
Masterclass on Climate Adaptation Finance

Session 3: Introduction to Climate Risk Modelling & Integration in Credit



GLOBAL
CENTER ON
ADAPTATION



BANK OF TANZANIA ACADEMY

AEBEL



Frankfurt School
of Finance & Management
German Excellence. Global Relevance.

Trainer



**Dr. Bogdan Putnikovic, Senior Climate Finance and
Climate Risk Expert**

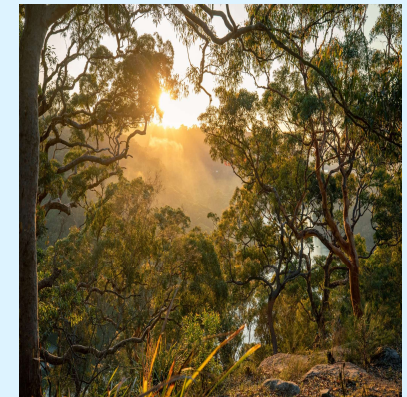
More than 30 years of experience in sustainable
finance, economic development, and climate risk

Context for the Masterclass

As **climate-related risks intensify and evolve**, financial institutions must move **beyond conventional risk frameworks** to ensure resilience, regulatory compliance, and long-term competitiveness. This session provides an introduction to the strategic relevance of climate risk modelling, with a focus on both physical and transition risks.

Learning outcomes

- *Understand climate risk modelling, including its key components, tools, and methodologies*
- *Differentiate how models capture both physical and transition climate risks and their implications for financial decisions.*
- *Recognize how climate risk modelling supports strategic decision-making, regulatory alignment, and competitive positioning across investment and risk management activities*
- *Evaluate the strengths and limitations of different modelling approaches and the need for a multi-model strategy*
- *Familiarize how to embedding climate risk into credit scoring, pricing, and ratings*



**Module 3: Climate Risk Modelling
for FIs**

The Masterclass on Climate Adaptation Finance



Purpose: Global Center on Adaptation (GCA) and European Bank for Reconstruction and Development (EBRD) in partnership with Frankfurt School of Finance & Management, RebelGroup, and Haskoning develop the Masterclass to engage the private sector in climate adaptation finance, unlocking market growth, protecting portfolios, and creating long-term value through innovative tools. The Masterclass positions adaptation as both a strategic opportunity and a risk management priority.

The Masterclass is built on a 6-module Body of Knowledge (BoK) to equip financial institutions (FIs) to understand physical climate risks and design bankable adaptation investments that build resilience, align with national priorities, and benefit millions of people.

M1: Rationale for Investing in Adaptation

M2: Understanding Climate Change Science: what FIs* must know

M3: Climate Risk Modeling for FIs

M4: Adaptation Needs, Finance Solutions & Tools

M5: Climate Adaptation Product and Pipeline Development in FIs

M6: Stakeholder Engagement and Policy Support for Scalable Climate Finance



Session 3: Outline

Climate Risk Modelling Foundations

Strategic Application of Climate Risk Models in
Financial Institutions

Embedding climate risk into credit scoring, pricing,
and ratings.

Introduction to Climate Risk Modelling

Climate risk modelling enables organizations to assess and reduce risks from physical and transition climate impacts on assets, portfolios, and operations to inform resilience planning and strategic alignment with sustainability goals.

Forward-looking Analytical Approach

Climate risk modeling uses forward-looking analysis to assess potential financial impacts of climate change on assets and operations.

Assessment of Financial Impacts

Models quantify both physical and transition risks, translating complex climate factors into actionable financial insights.

Strategic Risk Management

Institutions use climate risk models to inform decision-making, adapt business models, and meet resilience and regulatory goals.

Core question a climate model aims to answer

- How exposed is a portfolio to climate-related events or regulatory shocks?
- How vulnerable are financial assets, counterparties, or sectors under different climate futures?
- What financial impacts (e.g. losses, capital erosion, credit downgrades, liquidity shortages) could materialize over time?

Key Components of Climate Risk Modelling

1

Climate Scenarios: Explore a range of possible future climate conditions to capture uncertainty and guide forward-looking analysis.

Future climate projections based on IPCC pathways guide risk forecasting.

2

Hazard Data: Probabilistic characterization of the occurrence, magnitude, and frequency of climate-related physical events or transition shocks, forming the basis for risk exposure.

Physical climate variables like temperature and precipitation inform hazard assessment.

3

Exposure Data: Spatially and economically resolved mapping of assets, sectors, or portfolios that could be affected by climate hazards, providing the substrate for impact assessment.

Asset locations and values identify what is vulnerable to climate hazards.

4

Vulnerability Factors: Empirical or modelled indicators of sensitivity and adaptive capacity of assets, sectors, or systems to hazards, capturing the likelihood and severity of damage under stress.

Degree to which a company can absorb economic shocks from climate events (e.g., revenue sensitivity to extreme heat).

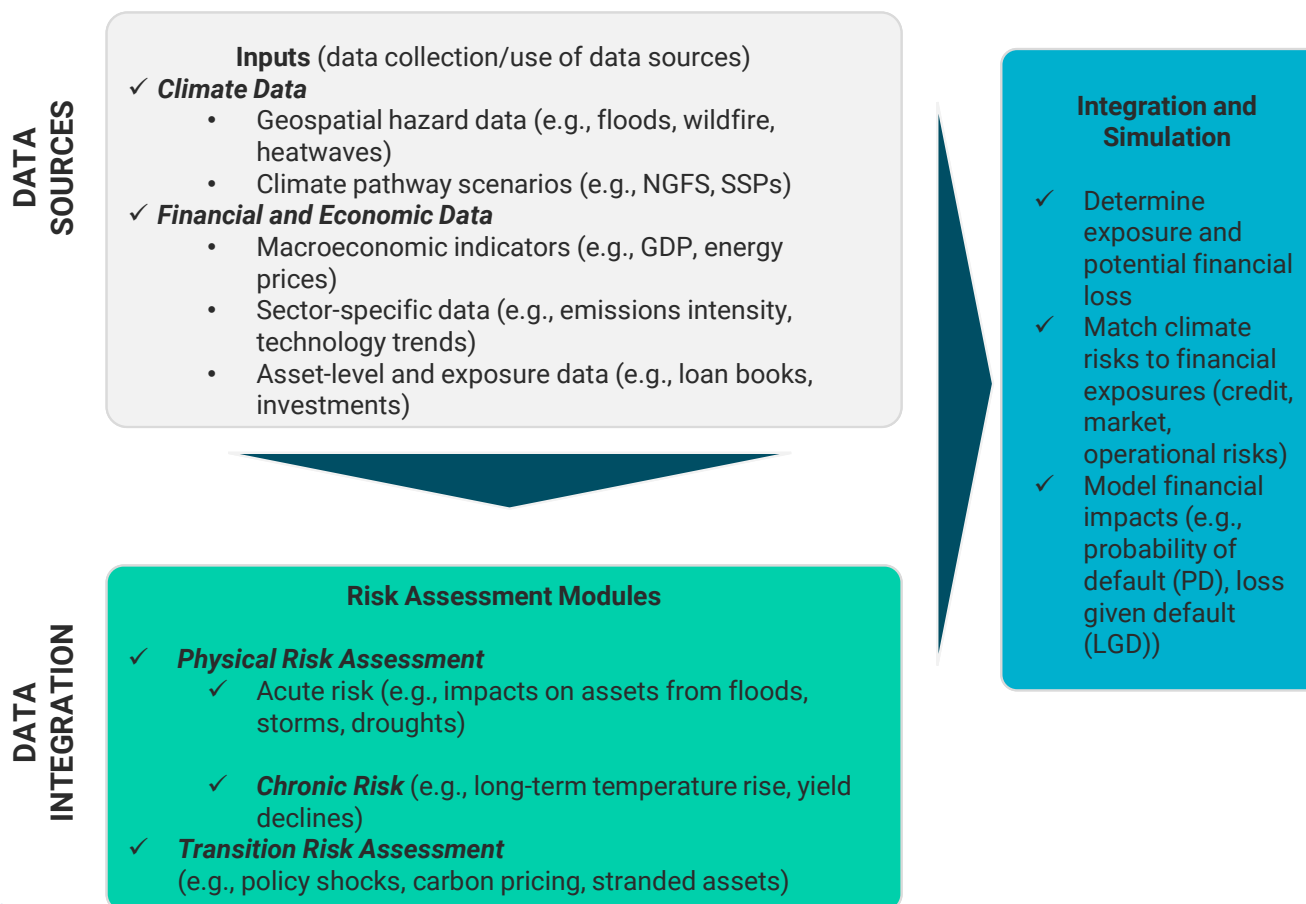
5

Financial Impact Assessment: Quantifies credit risk changes and financial losses from climate risks

