GLOBAL CENTER ON ADAPTATION

Handbook for Financial Institutions

Climate Adaptation Finance

Module 3

GLOBAL CENTER ON ADAPTATION

In collaboration with:

European Bank for Reconstruction and Development

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About the Global Center on Adaptation

The Global Center on Adaptation (GCA) is an international organization that promotes adaptation to the impacts of climate change. It works to accelerate action and support for adaptation solutions by shaping policy reforms and influencing investments made by international financial institutions and the private sector. The goal is to bring climate adaptation to the forefront of the global fight against climate change and ensure that it remains prominent. Founded in 2018, GCA ensures a continuous, two-way exchange of knowledge and best practices that empower communities and drive resilient and inclusive growth worldwide.

About the European Bank for Reconstruction and Development

The European Bank for Reconstruction and Development (EBRD) is a multilateral development bank founded in 1991 with a mandate to foster sustainable, well-functioning market economies. Its governance and mandate enable it to combine finance, policy support and capacity building – powerful tools for unlocking private investment and scaling adaptation finance in the financial sector.

The EBRD works closely with private-sector and public partners to complement its adaptation financing. The Bank has financed climate-resilient infrastructure in its regions, advanced nature-based solutions, and strengthened the management of physical risk across sectors. Through financial institutions, the EBRD channels green finance via hundreds of thousands of sub loans, an intermediation model that the Bank also leverages to expand adaptation lending.

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European Bank for Reconstruction and Development

Module 3

Climate Risk Modelling for Financial Institutions

From Compliance to Strategy

Authors and Acknowledgements

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The resulting Handbook reflects a **co-created approach**, shaped by valuable input and feedback from participating institutions. It draws on **real-world case studies, policy tools, financial instruments**, and **modelling techniques** relevant to FIs operating across both emerging and developed markets.

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Table of Contents

Figures

Boxes

Acronyms

BIS	Bank for International Settlements
DFI	Development Finance Institution
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortisation
EAD	Exposure at Default
ECB	European Central Bank
ESG	Environmental, Social and Governance
FI	Financial Institution
GDP	Gross Domestic Product
IFRS	International Financial Reporting Standard
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
LGD	Loss Given Default
NGFS	Network for Greening the Financial System
PD	Probability of Default
RCP	Representative Concentration Pathway
SSP	Shared Socio-economic Pathway
TCFD	Task Force on Climate-Related Financial Disclosures
UNEP	United Nations Environment Programme
VaR	Value-at-Risk

Module Description

Module 3: Strategic Relevance of Climate Risk Modelling for FIs

Description

As climate-related risks grow in scale and complexity, financial institutions (FIs) must assess how climate risk aggregates and materialises at the portfolio level, affecting capital adequacy and long-term financial resilience. This Module introduces climate risk modelling as a forward-looking approach, emphasising its role in identifying and managing both physical and transition risks. It lays the foundation by defining climate risk modelling, outlining key components, and explaining its value in enhancing long-term resilience and regulatory alignment. The Module explores how FIs can apply these models strategically, supporting deal origination, investment prioritisation, and competitive positioning across various financial sectors. It presents the tools and methodologies used in climate risk modelling, including scenario analysis, climate scoring, and stress testing, while highlighting the importance of a multi-model approach tailored to the complexity of climate realities. The Module equips FIs with the knowledge to transform climate risk analysis from a compliance obligation into a strategic asset.

Target group

- Executive Management; Strategy Department
- Sustainability/Environmental, Social and Governance (ESG) Department
- Risk Management (incl. Credit Risk, Operation Risk, Market Risk) and Compliance Departments
- Public- and private-sector practitioners involved in identifying, developing, or financing adaptation projects at national, regional, or local levels.

Learning outcomes

Chapter 1: Climate Risk Modelling Foundations

- Define climate risk modelling and its key components
- Understand how climate risk modelling assesses both physical and transition risks impacting financial assets and operations
- Analyse the role of climate risk modelling in enhancing long-term resilience, guiding investment strategies, and ensuring regulatory compliance to support sustainable growth and climate adaptation

Chapter 2: Strategic Application of Climate Risk Models in Financial Institutions

- Understand the strategic importance of climate risk modelling in managing financial exposures and meeting evolving regulatory requirements
- Recognise how forward-looking climate risk analysis supports deal origination, strategic decision-making and investment prioritisation
- Appreciate the value of climate risk insights for diverse FIs, such as banks, asset managers, and private equity, in identifying new growth opportunities and gaining a competitive advantage

01

Climate Risk Modelling Foundations

Climate risk modelling equips FIs with the tools to identify, quantify and respond to both physical and transition risks linked to climate change. By combining historical data with forward-looking climate scenarios, these models transform complex risk factors into actionable insights that help decision-makers understand and mitigate risks, safeguard assets, adapt business models, and seize new opportunities. FIs rely on these models to enhance strategic planning, meet resilience targets, and proactively adapt to climate risks.

This chapter addresses the following questions:

- **What is climate risk modelling, and what are its key components?**
- **Why is climate risk modelling important for organizations in the context of climate change?**
- **How does climate risk modelling assess physical and transition risks that impact financial assets and operations?**
- **How does climate risk modelling support FIs' adaptation efforts?**

Target Group: Executive Management; Strategy Department; Risk Management (incl. Credit Risk, Operational Risk, Market Risk) and Compliance Departments; Sustainability/ESG Department.

What is climate risk modelling, and what are its key components?

