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Module 4: Green Finance Risk Management

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GREEN FINANCE, Erasmus+ CBHE 101237817

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A Thai bank's capital and the climate loss it can absorb

Regulatory capital	THB 71 billion
Risk-weighted assets	THB 500 billion
Basel III minimum and buffer	10.5 %; the Bank of Thailand asks 11 %

> **Predict** How large a climate loss, in THB billion, takes the bank to 10.5 %? Write down a number.

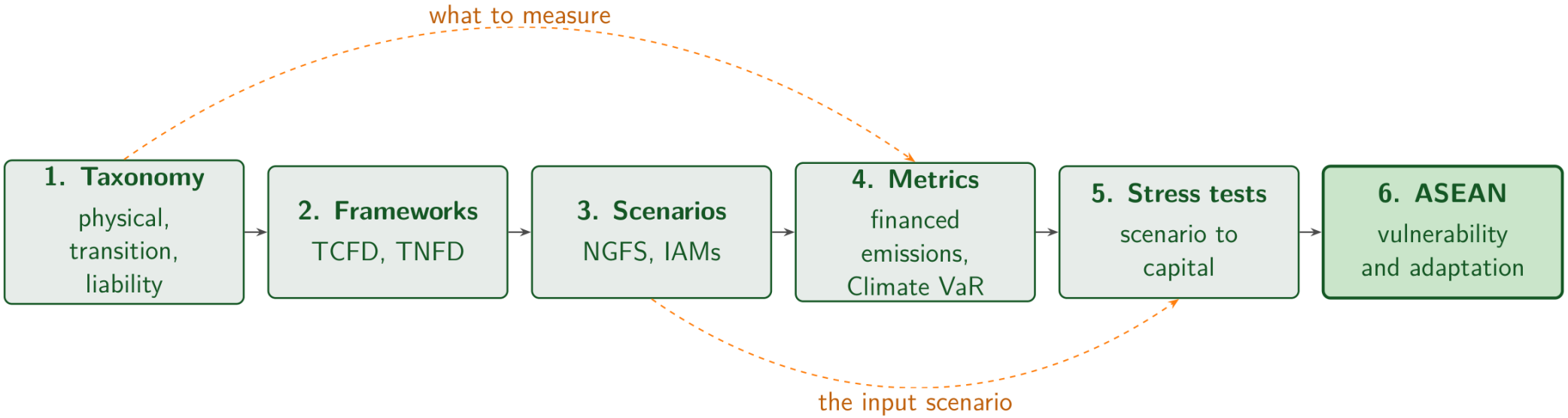
Illustrative bank, not a real institution. Source: BCBS, Basel III: A global regulatory framework for more resilient banks and banking systems (rev. June 2011), para 64; Bank of Thailand, Notification 12/2555, capital requirements.

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Each of the six lessons uses the ones before it

The six lessons and the order they depend on. Measurement needs the taxonomy; stress testing needs the scenarios.



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Students learn to classify, measure and manage climate risk in ASEAN

This module addresses climate-related financial risks and their management within financial institutions and investment portfolios.

Students learn to classify, measure, and manage climate risks using TCFD/TNFD frameworks, NGFS scenarios, carbon metrics, Climate Value-at-Risk (CVaR), and stress testing.

All concepts are applied to the ASEAN context with equal coverage of Vietnam, Thailand, and the Philippines.