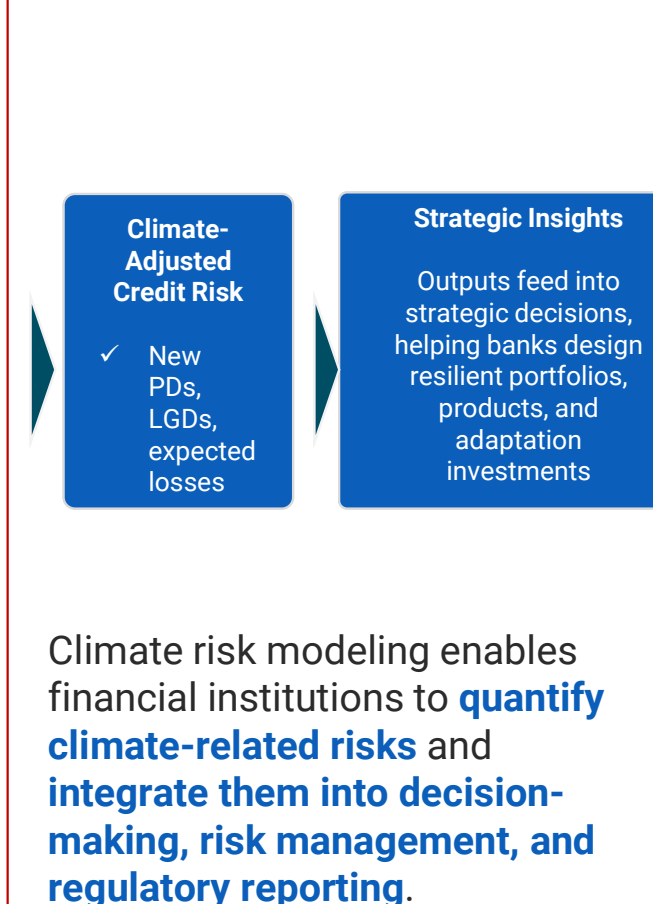
Increased probability of default (PD) for borrowers exposed to climate hazards.

Stylized component of a climate risk modelling

Model components



Actions



Backward-Looking Hazard Data

The components of a climate risk model (data collection, integration, simulation, and impact assessment) link historical hazard data with forward-looking projections.

Utilization of Historical Records...

Backward-looking **hazard** data relies on historical records such as flood maps and storm paths to analyze past **exposure** and **vulnerability** to climate hazards.

...to analyze of Past Exposure and Risk Patterns

This data helps understand past exposure patterns and storm frequency, providing a foundation for **assessing future flooding risks and improving climate risk management.**

Forward-Looking Climate Projections

Scenario-Based Forecasting for Future Risks

Forward-looking climate projections use scenario-based forecasting to anticipate risks under varying climate conditions.

Utilization of IPCC Pathways

Projections employ IPCC's representative concentration and socioeconomic pathways for long-term climate assessment.

Critical Role in Infrastructure and Energy Planning

These projections are vital for assessing impacts on infrastructure resilience and future energy demand patterns.

Quiz Question



In climate risk modelling, exposure data identifies which assets or sectors are located in hazard-prone areas, while vulnerability factors determine how severely those assets are likely to be affected when a climate hazard occurs.

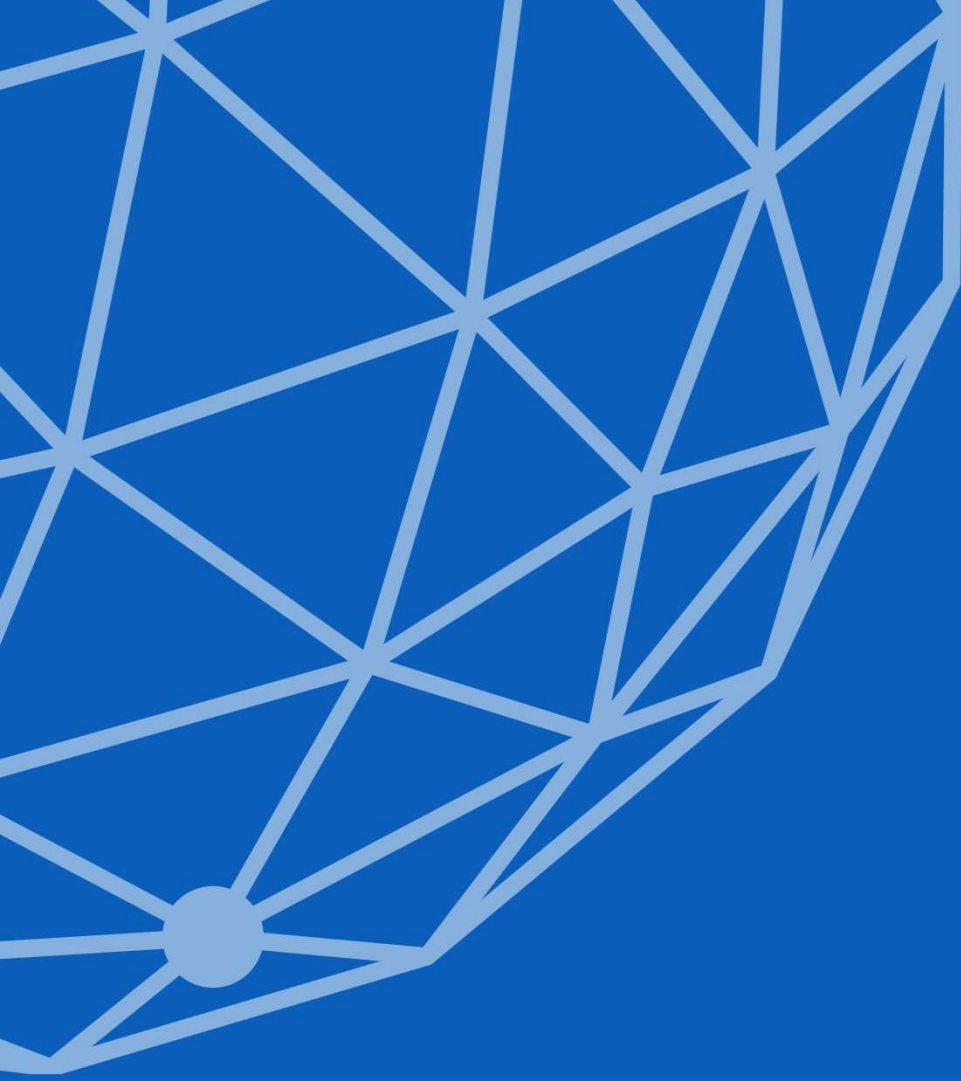
A) True

B) False

Exposure defines what is at risk based on location and value, while vulnerability captures sensitivity and adaptive capacity, which drive the severity of impacts.



Hover over each option and click on the answer you think is correct.