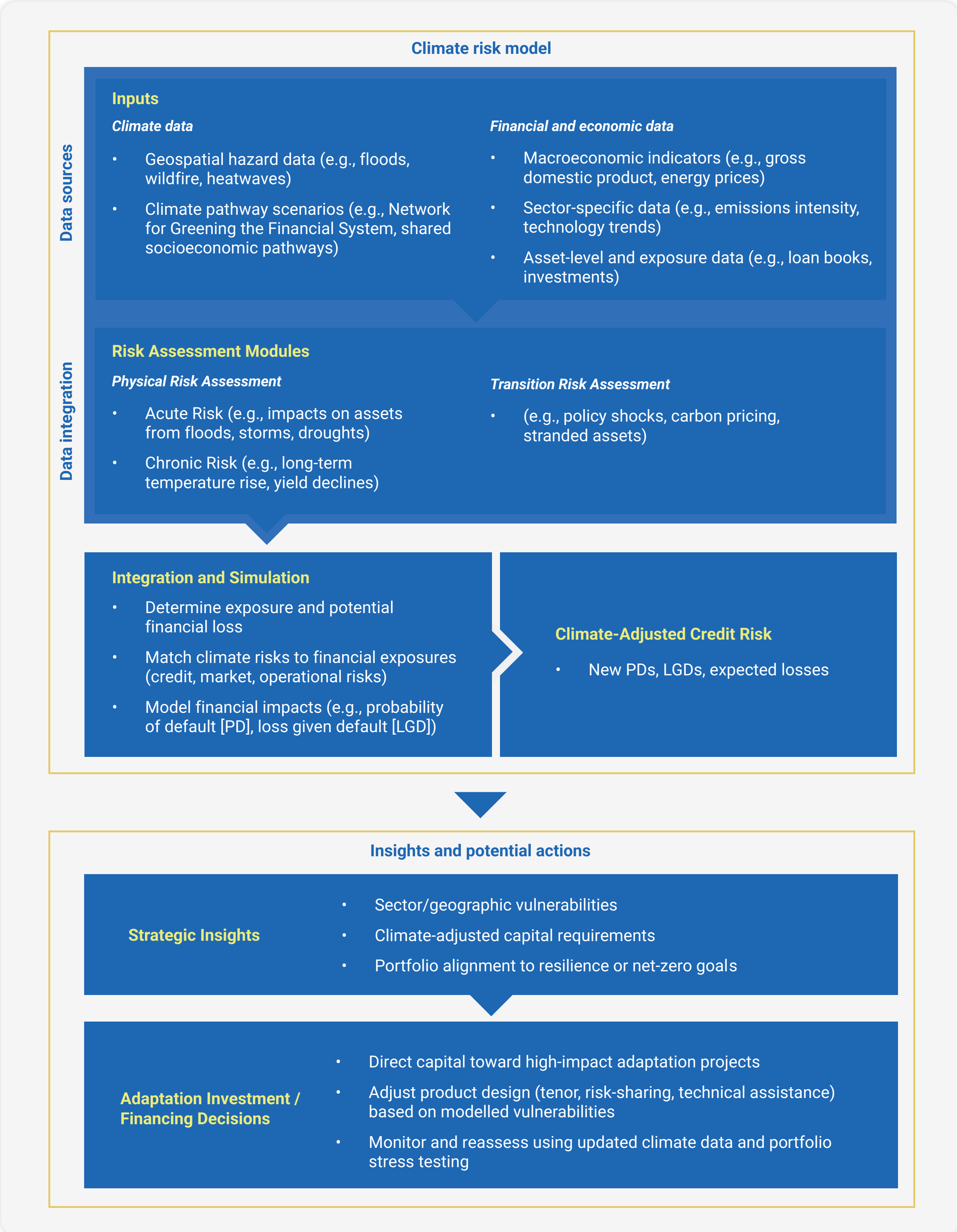
Climate risk modelling is not a single, uniform exercise. FIs apply climate risk analysis at multiple, interlinked levels: (1) to understand how physical climate hazards affect borrowers and economic sectors; (2) to assess climate-related risks at the level of individual projects for investment and credit approval; and (3) to evaluate climate-related risks and vulnerabilities across portfolios and at the institution-wide level. While these applications rely on standard analytical building blocks, they differ in purpose, scope, data requirements, and the use of decision-making. This Module focuses on portfolio-level climate risk modelling, while recognising that portfolio outcomes are shaped by underlying borrower-, sector-, and project-level risks. FIs use **climate risk modelling** as a forward-looking analytical approach to assess how the potential impacts of climate change may affect borrowers, projects, portfolios, and institutional operations. It incorporates **physical risks,** including **acute physical risks** (e.g., floods, wildfires, extreme heat) and **chronic physical risks** (e.g., sea-level rise, long-term temperature increase, and droughts), and **transition risks** (e.g., policy shifts, carbon pricing, and technology changes) to simulate various climate-related scenarios. These risks are analysed under alternative climate **scenarios** to estimate potential impacts on assets, cash flows, creditworthiness, and financial performance.

As illustrated in **Figure 1**, the key components of climate risk modelling include:

- **Climate scenarios** (e.g., Intergovernmental Panel on Climate Change [IPCC] pathways) that define alternative future climate and transition trajectories
- **Hazard data** (e.g., temperature, precipitation, sea-level rise, and extreme weather events)
- **Exposure data** (e.g., asset location, sector, counterparty type, and asset value)
- **Vulnerability factors** (e.g., sensitivity of assets, sectors, or borrowers to climate shocks and their adaptive capacity)

This modelling enables FIs to quantify climate-related risks and integrate them into decision-making, risk management and regulatory reporting. The outputs of climate risk models also inform adaptation-focused investment decisions, helping institutions identify priority sectors/clients, shape a pipeline of resilience projects, and guide deal origination and product design (e.g., use-of-proceeds or sustainability-linked structures with resilience key performance indicators).

Figure 1: Climate risk model: Stylised components, outputs and potential actions



Source: Authors.

Why is climate risk modelling important for organizations in the context of climate change?

Climate risk modelling is an essential tool for organizations seeking to manage portfolio-level risks in the context of accelerating climate change. As climate hazards intensify and historical patterns become less reliable predictors of future outcomes, effective climate risk modelling must integrate both historical records and forward-looking climate projections to capture the full range of potential impacts at the portfolio level. By combining past observations with scenario-based forecasting, climate risk modelling provides a dynamic framework for assessing, adapting to, and mitigating both chronic and acute climate threats, while evaluating their potential financial implications over different time horizons. This enables FIs to move beyond static, backwards-looking risk assessments and better anticipate how climate change may alter portfolio risk profiles.

