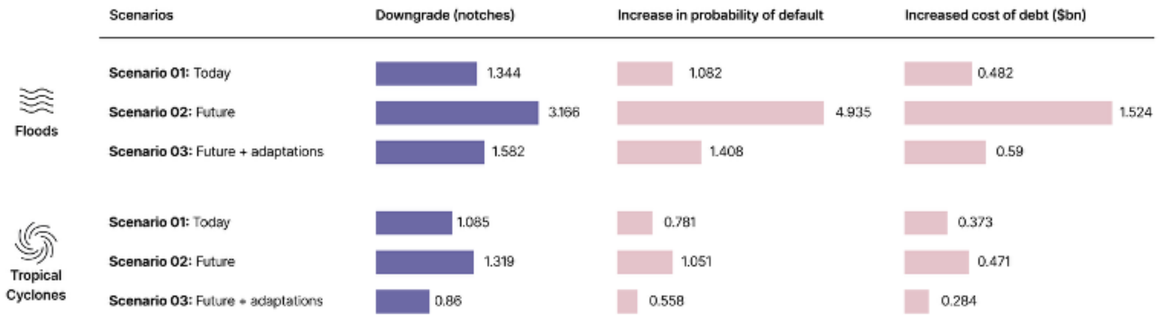



**FIGURE 15: SOVEREIGN CREDIT RATING DOWNGRADES, INCREASE IN PROBABILITY OF DEFAULT, AND INCREASED COST OF DEBT FOR THE FLOOD AND TROPICAL CYCLONE SCENARIOS IN THAILAND.**

This analysis is based on the following case study developed as part of the Resilient Planet Data Hub. The analysis has been further developed for river flooding, details can be found in the following paper[95,96]

This case study demonstrates the materiality of physical risks and adaptation for sovereign credit ratings and shows how current models can be used to inform financial decisions.

95 Resilient Planet Data Hub

96 Bernhofen et al, 2024. See Here

## 7.4 Assessment of pricing from a credit rating (banking) vs insurance premium perspective

Investing in resilience unlocks strategic advantages across the financial ecosystem benefiting investors, lenders, and insurers. For investors, financing resilience measures protects long-term asset value and reduces volatility, improving risk-adjusted returns. Lenders benefit from enhanced loan security, as resilient assets are less likely to suffer physical damage or business interruption, making them safer collateral and reducing default risk. Insurers, meanwhile, see reduced claims due to lower frequency and severity of losses, enabling more sustainable pricing and underwriting capacity. Collectively these outcomes create a reinforcing cycle of financial value, where resilience drives stability and financial confidence.

The PCRAM 2.0 case studies shifted the narrative away from loss minimisation towards asset value optimisation, achieved through adaptation and resilience investment. The case studies that analyse solar farm portfolios in Italy and France demonstrated that the integration of physical climate risk analysis into investment decision-making can lead to tangible financial benefits, including enhanced asset valuation. The case studies quantified how resilience interventions, such as hail protection systems and measures to manage chronic heat stress, reduced vulnerability and improved performance reliability. For investors, this meant a measurable uplift in the Internal Rate of Return (IRR) - the key financial indicator of value. The findings also reinforced the principle that investing in resilience is not only a risk management tool in the short-term, but also a driver of long-term value preservation and enhancement.

Increasing asset and portfolio resilience – through measures such as adaptation and risk-informed maintenance and operation regimes – should logically lead to improved insurance outcomes. Resilience investments reduce vulnerability and expected damage ratios, which in turn can lower both Average Annual Losses (AAL) and tail metrics (e.g., Probable Maximum Loss or Tail VaR). These reductions should support more favourable insurance terms including improved pricing, lower deductibles, broader coverage, and increased capacity.

As market signals begin to reflect the value of resilience, more resilient assets may attract capital and financing, creating a positive feedback loop that encourages further investment, helping to build the evidence base and inform future financial decision-making.