Session 3: Outline

Climate Risk Modelling Foundations

Strategic Application of Climate Risk Models in
Financial Institutions

Embedding climate risk into credit scoring, pricing,
and ratings

Strategic importance of climate risk modelling for FIs

Enhancing Portfolio Resilience

by integrating climate risk models helps institutions assess exposures, identify risk hotspots, enhance portfolio resilience, and capitalize on sustainable finance opportunities

Identifying potential adaptation investments

which could reduce risk levels associated with high-risk assets exposed to climate-related hazards.

Client Strategy

Integrate risk-adjusted returns into lending & insurance

Governance & Compliance

Meet regulations, attract sustainable finance capital

Example: Practical Applications of Climate Risk Modelling in FIs



Drought and Water Scarcity Risk Modelling

Agricultural lenders use hydrological and rainfall variability models to assess impacts on crop yields and irrigation demand, shaping resilience lending and water-efficient technology financing.



Heat Stress Assessment for Industrial and Urban Sectors

Financial institutions evaluate heat exposure for manufacturing and urban infrastructure, informing investments in cooling systems, energy efficiency, and worker protection measures.



Sea-Level Rise Analysis in Coastal Cities

Banks apply flood and salinity intrusion models to assess risks to real estate, logistics hubs, and ports, supporting resilient infrastructure and coastal protection financing.

New market Opportunities

Output of the climate risk model

- ✓ Sector/geographic vulnerabilities:
 - ✓ Identify priority sectors where climate hazards are most material
 - ✓ Identify client segments that are most vulnerable or exposed



Climate Risk Modelling to Support Deal Origination and Investment Prioritization

Integrating climate risk modelling enables financial institutions:

- to evaluate investment resilience
- direct capital toward high-impact adaptation projects to align portfolio to resilience
- highlight financial products that can strengthen resilience (e.g., irrigation loans, resilient infrastructure financing, insurance-linked products)
- adjust product design (tenor, risk-sharing, technical assistance) based on modelled vulnerabilities
- assess impact of potential regulatory and policy changes on investments
- quantify long-term financial impacts for informed decision-making
- monitor and reassess using updated climate data and portfolio stress testing
- climate-adjusted capital requirements

Examples for New market Opportunities

Targeting high-risk or high-opportunity clients

Institutions segment clients by climate vulnerability to tailor offerings and support adaptation, reducing portfolio risk effectively.

Supporting capital allocation and resilience building

Analysis helps redirect capital toward investments that strengthen systemic resilience and advance sustainability objectives.

Example: If a portfolio shows significant exposure to agriculture in drought-prone regions, the FI can develop engagement strategies with agribusiness clients to co-finance water-saving technologies or climate-resilient seeds.

Example: FIs could finance elevated housing developments, sea-wall reinforcement, or mangrove restoration informed by sea-level-rise projections.

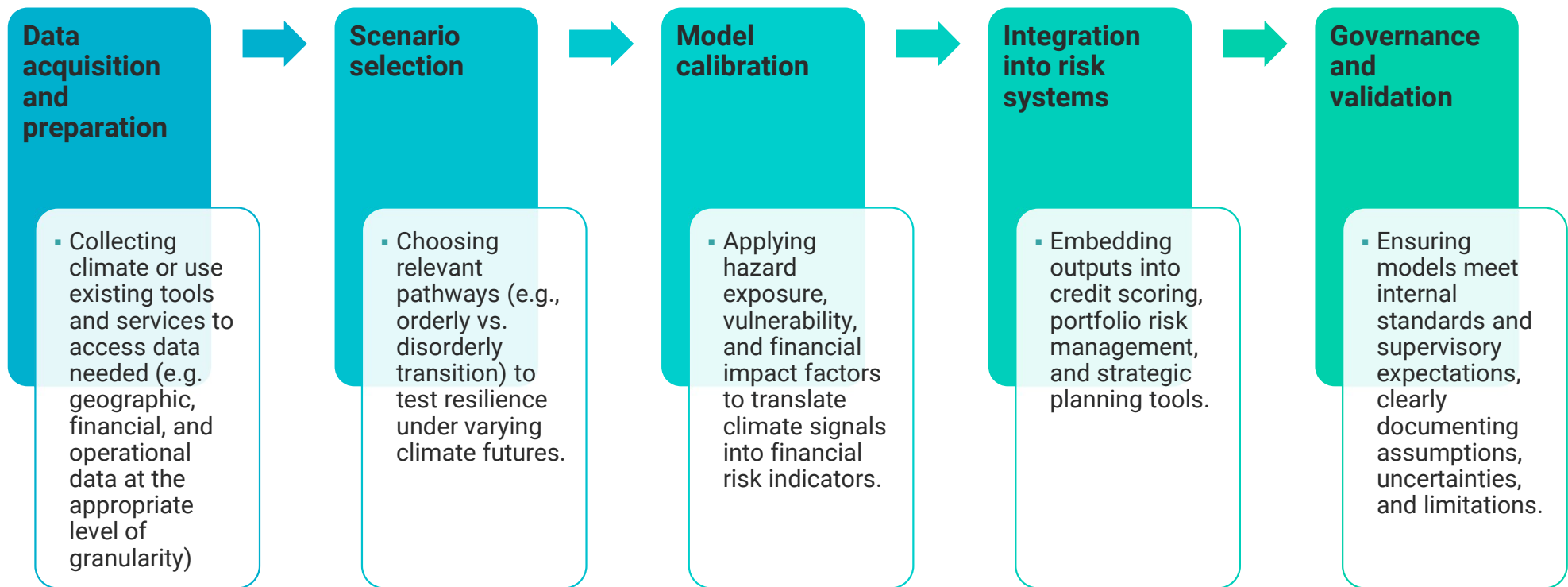
Client engagement: Driving Adaptation Finance through Tailored Financial Products

Developing Tailored Financial Products

Climate insights drive innovation in financial offerings and create opportunities for engagement:

- Use climate model outputs to identify opportunities for **adaptation-focused finance responding to the clients needs and increasing climate resilient output** particularly in sectors exposed to **drought, salinization, and water scarcity**
- Develop tailored solutions such as:
 - Resilience loans for farmers investing in drip irrigation systems, drought-tolerant crops, and soil salinity management
 - Climate-smart agriculture credit supporting water-efficient technologies and improved storage and distribution
 - Infrastructure adaptation bonds financing desalination plants, wastewater recycling, and resilient urban water networks
 - Insurance-linked products protecting agribusinesses and rural communities against extreme weather losses
- **Meet client demand** for financing solutions that **reduce vulnerability** and **enhance adaptive capacity**
- **Creating new revenue streams** while increasing resilience
- **Direct capital** towards sustainable investments, enhancing **portfolio resilience**.

Key steps for climate risk model implementation



Essential Concepts: Climate Scoring, Scenario Analysis, and Stress Testing



Standardized Scores for Risk Exposure

Climate risk scores standardize evaluation of asset exposure to physical and transition risks, combining hazard severity and sector vulnerability to guide risk management and compliance.



Structured Climate Pathways and Stress Testing

Scenario analysis explores future climate trajectories for strategic planning, while stress testing quantifies financial impacts under extreme climate events to assess institutional resilience.

Climate Risk Scores: Development and Application

1

Portfolio Data Cleaning and Validation

Ensure high-quality portfolio data by validating sector classification, geographic coordinates, and internal risk metrics.

2

Define Objectives, Scenarios, and Targets

Collaborate across departments to set analysis scope, time horizons, climate scenarios, and decarbonization goals.

3

Assign Physical and Transition Risk Scores

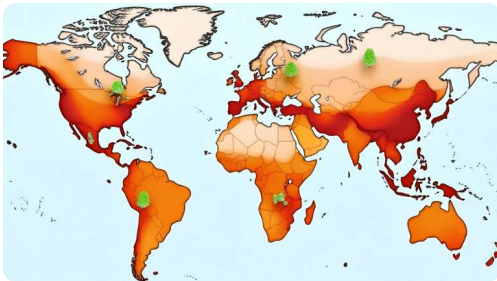
Evaluate assets using hazard and sensitivity scores for physical risks and policy exposure for transition risks.