At the portfolio level, climate risk modelling involves using data, scenarios and quantitative models to estimate the likelihood and severity of potential losses under different climate futures. It translates complex scientific and economic information into decision-relevant insights, supporting the assessment of vulnerabilities across asset portfolios, sectors and geographies, as well as exposure to broader economic and systemic risks. This dual-perspective approach ensures greater accuracy and relevance and relies on:

- Backwards-looking hazard data in climate risk modelling, such as flood maps, hurricane paths, or wildfire occurrences, are used to understand past **exposure** and **vulnerability**. For example, analysing the frequency and severity of storms over the past 50 years to estimate exposure to coastal flooding. These historical records provide valuable insight into how often certain hazards have occurred and where.
- Forward-looking projections help organizations anticipate future risks that may emerge under different climate scenarios. These projections, such as increases in average temperature under various greenhouse gas scenarios or sea-level rise, are modelled over long-time horizons using pathways like the IPCC **representative concentration pathways (RCPs)** or **shared socio-economic pathways (SSPs)** (discussed in Module 2). They are critical for understanding long-term risks like heat stress on infrastructure, changes in energy demand, or reduced agricultural yields.

By combining backwards-looking hazard data with forward-looking climate projections, climate risk models can offer a more complete and actionable assessment of future risk.

How does climate risk modelling assess physical and transition risks that impact financial assets and operations?

Climate risk modelling assesses the financial impacts of physical and transition risks through defined transmission channels that affect financial assets and operations. As discussed in Module 2, physical and transition risk drivers propagate through microeconomic and macroeconomic channels to ultimately materialise as traditional financial risks, such as credit, market, liquidity and operational risks.

Physical risk assessment typically combines geospatial hazard data (such as flood zones, wildfire frequency, or heatwave projections) with asset-level information to determine exposure, vulnerability and potential financial loss. For example, a commercial real estate lender may use high-resolution flood maps and IPCC temperature scenarios to assess how increasing flood risk affects the long-term viability and credit quality of coastal assets. Similarly, insurers and reinsurers use catastrophe and climate risk models to estimate future claims by assessing changes in the frequency and severity of weather-related hazards. Transition risk modelling evaluates how various climate policy pathways, such as rising carbon prices, bans on internal combustion engines, policy and regulatory developments, or consumer preferences, affect the financial health of sectors and firms. These models integrate macroeconomic variables (e.g., gross domestic product [GDP], energy prices), industry-specific data (e.g., emissions intensity, abatement costs), and finantial metrics (e.g., revenues, earnings before interest, taxes, depreciation, and amortisation [EBITDA] margins) to understand which borrowers or asset classes may face elevated credit risk. For instance, a bank with high exposure to fossil fuel clients may use transition risk models to estimate changes in borrower creditworthiness under a 1.5°C-aligned scenario.

How does climate risk modelling support FIs' adaptation efforts?

FIs use these tools to protect against disruption, strengthen long-term strategic planning, and meet resilience and mitigation targets. The power of climate risk modelling lies in its data-driven approach. By integrating large data sets, such as geospatial climate projections, historical **hazard** data, sector-specific **vulnerability**, and financial exposure profiles (e.g., non-performing loans; **probability of default [PD]; value-at-risk [VaR]**), models can pinpoint where and how physical climate risks will likely manifest and impact financial markets and institutions. However, the effectiveness of these models depends heavily on the analytical tools used. Whether identifying the financial implications of increased flooding in urban centres, the supply chain risks linked to drought in agricultural regions, or the insurance liabilities posed by rising wildfire frequency, modelling transforms projections into operational intelligence. This type of modelling is foundational for organizations committed to climate adaptation and resilience as it enables stakeholders to anticipate disruptions, justify investments in resilience-building adaptation measures, and proactively adapt to an increasingly volatile world. By leveraging advanced platforms and sector-specific expertise, climate risk modelling enables organizations to effectively respond to and navigate climate risks.

However, models alone are not enough. FIs must also invest in sound governance structures, robust data infrastructure, and internal capacity-building to ensure that modelling outputs are credible, trusted, and integrated into everyday operations. As climate science evolves and stakeholder expectations rise, models must remain dynamic, tested, refined and updated through continuous learning. Institutions that take a proactive approach to climate risk modelling will be better equipped to protect their assets, comply with emerging standards, and seize opportunities in the transition to a climate-resilient and low-carbon economy. The work begins with modelling, but its impact reaches far beyond, shaping how we finance, build, and thrive in a changing world.

02

Strategic Application of Climate Risk Models in Financial Institutions

This chapter focuses on how FIs apply portfolio-level climate risk modelling to support risk management, regulatory compliance and strategic decision-making. It demonstrates how climate risk insights can be translated into specific actions, including strengthening portfolio resilience, initiating adaptation-focused transactions, and developing financial products that support resilience-building outcomes. By applying climate modelling to portfolio management and business development, institutions can improve portfolio resilience while supporting compliance and strengthening competitiveness in the evolving climate finance landscape.

This chapter addresses the following questions:

- **Why must FIs understand and actively respond to climate risk by applying climate risk modelling?**
- **Why are climate risk models of strategic importance for FIs?**
- **How are FIs using climate risk modelling to manage climate-related risks?**
- **How do climate risk models help FIs comply with regulatory requirements?**
- **How does forward-looking climate risk modelling support strategic decision-making, investment opportunities, and deal origination for FIs?**
- **How does climate risk analysis benefit asset managers, private equity funds, and other FIs?**

Target Group: Executive Management; Strategy Department; Risk Management (incl. Credit Risk, Market Risk, Operational Risk) and Compliance Departments; Sustainability/ESG Department; Public- and private-sector adaptation practitioners.

Why must FIs understand and actively respond to climate risk by applying climate risk modelling?

Understanding climate risk has become a strategic objective for FIs worldwide. As climate change accelerates, it generates a growing spectrum of physical and transition risks arising from the shift toward a low-carbon economy. These risks can impact asset values, impair credit quality, increase insurance liabilities, and erode financial stability. For FIs, failure to anticipate and manage such risks can result in sudden losses, capital shortfalls and reputational damage. Conversely, integrating climate risk into financial decision-making enables the development of more resilient portfolios, informed pricing, and access to emerging green finance opportunities. Actively responding to climate risk is no longer optional, but essential for financial viability, long-term competitiveness, and evolving climate regulation. Institutions that invest early in robust, transparent, and science-based modelling frameworks will be better positioned to safeguard asset values, meet supervisory expectations, and unlock capital for sustainable development.

Why are climate risk models of strategic importance for FIs?