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1

Climate-related financial risks

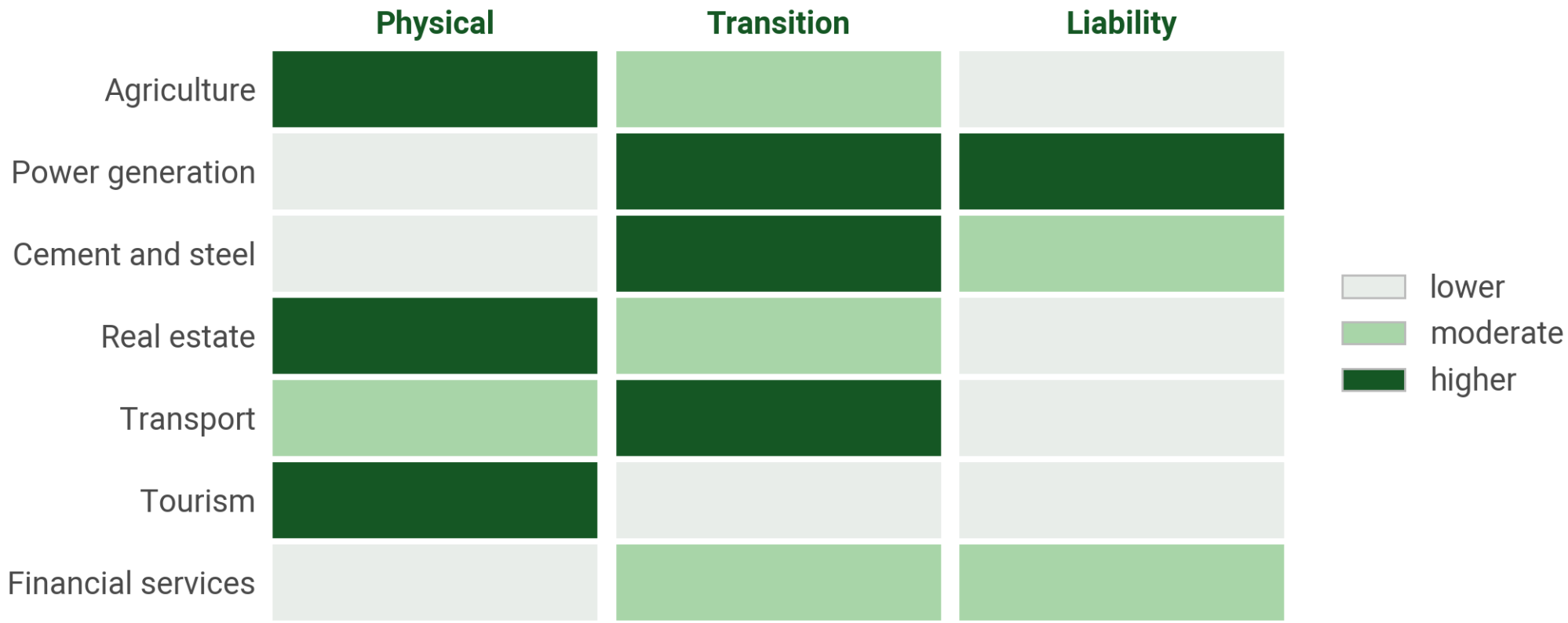
How does a hotter climate raise the expected loss on a Mekong Delta rice loan book?

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Three families of climate risk fall on different sectors

Seven sectors against the three legs of the taxonomy, in three named bands set by teaching judgement.



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Physical risk is damage from hazards: acute events and chronic trends

Physical risk: losses when a climate hazard damages assets, cuts output or stops operations.

Acute

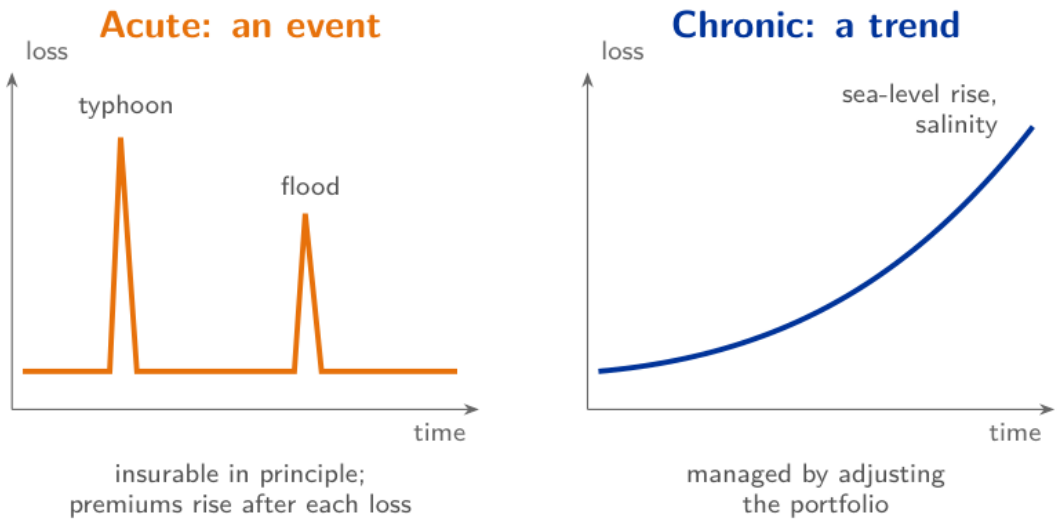
Events such as Philippine typhoons and the 2011 Thailand floods, insurable in principle

Chronic

Trends such as sea-level rise and Mekong Delta salinity, largely uninsurable

Insured share

Of about USD 250 billion of disaster losses in 2023, USD 95 billion was insured



Source: Munich Re (2024); World Bank (2012).

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Transition risk: the move to a low-carbon economy strands assets

Transition risk: losses from the move to a low-carbon economy, through policy and law, technology, markets and reputation.

Four types

Policy and legal, technology, market and reputation; buyers' behaviour is a market risk

Stranded assets

Coal plants retired early, reserves left in the ground, buildings below efficiency standards

For ASEAN exporters

A carbon charge applies to EU imports of steel and cement from 2026

Transition risk: the TCFD's four types

Policy and legal carbon pricing, emission rules, litigation	**Technology** lower-emission substitutes, cost of new technology
Market changing customer behaviour, cost of raw materials	**Reputation** shifting consumer preferences, stigma of a sector

Source: TCFD (2017), Final Report, Figure 1 and Table 1; European Commission, Carbon Border Adjustment Mechanism.