## 7.5 A review of mechanisms that have been used in the past for climate finance, and assess their suitability for adaptation and resilience

The following section outlines a range of mechanisms banks and insurers can employ to incentivise adaptation and resilience finance, encompassing regulatory, market-based, and strategic approaches. These tools can enhance the attractiveness of adaptation and resilience investments while contributing to broader environmental and financial stability outcomes.

### 7.5.1 Risk-based mechanisms

**Risk-Weighted Asset (RWA) adjustments**

Capital requirements are a central element of banking regulation. The risk weights applied to different types of assets directly affects the cost of lending and therefore the incentives for banks to engage in individual business lines. Article 501a under the EU's Capital Requirements Regulation (CRR2)[97] outlines the infrastructure supporting factor—a mechanism that allows less capital to be held against eligible transactions deemed to provide essential public infrastructure. This treatment mirrors the existing SME supporting factor and recognises the potentially lower long-term risk profile of environmentally sustainable investments. The Climate Financial Risk Forum (CFRF) aims to shine a light on these regulatory mechanisms, emphasising their role in fostering a more resilient and sustainable financial system.

**Capital Requirements Regulation 2 (CRR2) treatment [article 501(a)]:**

CRR2 was created to align EU Banking rules with updated Basel III standards, enhancing financial stability and transparency across the banking sector. Article 501a of CRR2, also known as the Infrastructure Supporting Factor, aims to promote investment in infrastructure. **Qualifying infrastructure investments that strengthen competitiveness and simulate jobs can avail of a reduction in risk-weighted assets (RWA) of 25% under the infrastructure supporting factor. This allows Banks to be more capital efficient.**

To qualify for this supporting factor, a list of conditions should be met, including:

- The exposure is to an entity which was created specifically to finance or operate physical structures or facilities, systems and networks that provide or support essential public services.
- The bank has assessed that the project contributes to environmental objectives (including climate change adaptation).[98]

To implement CRR2, banks need to update their internal systems, models, and processes to comply with new capital, liquidity and reporting requirements. They also need to be able to identify and correctly apply new risk weightings to eligible exposures. In addition, banks should ensure proper governance and enhance transparency through more detailed regulatory disclosures.

97 EBA | Report on the Application of the Infrastructure Supporting Factor

98 CRR2-Infrastructure Supporting factor | Katalysys - Risk and Regulatory Advisory

Application of Article 501a to the SCB Project & Export Finance portfolio commenced in Q2 2021. As at end of 2024, the Risk Weighted Assets ("RWA") adjustments under Article 501a were applied to 36 eligible Project and Export Finance transactions spanning multiple geographical locations.

An example of a project is an availability-based Public-Private Partnership (PPP) procured by the Queensland State Government for the design build, finance, non-clinical services, and maintenance of a tertiary level public hospital in Queensland. The delivery of all medical functions of the Sunshine University Coast Hospital ("SCUH") will be undertaken by the State of Queensland outside of the PPP contract.

This is applicable for CRR2 501a as the transaction involves the refinancing of the SCUH PPP. Project Finance scorecard is being applied, and the facility would benefit from standard project finance terms and security package typical for projects of this nature in Australia. The project meets the "**Climate change adaptation**" objective and does no harm to any of the other objectives. SCUH has been awarded certified ratings by the Green Building Council Australia and is the largest public healthcare facility in Australia to achieve the certification.
In May 2025, the PRA published near-final Policy Statement PS7/25, providing details on the proposed adjustments for infrastructure lending under Pillar 2A, aimed at minimising disruption following the removal of CRR2 501a under Basel 3.1 Pillar 1. The criteria for the infrastructure supporting factor under Pillar 2A will remain the same as those previously implemented under CRR2 501a. The go-live date for PS7/25 is aligned with Basel 3.1 implementation in the UK, currently set for 1 January 2027.

### 7.5.2 ESG integration in credit risk assessment

Banks can incorporate Environmental, Social, and Governance (ESG) considerations into their internal credit assessment models. By recognising the materiality of climate risks, such as stranded assets or regulatory transitions, banks can more accurately price risk and allocate capital. Green, social or sustainable project would be eligible for more favourable terms, effectively reducing their cost of capital.