Climate risk models enable institutions to assess exposures, identify emerging risks, align with evolving regulatory frameworks, and, most importantly, prepare for a future in which the climate will play an ever-greater role in determining financial performance and stability. By investing in robust, transparent, and adaptive measurement frameworks today, FIs can strengthen their capacity to manage climate risk while positioning themselves as credible actors in financing the transition to a more sustainable and resilient economy.

How are FIs using climate risk modelling to manage climate-related risks?

In practice, FIs are embedding climate risk modelling into core risk management, portfolio monitoring, and decision-making processes, rather than treating it as a standalone analytical exercise. These models are applied to stress-test portfolios under forward-looking climate scenarios, identify concentrations of climate exposure, and inform risk mitigation actions across business lines. For example, a commercial bank may use climate risk outputs to reassess collateral eligibility and credit terms for infrastructure or real estate assets exposed to increasing heat stress or water scarcity, adjusting loan tenors or covenants accordingly.
Asset managers may use climate risk indicators to rebalance portfolios away from regions or sectors with deteriorating physical risk profiles. At the same time, insurers may incorporate forward-looking climate signals into underwriting guidelines, reinsurance strategies or capital allocation decisions. Transition risk modelling assesses potential financial and operational impacts on organizations due to shifts toward a low-carbon economy, which are equally vital. As countries implement carbon pricing, fossil fuel bans, and renewable energy targets, clients in carbon-intensive sectors may see their operations become unviable. For example, a bank financing industrial projects in Southeast Asia might model how the introduction of a US$ 100/ton carbon tax would impact a cement manufacturer's cash flow and debt servicing capacity. This analysis can inform credit decisions and encourage clients to adopt cleaner technologies. At the portfolio level, these climate risk insights are increasingly translated into traditional credit risk metrics, such as PD, loss given default (LGD), and expected loss to support pricing, limit-setting, and portfolio monitoring (see **Box 1**).

Box 1: Linking climate risk drivers to credit risk metrics (Probability of Default, Loss Given Default, and Expected Loss)

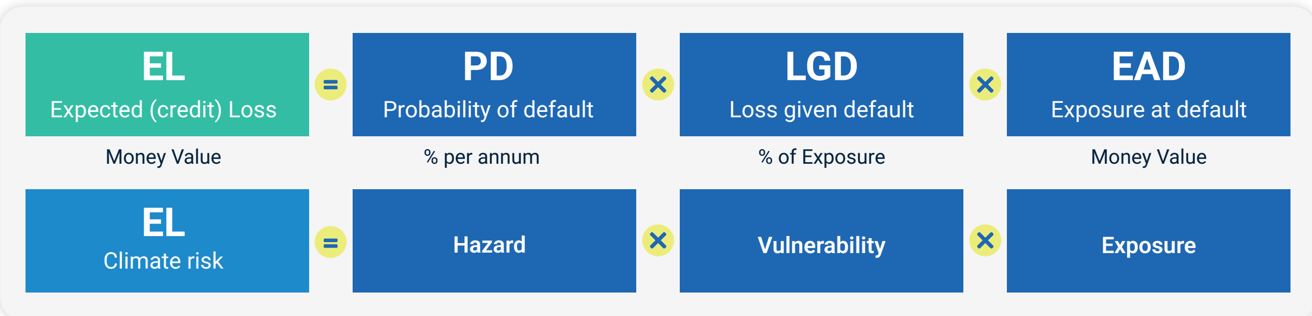
From an FI perspective, physical and transition climate risks primarily act as stress loss drivers that can increase the frequency and severity of credit losses within a loan portfolio. Climate risk modelling outputs can therefore be translated into traditional credit risk metrics. In most years, no major climate-related shocks may materialise, and observed credit losses may remain close to historical averages. However, climate change increases the likelihood of localised or sector-specific stress events, such as droughts affecting agricultural portfolios or flooding impacting urban areas with a high concentration of micro, small, and medium-sized enterprises. Such events can generate material losses, particularly for smaller or less-diversified institutions. Over time, repeated climate-related shocks can also erode borrower resilience and collateral values, leading to a gradual increase in baseline credit risk. This may be reflected in higher observed probabilities of PDs and LGDs, even in the absence of extreme events.

Climate risk modelling can be integrated into traditional credit risk frameworks by linking climate risk drivers to expected loss components:

- **Probability of Default (PD):** Climate hazards and transition pressures can affect clients' cash flows, operating costs and business continuity, increasing default risk.
- **Loss Given Default (LGD):** Physical damage to assets, reduced collateral values or impaired market liquidity can increase loss severity in the event of default.
- **Exposure at Default (EAD):** Climate-related disruptions may alter use patterns or drawdowns, affecting exposure levels.

The expected loss framework used in credit risk management provides a natural structure for integrating climate risk drivers. Expected loss in credit risk (**EL = PD × LGD × EAD**) closely mirrors the climate risk formulation (**Hazard × Vulnerability × Exposure**) introduced in Module 2, creating a clear conceptual bridge between climate risk analysis and established credit risk metrics (see **Figure 2**).

Figure 2: Expected loss logic for credit risk and climate risk



Source: Authors.

By linking climate hazard, exposure and vulnerability information to PD, LGD and EAD estimates, FIs can embed climate risk considerations into portfolio monitoring, pricing, limit-setting, and **stress testing**.

This expected loss logic underpins the integration of portfolio-level climate risk analysis into existing credit risk management processes.

How do climate risk models help FIs comply with regulatory requirements?

These models also support regulatory compliance. Disclosure frameworks, such as the International Financial Reporting Standards (IFRS) S2, (which fully incorporates prior Task Force on Climate-Related Financial Disclosures [TCFD] recommendations) require institutions to assess and report on climate risks that materially affect their business operations, strategy and financial performance. Climate stress tests, such as those conducted by the European Central Bank (ECB) or the Bank of England, simulate how adverse climate scenarios could affect capital buffers and solvency. In response, leading banks such as HSBC and BNP Paribas have begun to integrate climate **scenario analysis** into their enterprise risk management systems, while investors are increasingly demanding transparent and quantifiable assessments of portfolio exposure to climate risk.

How does forward-looking climate risk modelling support strategic decision-making, investment opportunities, and deal origination for FIs?

Understanding climate risk enables FIs to identify new market opportunities and guide strategic choices. Forward-looking climate analysis uses tools like scenario modelling, **geospatial risk mapping**, and **transition risk score** to uncover emerging trends in both vulnerable and high-growth sectors.