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Liability risk reaches the lender through the courts

Liability risk: losses from legal claims over climate harm, a failure to adapt, or misleading climate statements.

Litigation

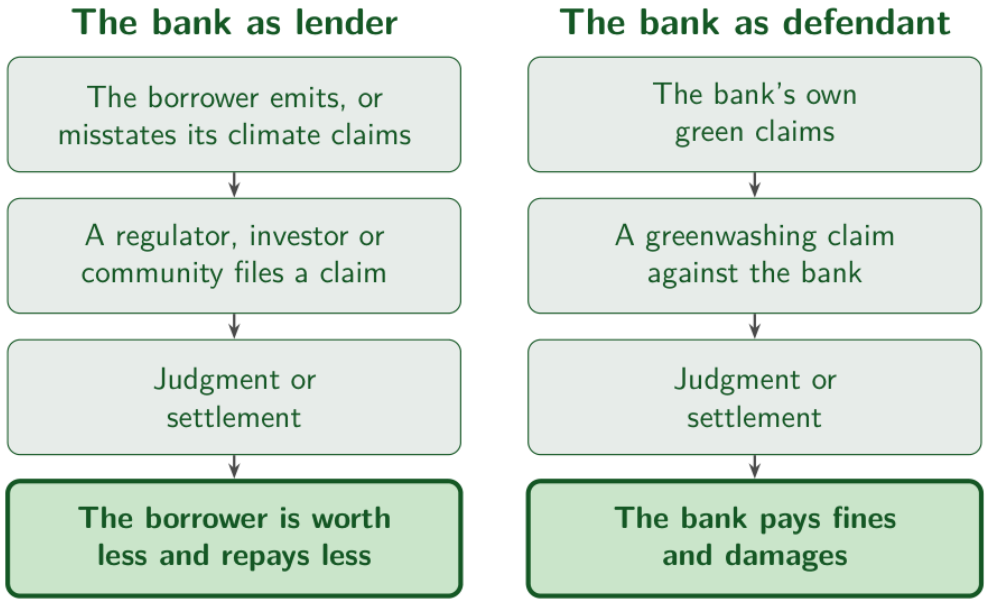
Setzer and Higham count 2,341 climate cases as of 2023

Greenwashing

Regulators and investors act against green claims the numbers do not support

The bank, twice

As lender to a defendant whose value falls, and as a defendant over its own green claims



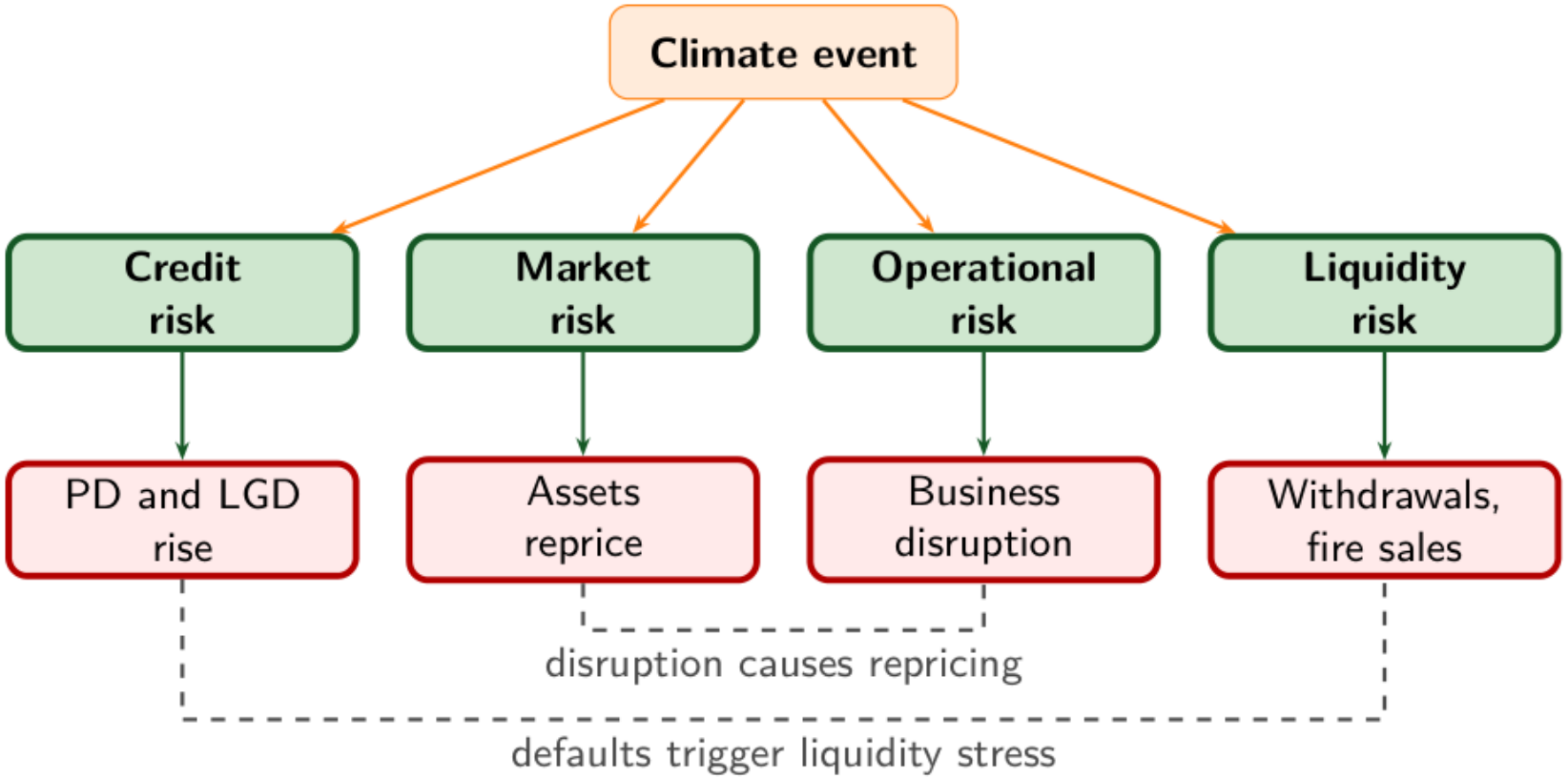
Source: Setzer and Higham (2023).