**Reframing for resilience:** The value of adaptation and resilience measures explicitly incorporated into internal ESG and climate risk assessments, with a more seamless link to improvements in credit quality and risk reduction.

### 7.5.3 Pricing incentives

**Preferential loan pricing**

One of the most direct ways banks can support green finance (including adaptation and resilience) is through preferential pricing for eligible loans. This might include offering lower interest rates, extended maturities, or reduced fees for projects that meet defined environmental criteria.

**Reframing for resilience:** Commonwealth Bank introduced a green home loan offer[99] - it promises lower interest rates for customers whose homes meet certain sustainable conditions, such as having a certified Green Star Home assessed against 3 categories, of which 1 is resilience (water efficient and climate change ready).

### Sustainability-linked instruments (SL-instruments)

Sustainability-Linked instruments link the cost of borrowing (in the case of loans) to the borrower's sustainability performance, typically through pre-agreed KPIs. If the borrower meets or exceeds these targets—such as reducing greenhouse gas emissions—the KPI is achieved, the interest payment on the loan is adjusted favourably to the borrower. There are also examples where if the borrower fails to meet the KPIs, the interest rate is adjusted higher. This mechanism aligns borrower incentives with broader sustainability goals and promotes ongoing improvements rather than one-off project alignment. Sustainability-Linked Loans and bond issuance has been declining since their peak in 2021[100] but when launched remained an effective instrument to encourage companies to enhance environmental and social KPIs. In principle, resilience enhancing KPIs can incentivise a company to support their own adaptation strategy.

**Reframing for resilience:** Banks could lend to clients to build resilience or adaptive capacity. Given that these loans should benefit the Bank, in terms of balance sheet de-risking, Banks could reward the capex investment with better pricing on a resiliency-linked basis. Equally, failure to use the capital for resilience could result in a penalty in a generic corporate loan. Recent research by Resendiz, Ranger et al. 2025[100] shows that adaptation and resilience KPIs are already used in the market, particularly in real-estate and agri-foods, yet the application remains underdeveloped. The research suggests significant untapped potential and makes recommendations on how to advance the application (see Box below).

**Reframing for resilience**: Aligned with the work that is developing in Deliverable 4 on resilience metrics, Banks could frame Sustainability-Linked transactions around adaptation and resilience. Such solutions could incorporate insurance mechanisms or products that underpin resilience metrics that are focused on improving asset vulnerability and preserving value.

### Status of sustainability-linked financial instruments for adaptation

As of early 2024, very few sustainability-linked loans or sustainability linked bonds explicitly include adaptation-related KPIs.[102] Where adaptation and resilience components are included, they are typically qualitative, indirect, or embedded within broader ESG or mitigation-oriented frameworks.

Despite this, research by Resendiz, Ranger et al. shows that there is significant untapped potential for