Understanding climate risk is essential for identifying new investment opportunities. For example, by mapping drought-prone regions and overlaying them with agricultural loan data, a microfinance institution may identify clients who would benefit from climate-resilient farming solutions, enabling the institution to develop tailored green loan products. Similarly, a commercial bank using climate data may determine that some agricultural regions are at high risk of water stress but show strong demand for climate-resilient irrigation systems or crop insurance. This insight can lead to the development of targeted green loans, climate adaptation bonds, or blended finance structures co-financed with development institutions.

By systematically assessing climate-related risks and opportunities, FIs can uncover new market segments, tailor financial products to evolve client needs, and position themselves as leaders in financing the transition to a climate-resilient, low-carbon economy. In short, climate risk analysis is a strategic asset. It allows FIs to initiate climate-aligned transactions, reposition portfolios for resilience, and offer differentiated products in emerging green markets. Institutions that leverage climate intelligence to guide investment decisions and client engagement will comply with regulatory demands and gain early-mover advantages in the climate finance landscape. **Box 2** illustrates how the results of climate risk analysis at the portfolio level inform client engagement and investment decisions, which are essential for several reasons, especially for FIs aiming to move from risk assessment to strategic action.

Box 2: Climate risk analysis to inform business decisions

This approach can be broken down into five key areas:

Translating data into strategic decisions	Targeting high-risk or high-opportunity clients	Supporting capital allocation and resilience building	Meeting regulatory and stakeholder expectations	Driving proactive and differentiated client engagement

1. Translating data into strategic decisions

Climate risk analysis at the portfolio level provides a big-picture view of **exposure** and **vulnerability** across geographies, sectors, and asset classes. However, its value lies in how institutions use that information to prioritise action. FIs need to translate these high-level risk assessments into real decisions, such as which clients to support in transition, and where to channel new capital for resilience.

Example: If a portfolio shows high exposure to tourism assets in regions experiencing longer and more intense heat seasons, the FI can work with hotel operators to finance cooling-efficient retrofits, water-efficiency measures, or diversification into year-round tourism offerings that reduce climate sensitivity.

2. Targeting high-risk or high-opportunity clients

By highlighting how climate risk results inform client segmentation, the section shows how institutions can differentiate between clients based on climate vulnerability or readiness. This enables tailored offerings (e.g., sustainability-linked loans, transition support) and helps de-risk portfolios by supporting clients with viable adaptation or mitigation pathways.

Example: An FI may identify water-intensive manufacturing clients operating in regions facing increasing water scarcity. This can trigger engagement to assess operational water risks and offer financing for water recycling systems, alternative cooling technologies, or process redesigns that reduce freshwater dependence.

3. Supporting capital allocation and resilience building

Portfolio-level climate analysis can guide capital allocation decisions, identifying where adaptation investments can most effectively reduce risk and preserve long-term value. Rather than reallocating capital away from climate-exposed actors, institutions can use insights to direct finance towards resilience-enhancing investments within those sectors and regions.

Example: Based on physical risk analysis, an investor may increase financing for climate-resilient coastal housing, such as elevated structures, flood-resilient materials, and improved drainage systems, in areas exposed to sea-level rise. This approach reduces long-term risks while maintaining market presence.

4. Meeting regulatory and stakeholder expectations

Supervisory bodies (e.g., ECB, Network for Greening the Financial System [NGFS]) and disclosure standards (e.g., IFRS S2 and TCFD) increasingly expect institutions to demonstrate how climate risk insights influence strategy and decision-making.

The next question to be discussed, “How does climate risk analysis benefit asset managers, private equity funds, and other FIs?”, highlights the importance of linking analysis to actions, which demonstrates maturity in climate risk governance and reinforces compliance narratives.

5. Driving proactive and differentiated client engagement

FIs need to go beyond passive risk monitoring toward proactive engagement with clients' adaptation and mitigation. A clear explanation of how portfolio-level insights guide such engagement positions the institution as a trusted advisor, not just a lender, and can open new business opportunities.

Example: A development bank identifies climate-exposed small and medium-sized enterprises in vulnerable regions and designs technical assistance programmes and concessional loan products to support their resilience plans.

How does climate risk analysis benefit asset managers, private equity funds, and other FIs?

For asset managers, private equity funds, and other FIs, climate risk analysis supports adaptation-focused investment decisions by identifying how physical climate risks affect asset performance, business continuity and long-term value. By assessing exposure to hazards such as heat stress, water scarcity, flooding, or extreme weather, investors can evaluate which assets, sectors or regions require resilience measures to remain viable over time. This enables more informed due diligence, asset selection and engagement strategies that prioritise risk reduction through adaptation rather than portfolio exit. For example, a private equity fund may identify a mid-sized manufacturing firm whose operations are increasingly constrained by water scarcity. Climate risk analysis can inform targeted investment in water-efficient technologies, alternative cooling systems or process redesign, improving operational resilience while protecting cash flows and asset value. Similarly, asset managers can use physical risk indicators to engage investee companies on adaptation plans, capital expenditure needs, and resilience metrics, strengthening long-term portfolio performance. Development finance institutions (DFIs) and commercial banks also use climate risk analysis to channel capital toward adaptation and resilience-building investments. DFIs increasingly apply climate modelling to prioritise investments in nature-based solutions, green infrastructure and resilient urban development. Commercial banks use climate risk insights to structure adaptation-linked loans, resilience-focused use-of-proceeds instruments and financing solutions that support clients in managing physical climate risks.

03

Additional Resources

Further sources on climate risk models for financial institutions

Reports

The following reports provide more detailed information on climate risks and transmission channels, stress testing, and climate scenario analysis:

- Bank for International Settlements. (BIS, 2021). Stress-testing banks for climate change – A comparison of practices. *Financial Stability Institute Insights,* No. 34.
- Basel Committee on Banking Supervision. (2022). *Climate-Related Risk Drivers and Their Transmission Channels*.
- Chartered Financial Analyst Institute. (2024). *Modeling climate transition risk: A network approach*.
- Edwards, B. et al. (2022). *Climate impact modelling framework*.
- European Central Bank (ECB, 2021). *Climate Risk Stress Test – Methodology*. ECB Supervisory Stress Test, 2022.
- European Central Bank (ECB, 2023). *Stress test of Euro area banks – Final results*.
- The Financial Conduct Authority - Bank of England (FCA BoE 2025). *Climate Financial Risk Forum report.* https://www.fca.org.uk/publication/corporate/from-risk-resilience-integrating-adaptation-finance.pdf.