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One climate event moves credit, market, operational and liquidity risk at once

A climate event moves credit, market, operational and liquidity risk together, and the channels amplify one another.



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Credit risk: climate raises default probability and loss given default

Credit risk: the borrower repays less than it owes, by defaulting or by leaving a smaller recovery.

How climate reaches it

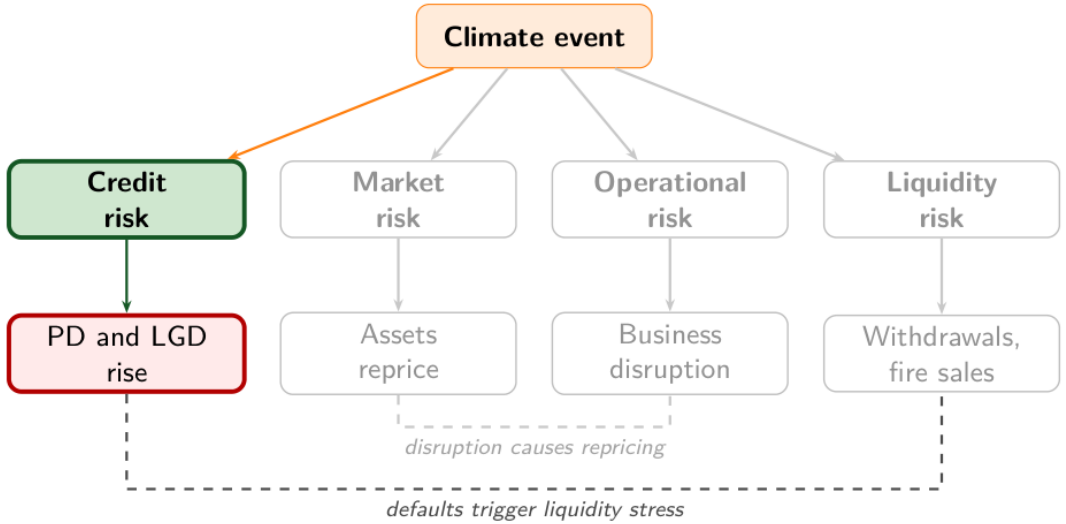
Drought lifts default probability (PD), floods lift loss given default (LGD), drawn lines lift exposure (EAD)

What the bank does

Scenario PD and LGD, limits by sector and region, shorter tenors, lower loan-to-value limits

Basel expects

Principle 8: climate risk over the whole credit life cycle, from onboarding to monitoring



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 8, paragraphs 35 to 37.

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Market risk: assets reprice before any borrower defaults

Market risk: losses on the instruments the bank holds when prices, rates or spreads move.