4

Aggregate Scores to Create Heatmaps

Combine scores by sector and geography to identify risk hotspots and support mitigation prioritization.

Using Climate Risk Scores for Portfolio Risk Assessment and Strategic Decisions



Highlight Sectoral and Geographic Risk Concentrations

Climate risk scores identify risk hotspots by sector and region, enabling targeted mitigation and prioritization in risk management.



Inform Portfolio Rebalancing and Risk Pricing

Scores guide adjustments in lending and investment portfolios, allowing appropriate risk repricing and exposure reduction in vulnerable areas.

[This Photo](#) by Unknown Author is licensed under [CC BY](#)



Support Development of Green Financial Products

Risk assessments facilitate the design of financial products that promote decarbonization and resilience aligned with transition pathways.

[This Photo](#) by Unknown Author is licensed under [CC BY-SA-NC](#)

Discussion

Your institution runs a climate risk assessment on its portfolio. The results show:

- High exposure to real estate and tourism assets in the Red Sea region facing increasing heat stress and rising cooling and water demands
- Growing demand from SMEs seeking financing for climate-resilient agricultural practices, improving water management and use efficiency, and creating new green business models to address coastal risks.
- Regulators signalling that climate stress-testing will soon be mandatory.
- Some large clients (e.g. ports) showing interest for transition.

If you were on the board, where would you prioritize action first?

New Market Opportunities:
Expand lending to
solar/green SMEs and
resilient infrastructure

Portfolio Resilience: Portfolio
Resilience: Reduce exposure
to flood risks by integrating
resilience criteria into real
estate financing decisions.

Client Strategy: Work closely
with exposed
agribusiness/manufacturing
clients to support their
transition.

Governance & Compliance:
Get ahead of regulators with
stronger reporting and
climate stress tests.

Quiz Question



Climate risk modelling supports financial institutions not only by identifying high-risk exposures but also by uncovering adaptation investment opportunities that can reduce portfolio risk while meeting governance and regulatory expectations.

A) True

B) False

Climate risk analysis links exposure hotspots to targeted resilience investments, strengthening portfolios and supporting compliance and sustainable finance objectives.

Quiz Question



Climate risk scores should be assigned before portfolio data cleaning and validation, since aggregation into heatmaps will correct most data quality issues automatically.

A) True

B) False

Reliable climate risk scoring depends on validated sector, location, and risk data; aggregation cannot compensate for poor or inconsistent underlying inputs.

Quiz Question

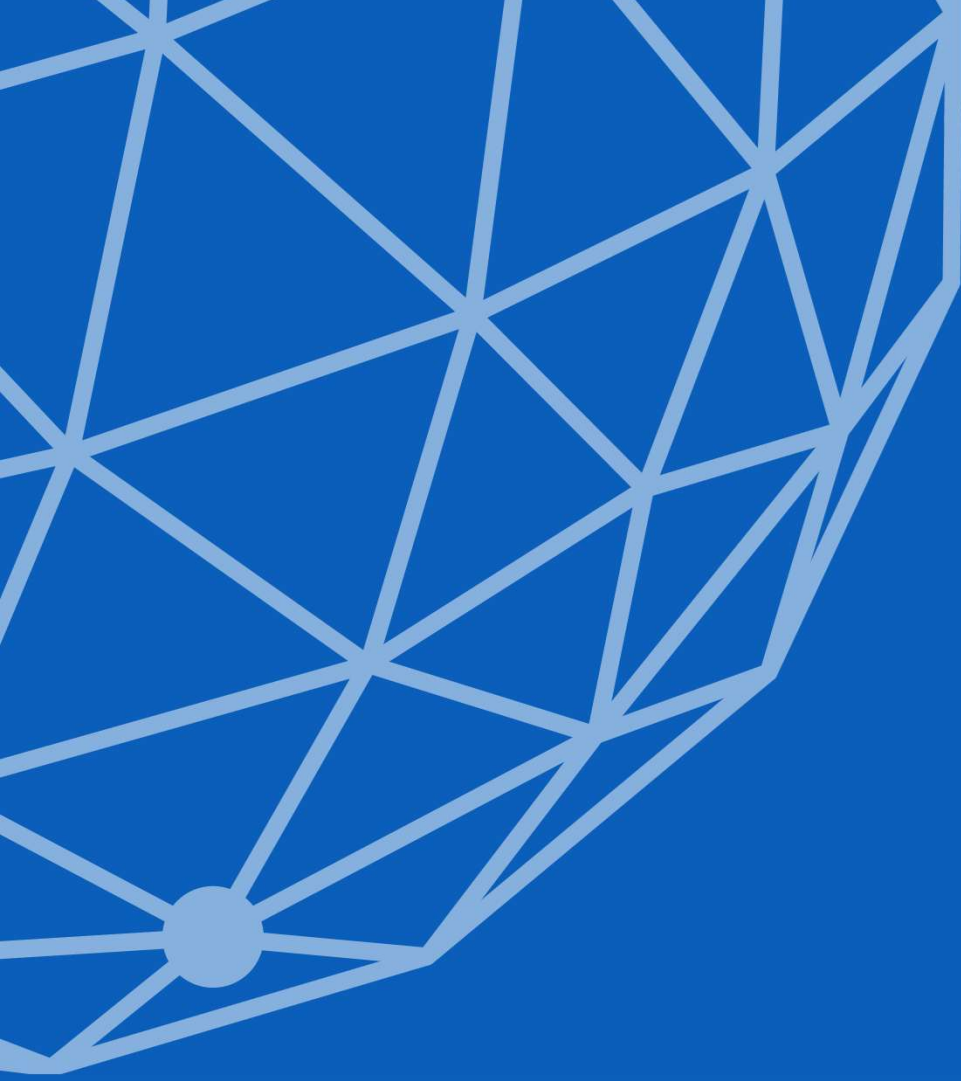


Using climate risk scores in portfolio management can simultaneously support risk-based repricing, guide reallocation away from concentrated hotspots, and inform the design of new green financial products.

A) True

B) False

Risk scores translate climate exposure into actionable signals for pricing, portfolio structure, and product development, linking risk management with strategic growth.