99 What you need to know about CommBank's Green Home Loan Offer | Mozo

100 Global sustainable finance 2025: mixed results highlight regional differences | articles | ING Think

100 Resendiz et al, 2025. See Here

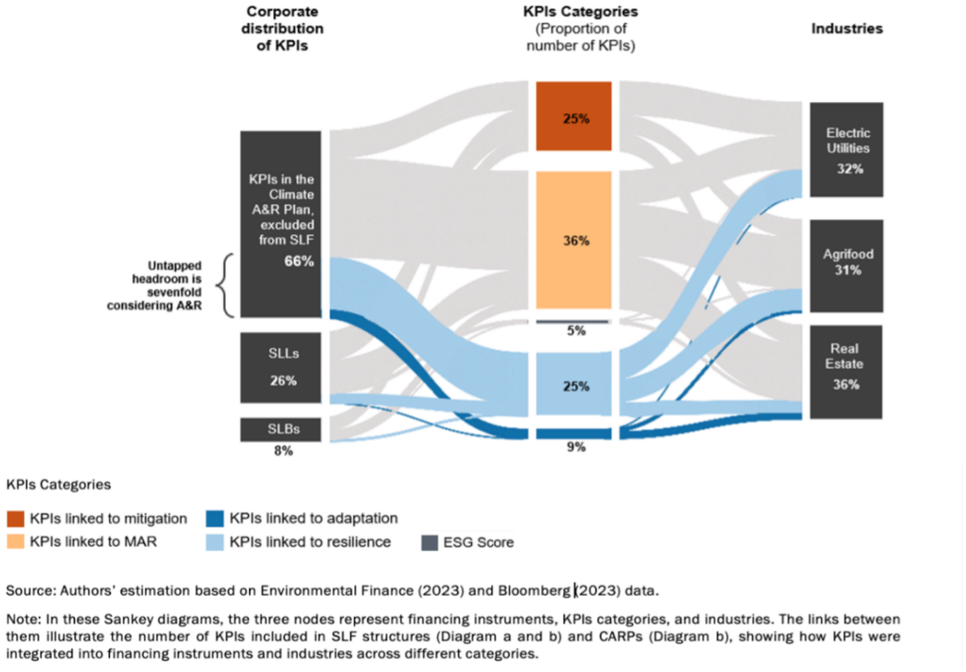
102 Sustainability-Linked Financing for Climate Resilience (part 1) - Cadlas

sustainability-linked finance to mobilise adaptation finance[103]. The research finds potential for a sevenfold increase in sustainability-linked finance KPIs on adaptation given that these KPIs are already included extensively in corporate sustainability plans. These existing, measurable targets—such as climate-resilient infrastructure upgrades and adaptive capacity indicators—offer a robust foundation for structuring credible, performance-based sustainability-linked bonds aligned with national adaptation priorities.

Market participants cite a number of technical and structural constraints: the lack of standardised resilience metrics; limited data availability and impact attribution tools; time-lagged benefits of adaptation investments; and reputational risks associated with perceived greenwashing. These limitations inhibit the development of performance-based pricing mechanisms that accurately reflect reductions in physical risk exposure or enhancements in adaptive capacity. In effect, sustainability-linked finance structures overwhelmingly prioritise decarbonisation targets, leaving a critical gap in financial mobilisation for adaptation.

### Key characteristics of the current market

- Low penetration of resilience-linked sustainability-linked finance instruments: A review of publicly available sustainability-linked bonds and loans found that less than 5% included any resilience-related targets, and even fewer had quantifiable adaptation metrics. Where adaptation is included, it is rarely material to loan pricing or bond coupons. This leads to underinvestment in resilience-enhancing measures, even where financial risk reduction is demonstrable.
- Lack of credible KPIs: Adaptation outcomes are often context-dependent and nonlinear, making it difficult to establish standardised, investor-grade KPIs.
- Challenges in performance verification: Existing verification mechanisms are largely tailored to mitigation KPIs (e.g., GHG intensity). For adaptation and resilience, forward-looking indicators (e.g., completion of resilience audits, percentage of climate-resilient infrastructure upgrades) lack common validation protocols.
- Market uncertainty and reputational risk: Without robust guidance or benchmarks, issuers and investors are concerned about credibility and greenwashing. As a result, adaptation targets are often excluded or diluted, especially in primary markets.




Source: Authors' estimation based on Environmental Finance (2023) and Bloomberg (2023) data.

Note: In these Sankey diagrams, the three nodes represent financing instruments, KPIs categories, and industries. The links between them illustrate the number of KPIs included in SLF structures (Diagram a and b) and CARPs (Diagram b), showing how KPIs were integrated into financing instruments and industries across different categories.