- Hong Kong Monetary Authority. (2023). *Guidelines for Banking Sector Climate Risk Stress Test*.
- International Monetary Fund (IMF, 2023). *Stress testing climate risk: A global perspective*.
- Network for Greening the Financial System (NGFS, 2020). *Guide to climate scenario analysis for central banks and supervisors*.
- Network for Greening the Financial System (NGFS, 2020, updated in January 2025). *Guide to climate scenario analysis for central banks and supervisors*.
- Reinders, H. J., Schoenmaker, D. and van Dijk, M. (2023). *Climate risk stress testing: A conceptual review*. Rotterdam School of Management, Erasmus University.
- United Nations Environment Programme Finance Initiative (UNEP Finance Initiative, 2021). *Comprehensive good practice guide to climate stress testing*.
- United Nations Environment Programme Finance Initiative (UNEP Finance Initiative, 2024). *A comprehensive review of global supervisory climate stress tests*.

Publicly available tools and training

- Climate Training Alliance (NGFS, BIS, IMF) is an online portal that centralises climate-related and environmental risk training resources for central banks and supervisors, offering live and self-study materials to build expertise in handling climate financial risks.
- NGFS Climate Scenarios and Resources is a repository of forward-looking climate scenario data and technical resources designed to help users assess climate-related physical and transition risks for different future pathways.
- UNEP Finance Initiative Climate Risk Resources provides a comprehensive collection of tools, methodologies, guides and climate scenarios aimed at helping FIs assess, disclose and manage climate and sustainability risks.
- British International Investment's Climate Risk Management Toolkit for FI's is a free, modular, and practical resource designed for FIs, particularly commercial banks and MFIs in emerging markets. It helps FIs at any maturity level to identify, manage, and disclose physical and transition climate-related risks, aligning with international standards.
- The ARIC Physical Climate Risk Playbook provides a practical, product-agnostic framework to help investors integrate physical climate risk identification, assessment, and management into corporate finance decisions across equity and debt.
- PCRAM 2.0 is a methodology from the Institutional Investors Group on Climate Change that offers systematic, objective, and replicable guidance for incorporating physical climate risks into investment decisions across industries.

04 Glossary

Unless otherwise specified, all the definitions are drawn from the IPCC (2023) Glossary.

Acute physical risks: refer to those that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods (TCFD, 2017).

Chronic physical risks: refer to longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves (TCFD, 2017).

Climate risk modelling: The process of using data, scenarios, and analytical tools to quantify how climate risks may impact financial portfolios, institutions or economic systems over time (Authors).

Exposure: The presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.

Geospatial risk mapping: A modelling technique that overlays climate hazard data with asset locations to assess physical exposure at a granular, location-specific level (Authors).

Hazard: The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Physical risks resulting from climate change can be event driven (acute) or longer-term shifts (chronic) in climate patterns. Physical risks may have financial implications for organizations, such as direct damage to assets and indirect impacts from supply chain disruption. Organizations' financial performance may also be affected by changes in water availability, sourcing, and quality; food security; and extreme temperature changes impacting organizations' premises, operations, supply chain, transport needs, and employee safety (TCFD, 2017).

Probability of default (PD) is a measure used in credit risk management to estimate the percentage probability of a borrower to produce a default on their loan obligations within a given time frame, usually one year (Authors).

Radiative forcing: The change in the net, downward minus upward, radiative flux (expressed in W m–2) due to a change in an external driver of climate change, such as a change in the concentration of carbon dioxide (CO_2), the concentration of volcanic aerosols or in the output of the Sun. The stratospherically adjusted radiative forcing is computed with all tropospheric properties held fixed at their unperturbed values, and after allowing for stratospheric temperatures, if perturbed, to readjust to radiative-dynamical equilibrium. Radiative forcing is called instantaneous if no change in stratospheric temperature is accounted for. The radiative forcing, once both stratospheric and tropospheric adjustments are accounted for, is termed the 'effective radiative forcing'.

Representative concentration pathways (RCPs): Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover (Moss et al.,2008; van Vuuren et al., 2011). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasises that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome (Moss et al., 2010; van Vuuren et al., 2011).

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions.

Scenario analysis: A forward-looking tool that examines the effects of various hypothetical climate futures (e.g., 1.5°C or 4°C warming) on assets or portfolios to test resilience and inform strategy (Authors).

Shared socio-economic pathways (SSPs) have been developed to complement the representative concentration pathways (RCPs). By design, the RCP emission and concentration pathways were stripped of their association with a specific socio-economic development. Different levels of emissions and climate change along the dimension of the RCPs can hence be explored against the backdrop of different socio-economic development pathways (SSPs) on the other dimension in a matrix. This integrative SSP–RCP framework is now widely used in the climate impact and policy analysis literature, where climate projections obtained under the RCP scenarios are analysed against the backdrop of various SSPs. As several emissions updates were due, a new set of emissions scenarios was developed in conjunction with the SSPs. Hence, the abbreviation SSP is now used for two things: First, SSP1, SSP2, …, SSP5 are used to denote the five socioeconomic scenario families. Second, the abbreviations SSP1-1.9, SSP1-2.6, …, SSP5-8.5 are used to denote the newly developed emissions scenarios that are the result of an SSP implementation within an integrated assessment model. Those SSP scenarios are without climate policy assumptions, but in combination with so-called shared policy assumptions, various approximate radiative forcing levels of 1.9, 2.6, …, or 8.5 W m–2 can be reached by the end of the century, respectively.

Stress testing: A technique used to assess how extreme but plausible climate-related shocks (e.g., floods or abrupt policy changes) affect financial performance, particularly capital adequacy (Authors).

Transition risk score: A qualitative or semi-quantitative score reflecting exposure to policy, market and technological risks associated with decarbonization (Authors).

Transition risks are related to extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements for accelerating the transition towards a lower-carbon economy. Depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organizations (TCFD, 2017).