Session 3: Outline

Climate Risk Modelling Foundations

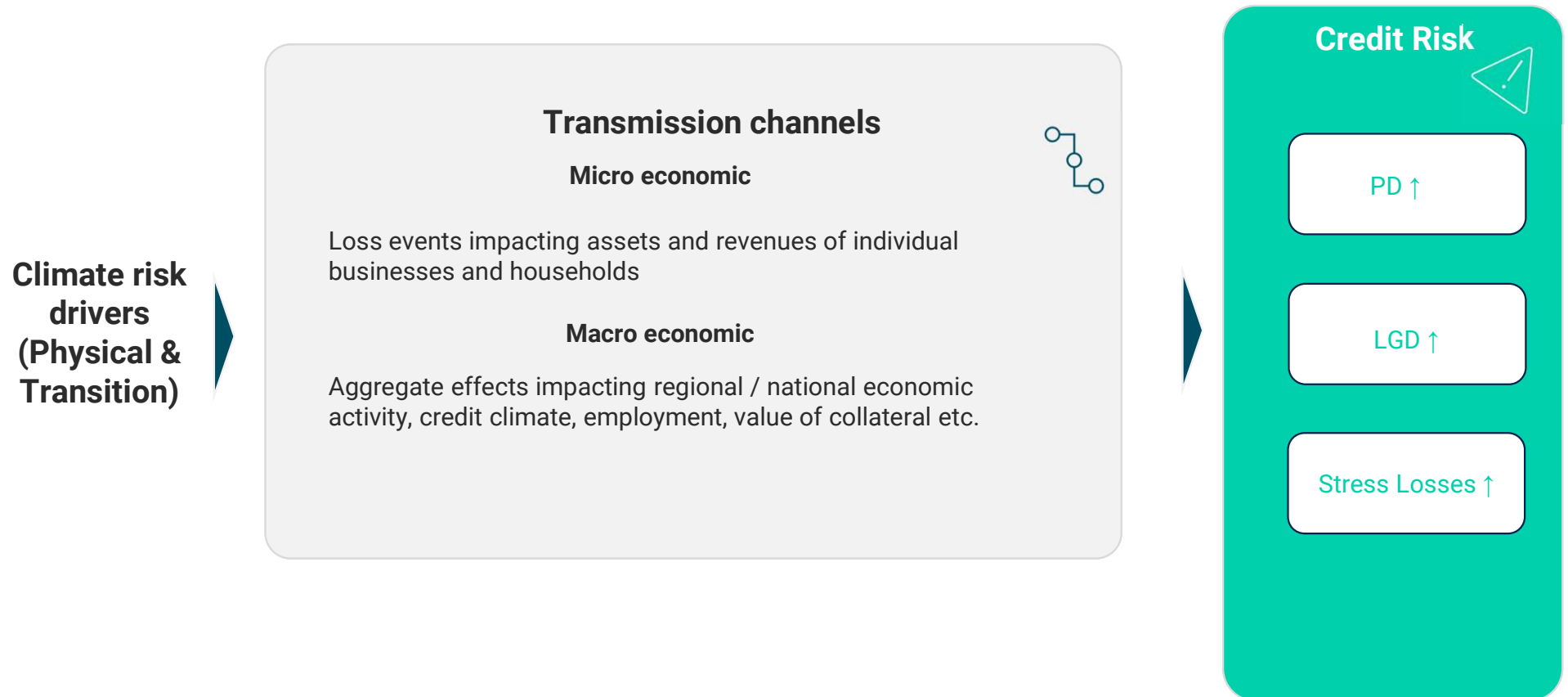
Strategic Application of Climate Risk Models in
Financial Institutions

Embedding climate risk into credit scoring, pricing,
and ratings

BCBS d517: The Impacts of climate risk drivers on banks can be observed through traditional risk categories. Apply an integrated Enterprise Risk Management approach.

Risk	Potential effects of climate risk drivers (physical and transition risks)
Credit risk	Credit risk increases if climate risk drivers reduce borrowers' ability to repay and service debt (income effect) or banks' ability to fully recover the value of a loan in the event of default (wealth effect).
Market risk	Reduction in financial asset values, including the potential to trigger large, sudden and negative price adjustments where climate risk is not yet incorporated into prices. Climate risk could also lead to a breakdown in correlations between assets or a change in market liquidity for particular assets, undermining risk management assumptions.
Liquidity risk	Banks's access to stable sources of funding could be reduced as market conditions change. Climate risk drivers may cause banks' counterparties to draw down deposits and credit lines.
Operational risk	Increasing legal and regulatory compliance associated with climate-sensitive investments and business.
Reputational risk	Increasing reputational risk to banks based on changing market or consumer sentiment.

Climate Risk Drivers transmit to Losses on Bank Balance Sheets



Is the Integrated BCBS Approach to Climate Risk suitable for MSME Lenders in Emerging Markets?

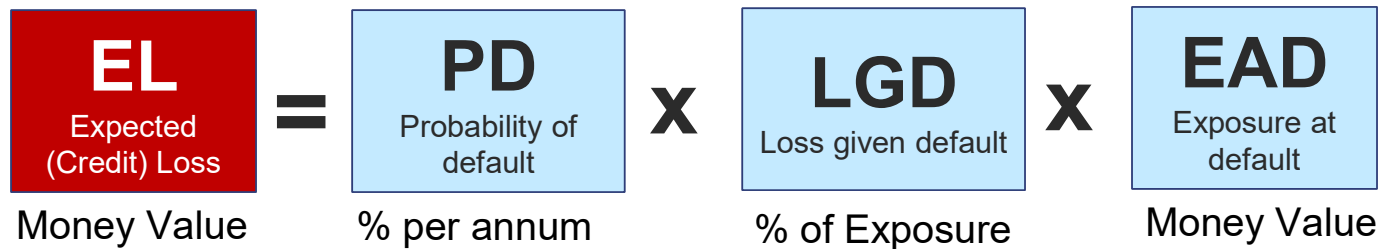
Three reasons...

Climate risk is not a new risk dimension but its materiality for financial institutions and businesses is becoming increasingly clear.

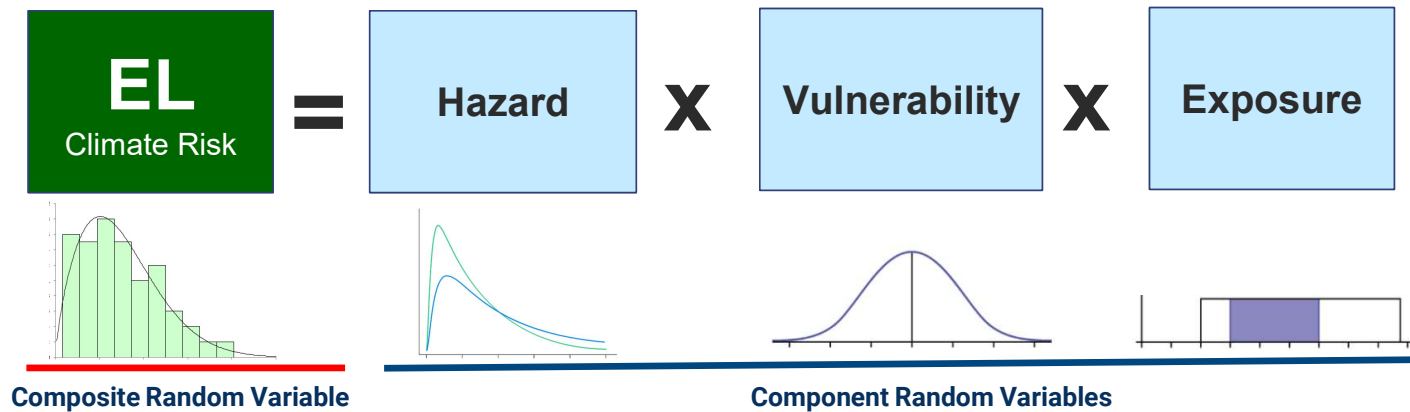
Traditional rating / scoring model has always considered natural hazards and regulatory compliance risks. What is different now is that the speed of change and the frequency / severity of occurrence has become more difficult to estimate.

MSME finance typically consists of short-term working capital loans, rather than long-term exposures. This provides MSME lenders with flexibility and time to adjust risk management tools and enhance portfolio diversification