**FIGURE 16: ANALYSIS OF ADAPTATION AND RESILIENCE LINKED KPIS IN THE SUSTAINABILITY LINKED LOAN MARKET**

103 Sustainability-linked finance: bridging nature disclosure gaps in Southeast Asia

To expand the use of sustainability-linked finance for adaptation, the research recommends:

1. **Develop Sector- and Location-Specific Resilience KPIs:** Collaborate with technical bodies (e.g., MDBs, NGOs, standards setters) to define quantifiable, evidence-based KPIs that reflect context-specific exposure and vulnerability.
2. **Integrate Physical Risk Data and Scenario Tools:** Use existing platforms (e.g., PCRAM, G-SRAT) to align loan/bond performance indicators with forward-looking hazard, exposure, and adaptation pathways. Embed physical risk-adjusted outcomes into pricing and structuring decisions.
3. **Advance Blended Structures and Performance-Based Grants:** Partner with public and concessional finance actors to pilot deals that incorporate resilience targets into pricing or repayment terms. For example, concessional tranches could reward the achievement of adaptation milestones or offer grace periods linked to resilience upgrades.
4. **Adapt sustainability-linked finance Frameworks to Reflect adaptation and resilience Characteristics:** Update existing International Capital Markets Association (ICMA) and Loan Market Association (LMA) guidance to explicitly incorporate adaptation materiality, recognising longer time horizons and system-level co-benefits. Encourage second-party opinion providers to include resilience-specific methodologies and impact assurance protocols.
5. **Enhance Incentive Mechanisms:** Explore differentiated pricing structures (e.g., step-down margins, fee rebates) tied to reduced insurance premiums, enhanced asset valuation, or verified resilience outcomes. This could help internalise the risk-reducing benefits of adaptation across capital markets.
6. **Build Capacity and Market Confidence:** Train internal structuring, risk, and ESG teams on adaptation metrics and scenario analysis. Engage with regulators and investors to promote disclosure of physical risk-adjusted financial metrics and integration of resilience KPIs into mainstream sustainability-linked finance reporting templates.

## 7.6 Financial innovation and product design

### 7.6.1 Green bonds and sustainability-linked bonds

By underwriting, issuing, or investing in green, social and sustainability bonds (Box above), banks help develop liquid capital markets for environmentally beneficial activities. These instruments allow issuers to raise funds for eligible projects, with use-of-proceeds structures ensuring transparency. Banks also benefit through fee income, brand positioning, and regulatory recognition.

**Reframing for resilience:** Banks can help issuers identify and issue resilience themed bonds, using their own taxonomies, or being guided also by resources such the Climate Bonds Initiative Resilience Taxonomy.[104]

### 7.6.2 Green securitisation

Green securitisation allows banks to pool green assets - such as renewable energy loans or green mortgages - and sell them as asset-backed securities. This helps banks manage balance sheet constraints, reduce risk concentration, and unlock capital for further lending. It also provides institutional investors with access to stable, long-dated green assets.

**Reframing for resilience:** Using Adaptation and Resilience Guides, such as the Guide for Adaptation and Resilience Finance[105], Banks can tag and track relevant adaptation and resilience exposures. Having done that, Banks can sell down some of these exposures to investors. This creates access for interested investors and also allows banks to lend more into these areas.[106]

### 7.6.3 Blended finance and country level platforms

**Adaptation and resilience guarantee products**

Blended finance represents a structuring approach that strategically leverages concessional capital (i.e., below market terms) and non-monetary assistance (e.g. technical assistance funded from public or philanthropic sources) to mobilise additional commercial capital for sustainable development projects.[107] Archetypical blended finance, as depicted in Figure 17, often involves the use of concessional funds within the capital structure of a project to lower the overall cost of capital or to provide an additional layer of protection to private investors. Often, this protection is further formalised through loan arrangements in which debt to concessional partner(s) is subordinated, while commercial debt is retained as senior. Concessional investors may also provide credit enhancement through guarantees or insurance on below-market terms making the project's risk-return profile increasingly attractive for commercial investors. Guarantee products for adaptation and resilience are financial instruments designed to mitigate the risks associated with climate change and enhance the resilience of various sectors, including

104 Climate Bonds | Climate Bonds Resilience Taxonomy

105 Guide for Adaptation and Resilience Finance | Standard Chartered (sc.com)

106 HLEG | Financing a Sustainable European Economy

107 Ranger et al. 2025 Here

infrastructure, agriculture, and water security. These products play a crucial role in encouraging investment in climate adaptation and resilience by providing financial assurance and reducing the perceived risk for investors and lenders.