How climate reaches it

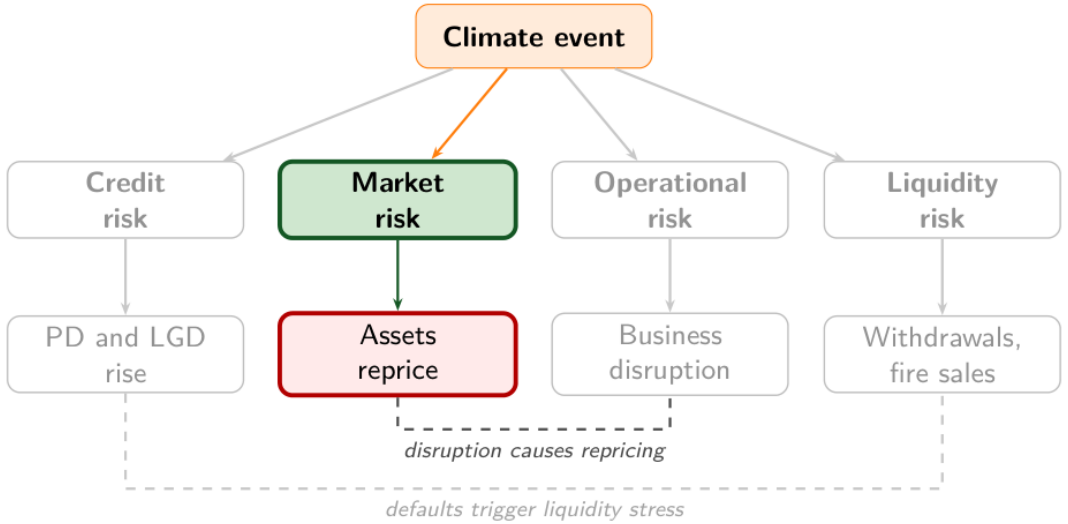
A carbon price reprices carbon-heavy issuers before any default; flood maps reprice property

What the bank does

A sudden climate shock on the trading book, the cost of hedges, the value of bonds held

Basel expects

Principle 9: how climate drivers change the value and volatility of instruments held



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 9, paragraphs 38 to 40.

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Operational risk: a flood stops the bank's own branches and systems

Operational risk: loss from failed processes, people and systems, or from external events, in the Basel definition.

How climate reaches it

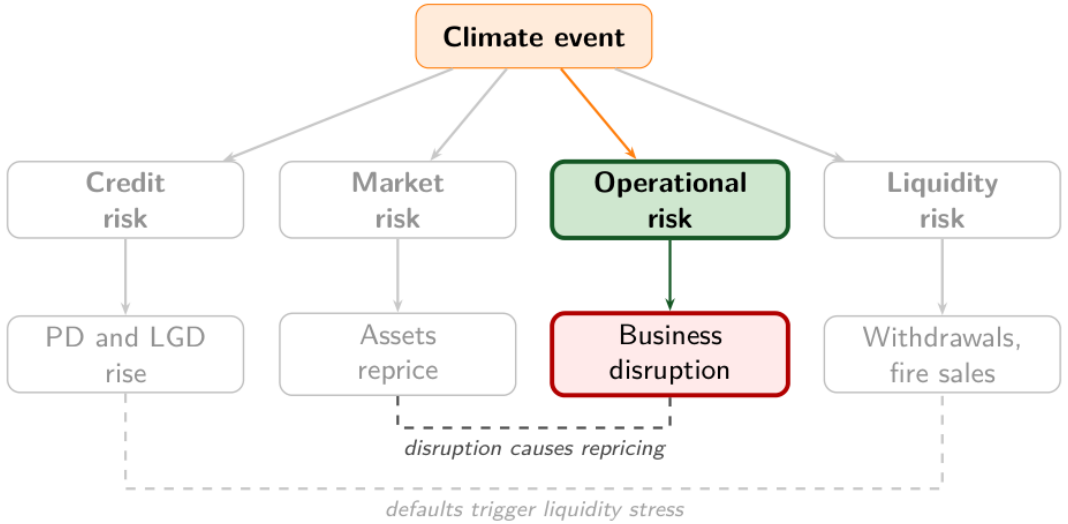
Flooded branches and data centres, staff cut off, outsourced services down, greenwashing fines

What the bank does

Hazard maps of its own sites and suppliers, recovery tests, a record of climate loss events

Basel expects

Principle 11: business continuity plans that account for physical risk drivers



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 11, paragraph 42.

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Liquidity risk: withdrawals and drawdowns arrive with the losses

Liquidity risk: the bank cannot meet its cash outflows without selling assets at a loss or borrowing at a penalty.