The EL = PD x LGD x EAD Logic also works for Climate Risk



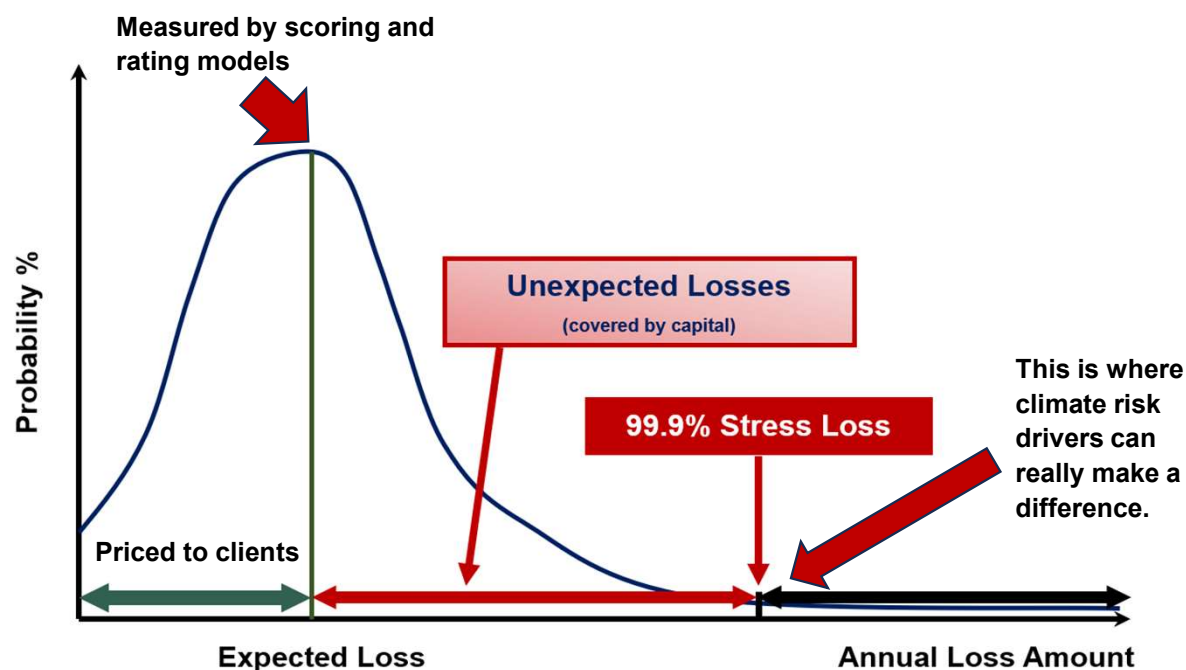
Climate risk driver influence PD, LGD and EAD



Average Expected Credit Losses versus Unexpected Stress Losses

Consider the Theoretical Probability Density Distribution of Annual Losses in a SME Credit Portfolio below.

- The incremental effect from climate risk drivers on the expected loss is typically small.
- The expected loss rate, $PD \times LGD$ (including climate risk drivers) is priced to clients by way of a credit spread.
- Credit scoring explains the average through-the-cycle 3-5 year expected loss including the impact of climate risk.



- BCBS Guidance currently does not require incremental regulatory capital for climate related risk drivers in Pillar 1.
- Instead, climate risk is a Pillar 2 topic subject to the SREP (Supervisory Review and Evaluation Process).
- Climate risk is seen as a correlation driver that should be considered in stress testing and flow into the ICAAP.

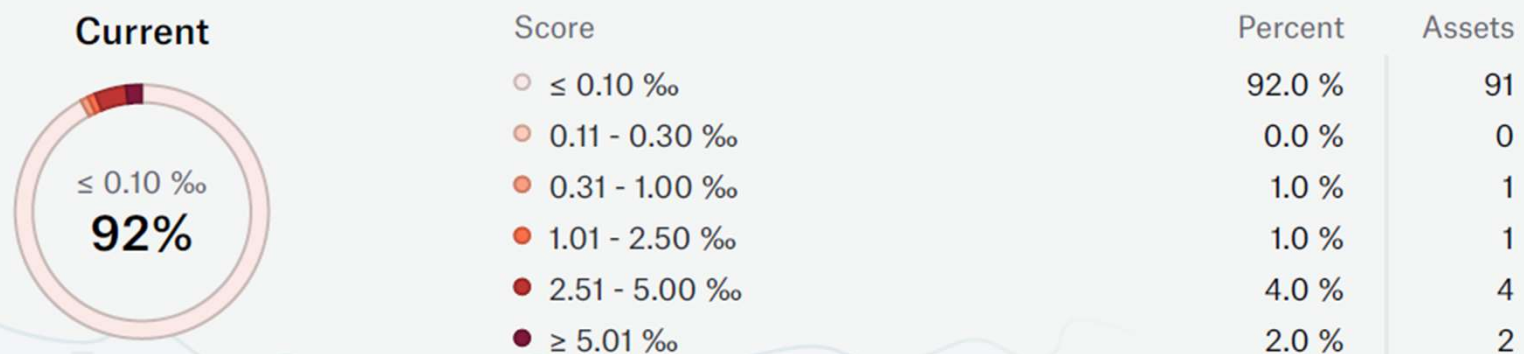
Example from a Portfolio Risk Review by MunichRe

- Typical **per-hazard annual loss rates remain very small** and only escalate gradually with various climate scenarios.
- The average losses that **feed through to a lender as credit losses** are even lower.
- The **concern is about rare but catastrophic stress losses** that could arise when multiple compounding hazards materialize alongside other adverse macro-economic effects and interact with a portfolio concentration in the affected locations or economic sectors.



River Flood (Defended) Climate Expected Loss

Climate Expected Loss is the average annual loss, i.e. annualised expected loss, due to physical damage to buildings and their contents due to River Flood events. The Climate Expected Loss is measured relative to the total cost of rebuilding, assuming region-specific standard building characteristics which are captured in the vulnerability functions used.



The Climate Stress Testing Rationale



Climate Risk must be a key element in every stress testing program:

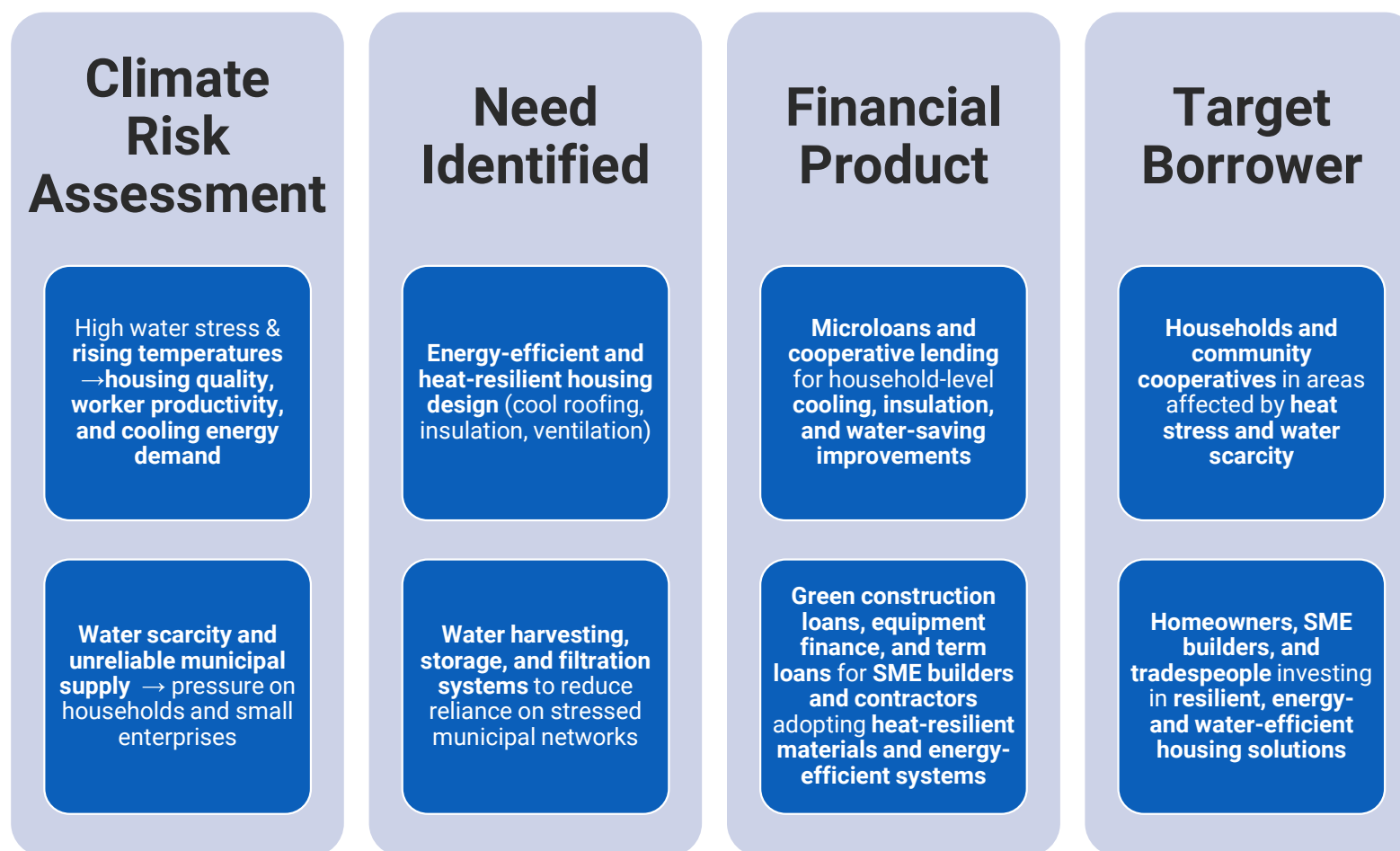
- Physical and transition risks are major correlation drivers: “when it rains, it pours”.
- The economically most vulnerable borrowers are also very likely to be impacted by climate risk events.