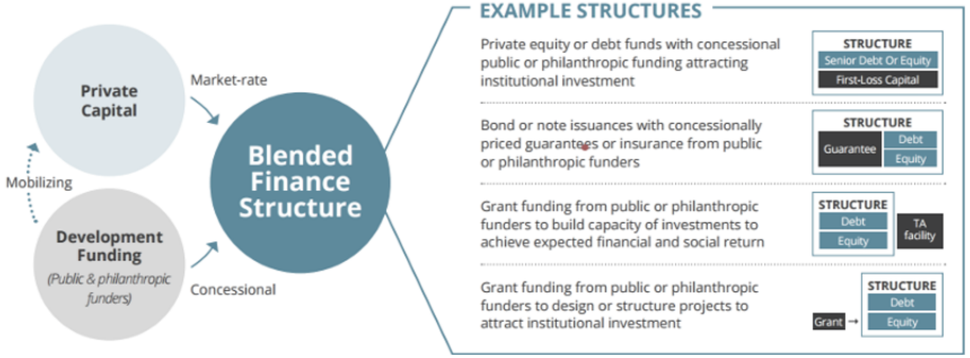



**FIGURE 17: CURRENT LANDSCAPE OF BLENDED FINANCING STRUCTURES AND LEVERAGING MECHANISMS: SOURCE: (CONVERGENCE 2023)**

**Reframing for resilience:** The Green Climate Fund (GCF)[108] is investing in developing countries' efforts to adapt to the effects of climate change. GCF is delivering on targets for adaptation and resilience by ensuring a 50/50 balance in allocation of funding between mitigation and adaptation projects, with over 50% of adaptation funding going to Least Developed Countries (LDCs), Small Islands Developing States (SIDS) and African States. The Green Guarantee Company (GGC) was established in 2024 to provide guarantees to borrowers in developing markets to enhance credit quality and enable access to global capital markets. GGC are primarily focused on low carbon infrastructure but could be extended to adaptation-focused assets by supporting A&R loans.

### 7.6.4 Case study: Helios CLEAR Fund – scaling private capital for climate resilience in Africa

**Overview**

The Private Infrastructure Development Group (PIDG) is a multi-donor development finance institution that mobilises private investment into infrastructure in frontier markets, with a strong emphasis on development impact and climate resilience. Over the past few years, PIDG has become one of the leaders in blended finance for adaptation. As an example, in 2023, PIDG—through its company InfraCo Africa—anchored the first close of the **Helios Climate, Energy Access, and Resilience (CLEAR) Fund**, which secured USD200 million in commitments. The fund is managed by Helios Investment Partners and supported by the UK's Foreign, Commonwealth & Development Office (FCDO) via the MOBILIST programme.

**Adaptation and resilience integration[109]**

CLEAR targets investments in climate-smart sectors such as **resilient agriculture, decentralised energy, green mobility**, and **digital enablers of climate resilience**. The fund embeds adaptation and resilience considerations into its investment strategy, due diligence, and impact measurement—seeking to improve long-term climate preparedness while delivering risk-adjusted financial returns.

**Relevance for systemic resilience and adaptation finance**

- CLEAR demonstrates how blended finance structures can crowd in commercial capital for resilience-oriented infrastructure and services.
- By targeting under-invested, high-climate-risk sectors across Africa, the fund aims to increase access to adaptation-enabling technologies, services, and infrastructure.
- PIDG's early-stage catalytic investment played a key role in de-risking the fund and aligning private capital with adaptation and resilience outcomes.

108 Thematic brief: Adaptation | Green Climate Fund

109 UK backing enables new Africa-focused climate fund to achieve USD200m first close - PIDG

## 7.7 Strategic and portfolio-level approaches

### a. Portfolio targets

Banks can voluntarily set quantitative targets for the share of their lending or investment portfolios that support sustainable activities. These targets often form part of broader sustainability or net-zero commitments and can drive internal alignment across business units.