Value-at-risk (VaR): A statistical model used to estimate the potential financial loss in a portfolio over a given period under normal market conditions; adapted in climate modelling to account for climate volatility (Authors).

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

05 Key References

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06

Practice Questions

The following set of 15 single-response, multiple-choice questions is designed to test understanding of key concepts covered in **Module 3: Climate Risk Modelling for Financial Institutions**. The questions are intentionally challenging and go beyond simple recall, requiring application, analysis, and comparison of concepts. The questions cover the following chapters of Module 3:

- **Chapter 1: Climate Risk Modelling Foundations**
- **Chapter 2: Strategic Application of Climate Risk Models in Financial Institutions**

Each question has **four answer options**, with only **one correct solution.** This is followed by an explanation clarifying the reasoning and key learning points.

1 Which combination best captures both the scope and building blocks of climate risk modelling used by FIs?

A. A backwards-looking assessment of historical losses using hazard maps and insurance claims.

B. A sector-level stress test focused only on transition risks such as carbon pricing and regulation.

C. A forward-looking analysis that applies climate scenarios to hazard, exposure and vulnerability data across borrowers, projects and portfolios.

D. A project appraisal tool that evaluates physical risks without considering institutional or portfolio impacts.

2 Why is climate risk modelling a critical tool for organizations, particularly FIs, in the context of climate change?

A. It is only relevant for governments and has limited application in the private sector.

B. It combines historical hazard data with forward-looking climate projections to assess vulnerabilities, estimate potential losses, and support strategic decision-making under uncertainty.

C. It focuses solely on historical weather data to predict future investment returns.

D. It eliminates the need for scenario planning by providing fixed forecasts.

3 Which of the following options correctly describes how different data inputs are used within the core components of climate risk modelling?

A. Climate scenarios define short-term weather forecasts, hazard data capture borrower financial performance, exposure data describe regulatory capital requirements, and vulnerability factors measure disclosure readiness.

B. Climate scenarios describe alternative future climate and transition pathways, hazard data quantify physical climate variables such as temperature and extreme events, exposure data identify where assets and counterparties are located, and their values and vulnerability factors assess how sensitive those assets or borrowers are to climate shocks and their capacity to adapt.

C. Climate scenarios focus on historical climate losses, hazard data estimate sectoral GDP growth, exposure data model policy and technology shifts, and vulnerability factors represent market sentiment indicators.

D. Climate scenarios are used only for regulatory stress testing, hazard data replace traditional credit risk metrics, exposure data reflect mitigation technology costs, and vulnerability factors capture short-term liquidity risks.

4 Which statement best describes how climate risk modelling translates physical and transition risks into financial risk outcomes?

A. By directly replacing traditional financial risk models with climate-only indicators.

B. By focusing exclusively on geospatial hazards without linking them to borrower or sector performance.

C. By assessing policy changes qualitatively without using financial or macroeconomic data.

D. By mapping climate risk drivers through economic transmission channels that affect credit, market, liquidity, and operational risks.

5 An FI is conducting climate risk modelling to evaluate its exposure to both physical and transition risks. Which of the following approaches best reflects how these risks are assessed?

A. Physical risks are modelled using global GDP forecasts, while transition risks rely on flood maps and wildfire data.

B. Physical risks are assessed by overlaying geospatial hazard data with asset-level information. In contrast, transition risks are modelled using policy scenarios, macroeconomic variables, and financial metrics to estimate sectoral credit risk.

C. Both physical and transition risks are assessed using historical weather data alone.

D. Transition risks are only relevant for agriculture and do not require financial modelling.

6 Why is climate risk modelling alone insufficient for FIs to support climate adaptation and resilience effectively?

A. Because climate risk models focus primarily on regulatory disclosure and are not designed for operational use.

B. Because the value of climate risk modelling depends on strong governance, robust data infrastructure, internal capacity-building, and continuous model validation to ensure outputs are credible and embedded in decision-making.

C. Because climate risk modelling can only assess physical risks and cannot support strategic planning or investment decisions.

D. Because once developed, climate risk models do not require updating as climate science and market conditions evolve.

7 How does climate risk modelling support FIs in their climate adaptation efforts?

A. By providing short-term weather forecasts to guide daily financial operations.

B. By eliminating the need for financial exposure analysis through automated climate projections.

C. By integrating diverse data sets to identify where and how climate risks may impact financial markets and institutions, enabling strategic planning and resilience building.

D. By focusing exclusively on regulatory compliance and reporting requirements.

8 Why is it critical for FIs to move beyond understanding climate risk and actively apply climate risk modelling in their decision-making?

A. Because climate risks only affect environmental reporting and have limited financial relevance.

B. Because proactive modelling helps prevent financial losses, strengthens resilience, and supports compliance and competitiveness.

C. Because climate risk modelling replaces the need for traditional risk management frameworks.

D. Because regulators require identical climate scenarios to be applied across all institutions.

9 How do climate risk drivers translate into traditional credit risk metrics such as PD and LGD for FIs?

A. Climate risks only affect credit losses during extreme events and therefore do not influence baseline PD or LGD estimates.

B. Climate risks act as stress loss drivers that can increase both the frequency and severity of credit losses over time, leading to higher PDs, higher LGDs and increased expected losses across exposed portfolios.

C. Climate risk modelling replaces traditional credit risk metrics by introducing climate-specific loss indicators.

D. Climate risks primarily affect market risk and have limited relevance for credit risk modelling.

10 How can climate risk modelling be systematically integrated into traditional credit risk frameworks used by FIs?

A. By replacing the expected loss framework with a separate climate risk loss metric that is managed outside existing credit processes.

B. By mapping climate hazard, vulnerability, and exposure information to PD, LGD, and EAD, allowing climate risks to be embedded into expected loss calculations, pricing, limits, and stress testing.

C. By using climate scenarios only for qualitative assessments while maintaining unchanged PD, LGD and EAD estimates.

D. By focusing climate risk integration exclusively on exposure at default, as PD and LGD are unaffected by climate factors.

11 What makes climate risk models strategically important for FIs?

A. They support exposure assessment, regulatory alignment and long-term positioning in a climate-constrained economy.

B. They are primarily used to meet short-term disclosure requirements.

C. They allow institutions to quantify past climate losses for accounting purposes.

D. They eliminate uncertainty in future climate and market outcomes.

12 A retail bank with significant mortgage exposure in coastal cities is concerned about the long-term impact of climate change on its loan portfolio. How can climate risk modelling help the bank manage these risks?