Stress testing also highlights opportunities:

- Identify financial products and business models that are resilient and can be scaled up.
- Design climate mitigation / adaptation products for vulnerable clients and locations.
- Monte Carlo simulation with conditional hazard probabilities (see Annex) is better suited for compounding effects, points of no return, market panic etc.

Example: Residential Housing

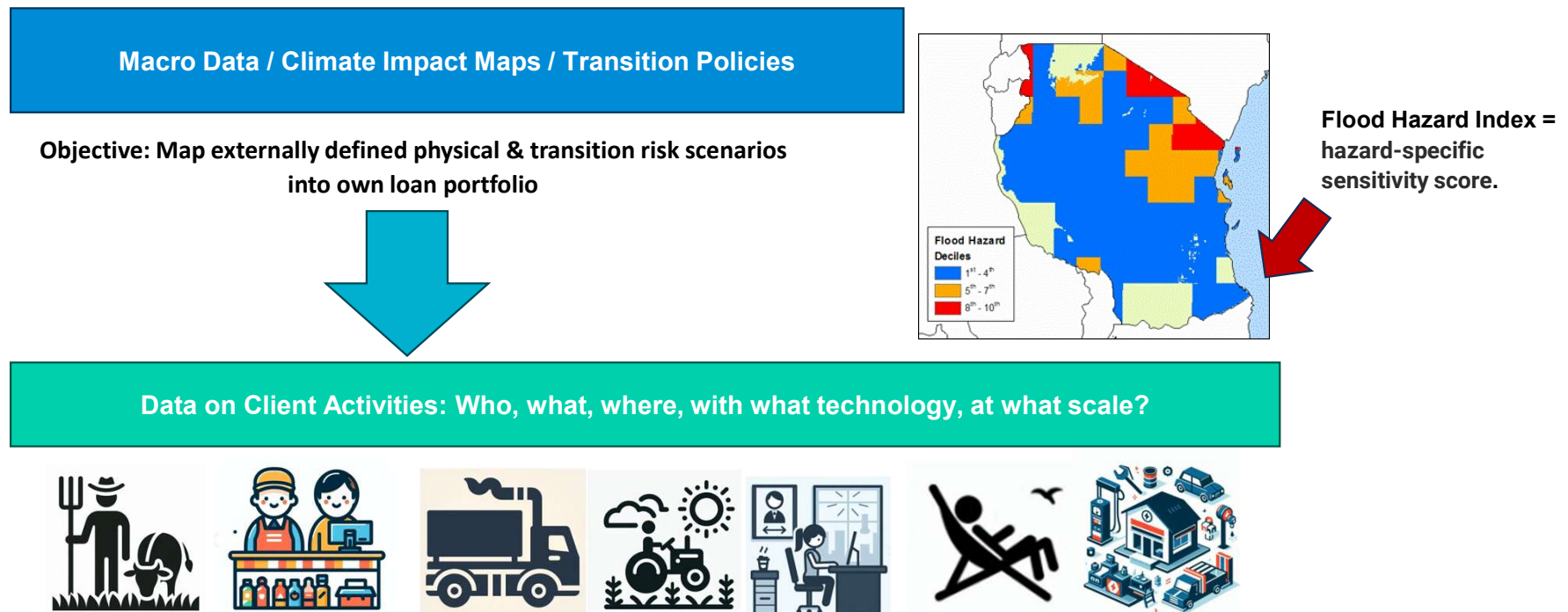


Slide 35

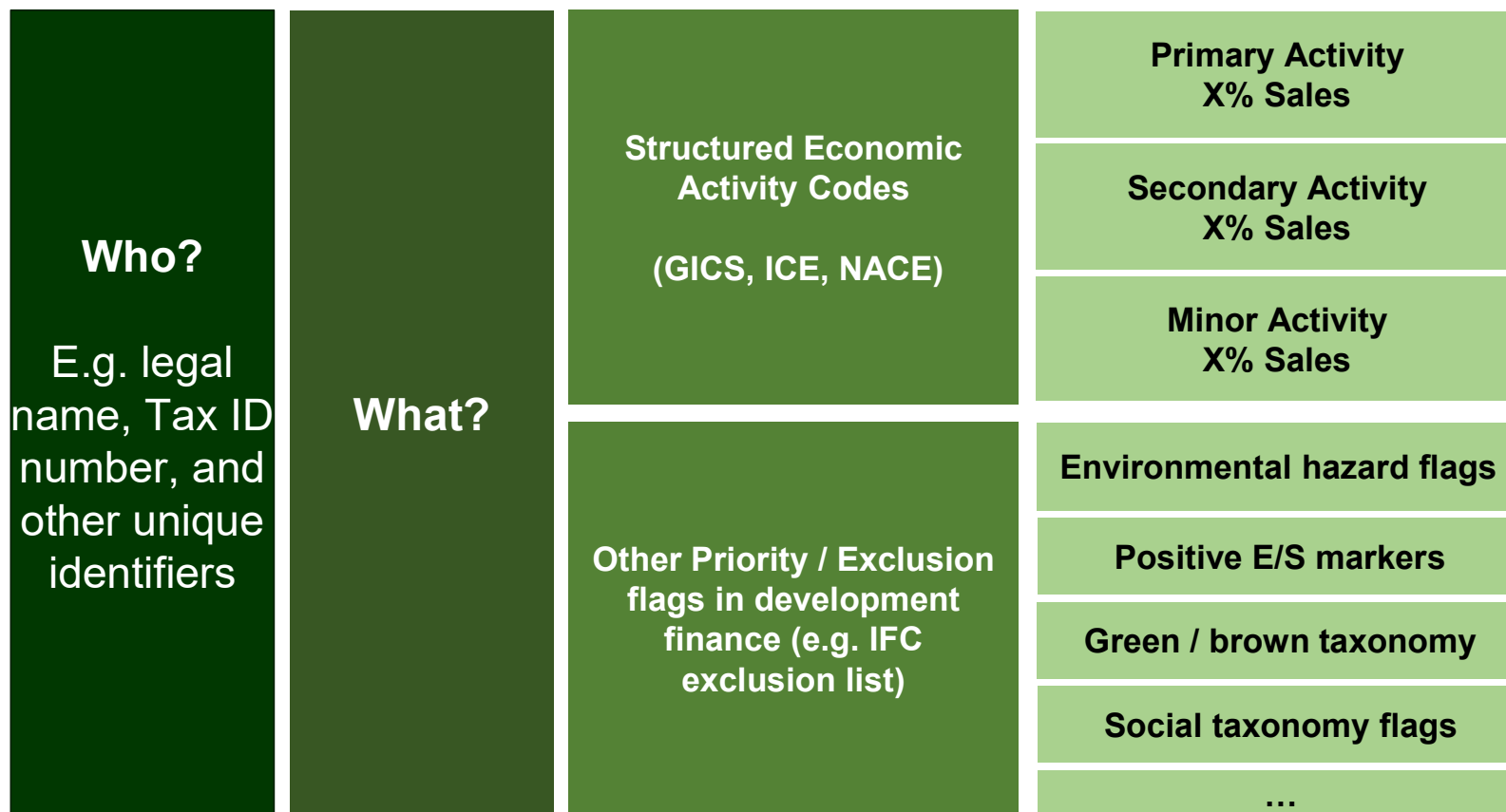
du1 floods and wildfires aren't that common. Suggest to use heat stress as the example
duffs@ebrd.com, 2025-11-04T16:39:18.242

The Data Context for Climate Risk Analysis

How to Map Climate Risk Data into an existing Loan Portfolio.