How climate reaches it

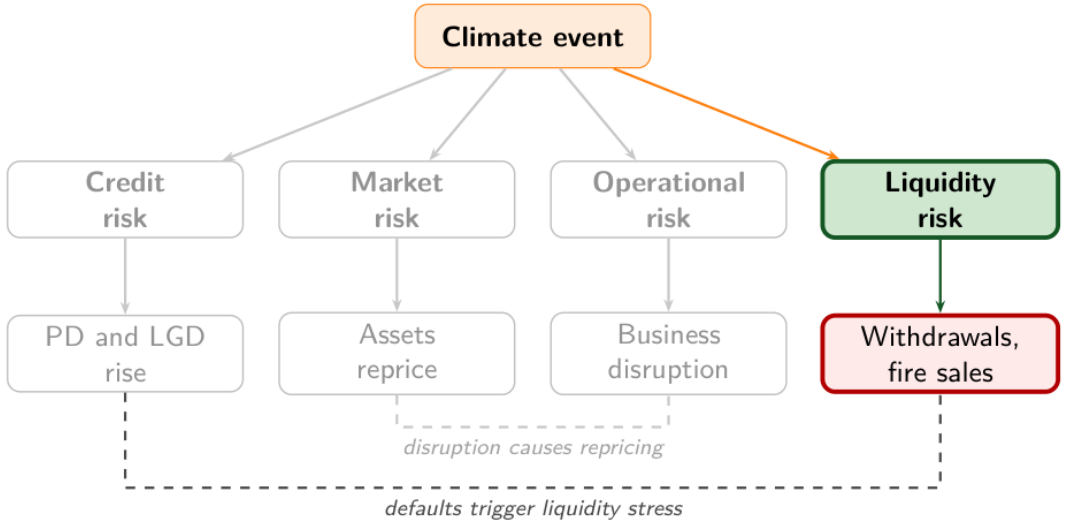
After a disaster, deposits are withdrawn, credit lines drawn, and buffer bonds lose value

What the bank does

A liquidity coverage ratio stress with a climate event in the scenario

Basel expects

Principle 10: climate effects on net cash outflows and on the value of liquidity buffers



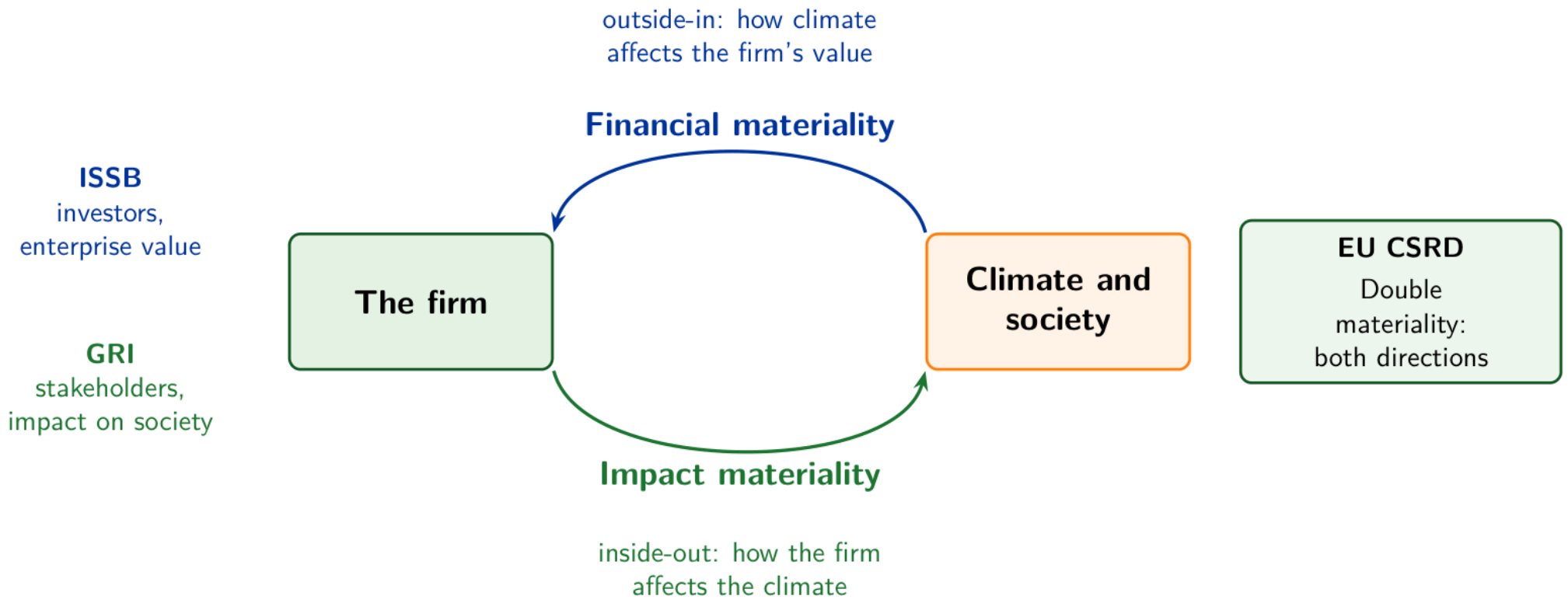
Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 10, paragraph 41.

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Financial materiality is outside-in, impact materiality inside-out

ISSB asks how climate affects the firm's value, GRI how the firm affects climate; the EU CSRD asks both.