A. By using high-resolution flood maps and climate projections to assess future impacts on property values and loan-to-value ratios.

B. By analysing historical loan performance to predict future credit risk.

C. By relying on short-term weather forecasts to adjust interest rates.

D. By eliminating the need for scenario analysis through automated regulatory reporting.

13 How does forward-looking climate risk modelling support strategic decision-making and investment opportunities for FIs?

A. By focusing solely on regulatory compliance and minimising reporting burdens.

B. By using historical climate data to maintain traditional investment strategies.

C. By avoiding investments in sectors affected by climate change through blanket exclusions.

D. By identifying emerging trends in vulnerable and high-growth sectors, enabling tailored financial products and climate-aligned deal origination.

14 How do climate risk models support FIs in meeting regulatory and supervisory expectations?

A. By standardising a single global climate scenario for all regulatory disclosures.

B. By enabling institutions to disclose qualitative climate narratives without financial analysis.

C. By supporting climate-related disclosures, stress testing, and assessments of capital and solvency under adverse scenarios.

D. By transferring climate risk reporting responsibilities entirely to external auditors

15 In what way can climate risk analysis enhance the investment strategies of asset managers and private equity firms?

A. By enabling investors to spot firms with potential for low-carbon transition and structure deals that combine financial returns with measurable climate impact.

B. By identifying companies with strong historical returns, regardless of environmental performance.

C. By limiting investment options to only government-backed green bonds.

D. By focusing exclusively on ESG ratings without considering operational risks or sectoral exposure.

07
Question Solutions

1

Correct: C

Explanation: Climate risk modelling is a forward-looking approach that uses alternative climate scenarios to analyse how physical and transition risks affect borrowers, projects, portfolios, and institutions. It combines climate scenarios with hazard data, exposure data and vulnerability factors to estimate impacts on assets, cash flows and financial performance, supporting risk management and strategic decision-making.

2

Correct: B

Explanation: Climate risk modelling is essential for FIs because it integrates historical hazard data with forward-looking climate projections to identify vulnerabilities and estimate potential losses. This approach supports strategic decision-making under uncertainty, helping organizations prepare for a range of possible climate futures and strengthen their resilience to evolving risks.

3

Correct: B

Explanation: Climate risk modelling relies on forward-looking climate scenarios, combined with hazard, exposure, and vulnerability data, to assess how physical and transition risks may affect assets, borrowers, and portfolios over time.

4

Correct: D

Explanation: Climate risk modelling evaluates how physical and transition risk drivers propagate through microeconomic and macroeconomic transmission channels. Physical risks are assessed using hazard, exposure and vulnerability data to estimate potential losses, while transition risks are modelled through policy, market and technology pathways that affect sectors, firms and financial metrics, ultimately materialising as traditional financial risks.

5

Correct: B

Explanation: Physical risks are assessed by combining geospatial hazard data, such as flood zones or heat maps, with detailed asset-level information to understand exposure and vulnerability. In contrast, transition risks are modelled using policy scenarios, macroeconomic trends and financial indicators to estimate how shifts in regulations, technologies or market preferences could impact creditworthiness across sectors. This dual approach allows FIs to evaluate both immediate and long-term climate-related risks comprehensively.

6

Correct: B

Explanation: Climate risk models only generate meaningful adaptation outcomes when they are supported by sound governance, reliable data systems, skilled internal teams and continuous learning that integrate model outputs into everyday risk management and strategic decisions.

7

Correct: C

Explanation: Climate risk modelling supports FIs in climate adaptation by integrating diverse data sources, such as hazard maps, asset locations and climate projections, to identify where and how climate risks may affect financial systems. This enables strategic planning, informed decision-making and the development of resilience measures to manage both current and future climate-related challenges.

8

Correct: B

Explanation: Actively applying climate risk modelling allows FIs to anticipate physical and transition risks before they materialise as financial losses. This supports resilient portfolio construction, informed pricing, regulatory readiness, and access to green finance opportunities, while reducing the risk of capital shortfalls and reputational damage.

9

Correct: B

Explanation: Physical and transition climate risks increase the likelihood and severity of credit losses by affecting borrower cash flows, resilience and collateral values. Over time, this translates into higher PDs, higher LGDs and increased expected losses, even in the absence of extreme climate events.

10

Correct: B

Explanation: The expected loss framework ($EL = PD \times LGD \times EAD$) provides a natural and familiar structure for integrating climate risk drivers. By linking climate hazard, vulnerability and exposure information to PD, LGD and EAD estimates, FIs can embed climate risk into portfolio monitoring, pricing, limit-setting and stress testing within existing credit risk processes.

11

Correct: A

Explanation: Climate risk models have strategic value because they help FIs identify emerging exposures, adapt to evolving regulatory expectations, and prepare for a future where climate factors significantly influence financial performance and stability, while supporting their role in financing a sustainable transition.

12

Correct: A

Explanation: Climate risk modelling helps the bank by using high-resolution flood maps and climate projections to assess how rising sea levels and extreme weather events could affect property values in coastal areas. This insight allows the bank to evaluate future loan-to-value ratios and credit risk, enabling proactive adjustments to lending strategies and portfolio management.

13

Correct: D

Explanation: Forward-looking climate risk modelling helps FIs identify emerging trends and vulnerabilities across sectors, enabling them to tailor financial products and investment strategies. By anticipating shifts in policy, technology and market dynamics, institutions can initiate climate-aligned deals and seize opportunities in high-growth areas, supporting both resilience and sustainable development.

14

Correct: C

Explanation: Climate risk models help FIs comply with regulatory requirements by enabling scenario analysis, stress testing and transparent disclosure of material climate risks. They support frameworks such as the TCFD and IFRS S2, as well as supervisory climate stress tests conducted by authorities like the ECB and the Bank of England, helping institutions assess potential impacts on capital, solvency, and portfolio exposure.

15

Correct: A

Explanation: Climate risk analysis enables asset managers and private equity firms to identify companies with strong potential for low-carbon transition. This insight allows them to structure investments that deliver both financial returns and measurable impact on climate, aligning portfolios with sustainability goals and emerging market opportunities.

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