Example: Who and what?



Example Where: The Data Context for Climate Risk Analysis

Where?	Locations	Address History		Property Description	Rent / Valuation
		Ownership	m ²	GPS Coordinates	...
		Hazard flags	Insurance classification		

Examples from a Portfolio Risk Review by Munich Re

⇒ Storm

Storm Risk Score quantifies a location's risk of physical damage caused by Tropical cyclones, Extratropical storms, Hail, Tornadoes and Lightning.



🌊 Flood (Defended)

Flood Risk Score quantifies a location's risk of physical damage caused by River flood, Flash flood and Storm surge.



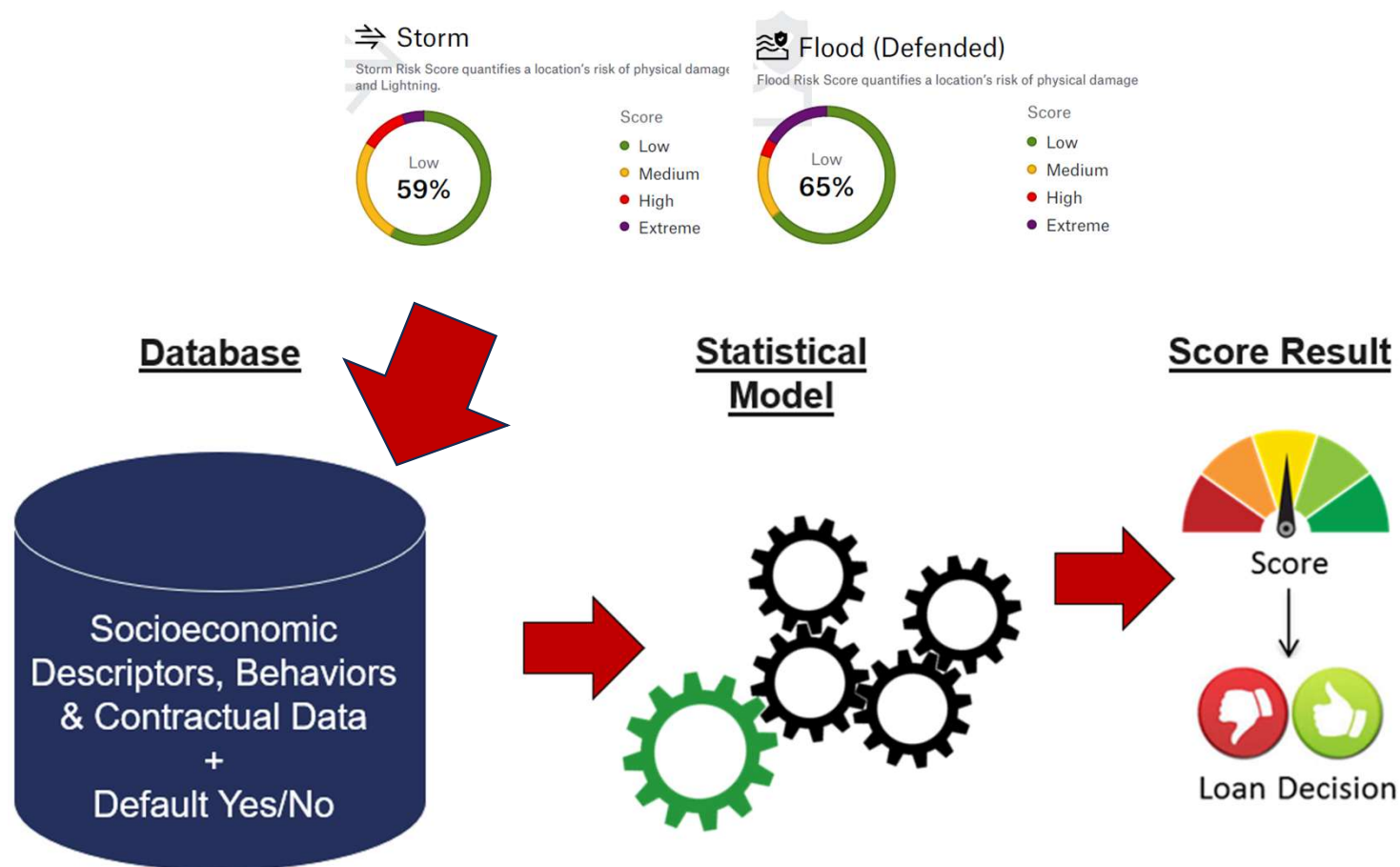
⚡ Hail

Frequency and intensity of hailstorms. The hail zoning expresses the location-specific hail potential, which is derived from lightning frequency, drop length, evapotranspiration and temperature. The hail zoning is based on the representation of atmospheric conditions that can lead to a hailstorm, and does not allow frequency (or return period) attributions for hailstorms of certain intensities and vice versa.



- These **physical hazard sensitivity scores** are read out from climate risk heat maps (public geodata) using the GPS coordinates of the portfolio assets.
- **Flood Risk (defended)** means that the risk assessment incorporates the presence and effectiveness of local flood protection infrastructure.

Sensitivity Scores are used as additional Explanatory Variables in Credit Scoring & Rating Models



Recap

1

Climate risk modelling transforms complex climate risks into insights that guide resilience, compliance, and strategy.

2

Positioning Financial Institutions for a Climate-Resilient Future.

Climate risk modeling has evolved into a strategic asset for financial institutions, enabling compliance and unlocking new growth opportunities.

3

Multiple approaches matter from sector-specific models to probabilistic hazard mapping and integrated climate-economic analysis, methodologies must be tailored to portfolios and geographies.

4

Models must drive action supported by strong governance, robust data, and continuous refinement, modelling enables institutions to protect assets, align with standards, and capture opportunities in a climate resilient economy.

Quiz Question

A bank is assessing how a severe flood could affect expected credit losses (EL) for a portfolio of MSME loans. Which chain of effects is most consistent with an integrated climate risk approach?

A) Flood risk mainly affects market risk and therefore has no material impact on credit risk metrics

B) Flood risk directly increases EL by raising operating costs, without affecting PD, LGD, or EAD.

C) Flood risk affects EL only if it is fully priced into asset values beforehand.

D) Flood risk increases PD through income disruption, increases LGD through lower collateral values, and may increase EAD if credit lines are drawn during stress.

Physical climate hazards can disrupt borrower cash flows (raising PD), reduce collateral recovery values (raising LGD), and trigger higher utilization of credit lines under stress (raising EAD), jointly increasing expected credit losses.

Quiz Question

When mapping climate risk into an existing loan portfolio and using climate stress testing, which approach best captures both borrower-level vulnerability and system-wide amplification of losses?

A) Combining macro climate scenarios with borrower-level activity data and using Monte Carlo simulations with conditional hazard probabilities

B) Applying a single national hazard index to all borrowers and adjusting interest rates uniformly

C) Focusing only on historical default rates of climate-exposed sectors

D) Stress testing portfolios using static balance-sheet assumptions without scenario analysis

This approach links external climate scenarios to granular client data and captures non-linear, compounding effects through probabilistic stress testing, which static or purely historical methods miss.



GLOBAL
CENTER ON
ADAPTATION