**Reframing for resilience:** Using Adaptation and Resilience Guides, such as the Guide for Adaptation and Resilience Finance, Banks can tag and track relevant adaptation and resilience exposures. Having done this, Banks can set targets on how they want to grow adaptation and resilience investment. Useful guidance on this has been published by the UNPRB[110].

### b. Exclusion and divestment policies

To complement positive incentives, banks may also restrict exposure to environmentally harmful sectors—such as coal, Arctic drilling, or deforestation-linked agriculture. These exclusionary policies reduce reputational risk, align with client values, and reinforce the bank's strategic positioning on sustainability. Furthermore, it supports a shift of capital allocation away from harmful sectors and potentially towards those focused on adaptation and resilience.

### 7.7.1 Policy and regulatory leverage

**Central bank incentives**

Monetary authorities can support green finance through preferential refinancing schemes or by accepting green assets as eligible collateral. For example, the People's Bank of China has implemented re-lending facilities at concessional rates for banks financing carbon-reduction projects. Such measures reduce funding costs and improve liquidity for green sectors. However, it is important to recognize that different central banks have different mandates and priorities and also choose to support green and sustainable finance in different manners, using a wide variety of mechanisms.

**Reframing for resilience:** Under this facility, the People's Bank of China lends 60% of the principal amount of qualified green loans made by financial institutions at a one-year interest rate of 1.75%. The facility primarily supports projects in clean energy and energy conservation, these areas show strong co-benefits with adaptation and resilience.

### 7.7.2 Client engagement and advisory

Banks and insurers can act as transition partners for their clients by offering strategic advice, financing solutions, and data tools to facilitate decarbonisation as well as adaptation solutions. Services may include ESG advisory, climate scenario analysis, risk advisory and transition planning support. These offerings help clients align with regulatory trends, improve ESG ratings, and maintain access to competitive capital.

The role of advisory can be tailored based on a client's physical risk exposure and maturity of their resilience planning. A client with key or high value assets in an area with high vulnerability to one or multiple risks may have implemented measures to reduce potential impacts but may not necessarily have disclosed these investments where client engagement may provide these additional details where adaptation assessment can be focused on specific risks or measures.

### 7.7.3 Case study: first comprehensive, climate-conditioned agricultural risk model across the EU 27 countries[111]

In 2025, the EU Commission, supported by work completed by the European Investment Bank and Howden, published a comprehensive, climate-conditioned agricultural risk model for all EU 27 countries demonstrating the impact of climate-risks on the European agricultural sector. This report models climate risks to EU agriculture (now and into 2050) and assessed agriculture-insurance schemes across the 27 EU Member States, quantifying the size of the remaining protection gap.

The analysis shows that the European agriculture sector loses an average of €28bn annually due to adverse weather, with losses projected to exceed €40bn per year by 2050 under business-as-usual emissions scenarios, and in excess of €90bn in a catastrophic year by 2050. Importantly, using insurance risk quantification methods allows the EU Commission to a) value to potential exposure to an entire sector, b) use those values to inform decision-making, for example around potential resilience and adaptation measures and c) consider risk transfer mechanisms to manage the risk exposures.

The report includes a number of recommendations for the EU and member states, including:

- Improving data, analytics and modelling to understand EU agriculture climate risks and therefore manage them
- Accessing risk capital markets, including (re) insurance and catastrophe bonds to better protect the farming community
- Enhancing agriculture adaptation and financial resilience, through interventions at a farm and regional level.

### 7.7.4 Case study: incentivising adaptation through insurance innovation: the case of Zephyr Power

Innovative insurance solutions can play a critical role in unlocking investment in climate adaptation and resilience. By recognising and rewarding risk-reducing measures, insurers can help shift market behaviour and direct capital toward solutions that enhance long-term asset viability. The following example from Zephyr Power's wind project in Pakistan illustrates how integrating insurance with on-the-ground adaptation — in this case, mangrove restoration — not only reduced physical climate risks but also improved financial outcomes.