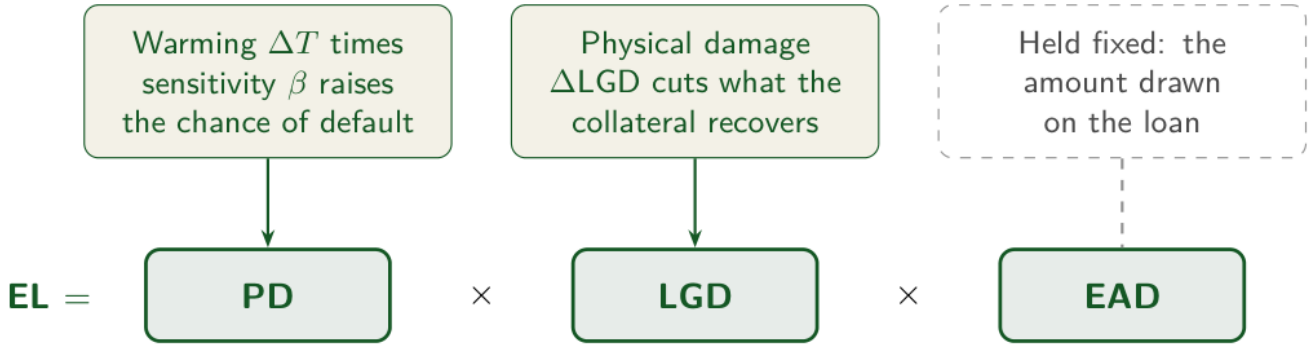
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Climate multiplies default probability and adds to loss given default

$$\mathrm{EL}_{\mathrm{climate}} = \mathrm{PD}_{\mathrm{base}}(1 + \Delta T \cdot \beta) \times (\mathrm{LGD}_{\mathrm{base}} + \Delta \mathrm{LGD}) \times \mathrm{EAD}$$

$\mathrm{PD}_{\mathrm{base}}$: default probability today. ΔT: warming beyond today's climate, °C. β: the sector's climate sensitivity. $\mathrm{LGD}_{\mathrm{base}}$: loss given default today. $\Delta \mathrm{LGD}$: collateral lost to physical damage. EAD: exposure at default, held fixed.



Climate keeps the form PD × LGD × EAD and changes its inputs.

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A Mekong Delta rice portfolio at plus 2.0 °C

Default probability today	5.0 %
Climate sensitivity β, agriculture	0.35 per °C
Warming beyond today, ΔT	plus 2.0 °C
Loss given default today	60 %, plus 5 points of collateral damage
Exposure at default	USD 300 million, unchanged

> **Predict** Expected loss today is USD 9.0 million. Write down the percentage rise you expect at plus 2.0 °C.

Illustrative Mekong Delta rice portfolio, chosen to make the mechanism visible.

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Expected loss rises 84 percent, from USD 9.0 million to 16.6 million

1. Climate-adjusted PD = 0.05 × (1 + 2.0 × 0.35) = 0.085, or 8.5 %
2. Climate-adjusted LGD = 60 % + 5 points = 65 %
3. Expected loss today = 0.05 × 0.60 × USD 300 million = USD 9.0 million
4. Expected loss at plus 2.0 °C = 0.085 × 0.65 × USD 300 million = USD 16.6 million

USD 7.6 million of added loss, a rise of 84 percent

Illustrative Mekong Delta rice portfolio, chosen to make the mechanism visible.

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A 70 percent rise in default probability and an 84 percent rise in expected loss

Default probability rises 70 percent and expected loss 84 percent. Where do the other 14 points come from?

A Exposure at default grows in the warmer scenario

B Default correlation among farmers in the same delta

C Loss given default rises from 60 to 65 percent

D A separate climate term added to expected loss

Illustrative Mekong Delta rice portfolio, chosen to make the mechanism visible.

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The loss given default moves too

C Loss given default rises from 60 to 65 percent

Why

The two rises multiply: 1.70 × 1.083 = 1.84. A 70 percent rise in PD and an 8.3 percent rise in LGD make an 84 percent rise in expected loss.

Tempting: A, Exposure at default grows in the warmer scenario

Exposure growth raises expected loss in a real book, and the example holds exposure at USD 300 million in both columns.

Takeaway Climate enters expected loss through its terms, and their rises multiply.

Illustrative Mekong Delta rice portfolio, chosen to make the mechanism visible.

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TCFD and TNFD risk assessment

A supervisor opens a bank's climate report. What does the supervisor look for first?

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Four pillars, with Risk Management as the operational core

Governance, Strategy, Risk Management, and Metrics and Targets: the four pillars of the TCFD recommendations of 2017.



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Governance: the board oversees climate risk and management runs it

Governance: the organization's governance around climate-related risks and opportunities, in the TCFD's words.