110 PRB Adaptation Target Setting Guidance (unepfi.org)

111 Insurance EU agriculture (howdengroup.com)

**Challenges**
Zephyr Power's wind project in Pakistan's Indus River Delta 23 faced environmental threats, such as tidal erosion and storm surges and typhoons. These risks were worsened by the degradation of local mangroves, leaving the wind power infrastructure vulnerable.

**Risk exposure**
Environmental hazards threatened to increase maintenance costs and disrupt energy production, undermining the long-term financial viability of the project.

**Risk mitigation**
Zephyr implemented a hybrid solution, integrating Mangrove Restoration with Asset Protection Insurance. The restored mangroves acted as a natural barrier, shielding the wind power infrastructure from environmental risks.

**Impact**
The USD352,400 investment in mangrove restoration is expected to save Zephyr Power USD1 million in maintenance costs over the project's lifetime, justify reduced insurance premiums for the USD7m wind turbines and is projected to generate USD6.75 million in increased local fishing revenues over 25 years, doubling local community incomes demonstrating financial, nature and local community benefits.

This example is one of many outlined in "The Great Enabler" (2024) report published by Howden and BCG to highlight examples of how insurance is being used to unlock investments and projects that will accelerate a shift to a resilient economy[112].

### **7.7.5 Case Study:** PCRAM 2.0: enhancing investment resilience for solar assets in Italy

Building on the PCRAM 2.0 case study outlined in 4.2.1 investment fund portfolio of solar farms across Italy – Howden's Resilience Laboratory operationalised the PCRAM framework using Microsoft's computational platform, together with proprietary climate, risk engineering, and financial modelling methodologies to quantify the materiality of climate risk impacts on the portfolio and translate those insights into actionable metrics to inform investment decisions.

The end-to-end risk intelligence model was able to:

- Identify material climate risks ranked by investment vulnerability
- Provide a comparison of climate- and resilience-adjusted cash flow projections
- Quantify reduction in investment return expectations
- Recommend optimal resilience measures based on cost-benefit analysis

The insights generated through this analytical assessment helped to understand the materiality of climate risks to cash flows, identify ways to establish a climate-resilient revenue stream and understand which resilient measures could be implemented to reduce the downside risk and ensure optimal divestment opportunities.

This case study illustrates how PCRAM 2.0 can be operationalised to support investor decision-making and unlock strategic financial value through resilience.

## Summary

Chapter 7 highlights how financial markets can help scale adaptation and resilience by embedding climate risk and resilience into credit assessments, insurance pricing, and investment products. Case studies demonstrate how resilience measures can reduce losses, strengthen creditworthiness, and unlock capital flows. Looking ahead, the priority is to ensure resilience is systematically valued through improved pricing, financial innovation, and policy frameworks—so that adaptation becomes a mainstream component of financial decision-making.

112 The Great Enabler (howdenprod.com)

# 8. Skilling up – training available on physical risks of climate change in the financial sector

**Writers:** Rebecca Osborne, Daisy Harley-Nyang, Pete Walton, Jason Lowe, Victoria Ramsey, Lisa Marshall, Hannah Griffith, Natalie Garrett, Theresa Löber, Rebecca Sawyer, Yasmine Orchard, Alison Flack

Building capacity to enable financial institutions to act on the insights from this is key to mobilise adaptation finance. Initial training needs for the finance sector around understanding the physical risks of climate change include the following four aspects.

1. Basic climate understanding for finance professionals.
2. Technical information on climate data sources and tools for processing.
3. Guidance to differentiate between high and low-quality climate data providers.
4. C-suite training for senior staff.

### **8.1 Case study:** EFFAS Climate Risk Analyst certification (ECRA)[113]

Development of a Climate Risk Analyst certification program: Marsh McLennan has developed a training programme for the European Federation of Financial Analysts Societies (EFFAS), providing a range of climate-specific skills and tools to financial analysts and other professionals as part of the new EFFAS Climate Risk Analyst certification (ECRA). The course also includes dedicated modules on climate modelling, risk quantification and scenario analysis, equipping professionals with the skills to engage with and utilize climate analytics.

113 EFFAS Climate Risk Analyst® (ECRA) - EFFAS