TCFD asks

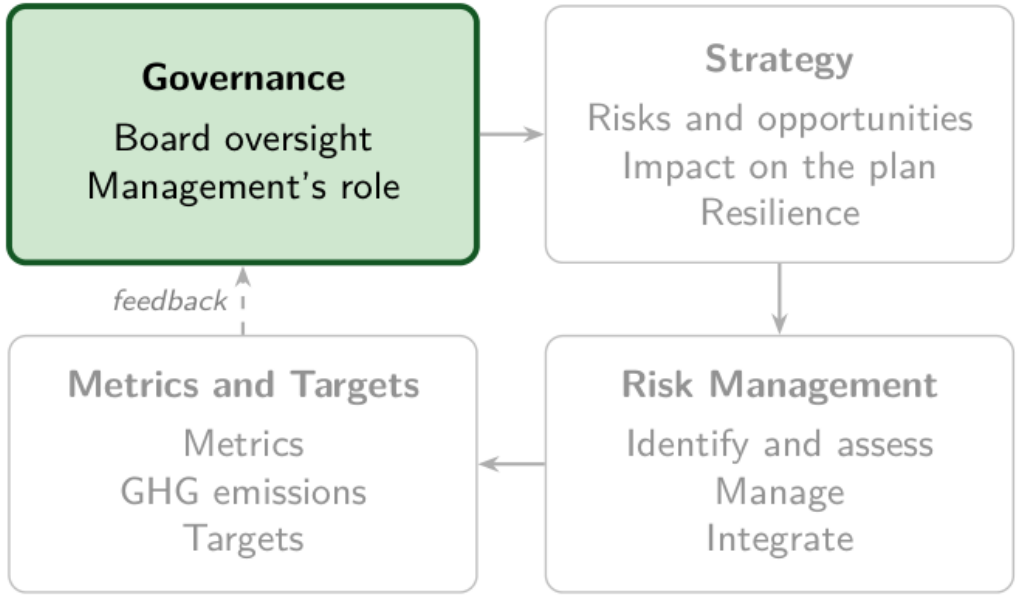
The board's oversight of climate risks and opportunities, and management's role in managing them

In a bank

The board's risk committee sets a climate risk appetite and names the executive who answers for it

Basel expects

Principle 2: the board assigns climate responsibilities and oversees the risks



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 2, paragraphs 15 to 17; TCFD (2017), Final Report, Figures 2 and 4.

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Strategy: what climate does to the business plan over three horizons

Strategy: the actual and potential impacts of climate risks and opportunities on the business, strategy and planning.

TCFD asks

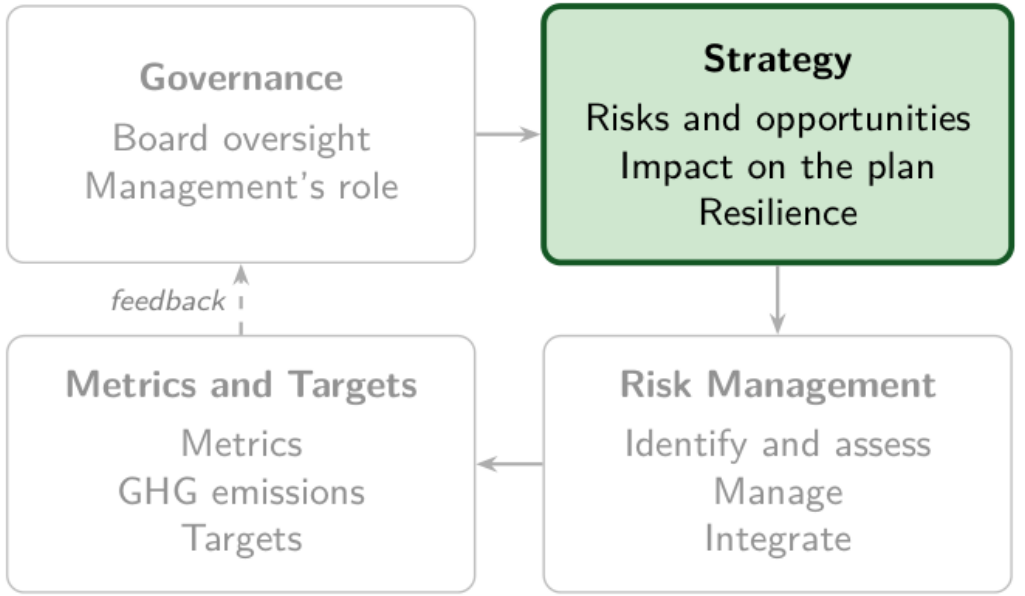
Risks over the short, medium and long term, their impact on the plan, its resilience across scenarios

In a bank

Which sectors and regions the loan book grows or leaves, tested against the NGFS scenarios

Basel expects

Principle 1: climate risks over various horizons, built into the business strategy



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 1, paragraphs 12 to 14; TCFD (2017), Final Report, Figures 2 and 4.

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Risk Management: identify, assess and manage climate risk, then integrate it

Risk Management: the processes used by the organization to identify, assess and manage climate-related risks.

TCFD asks

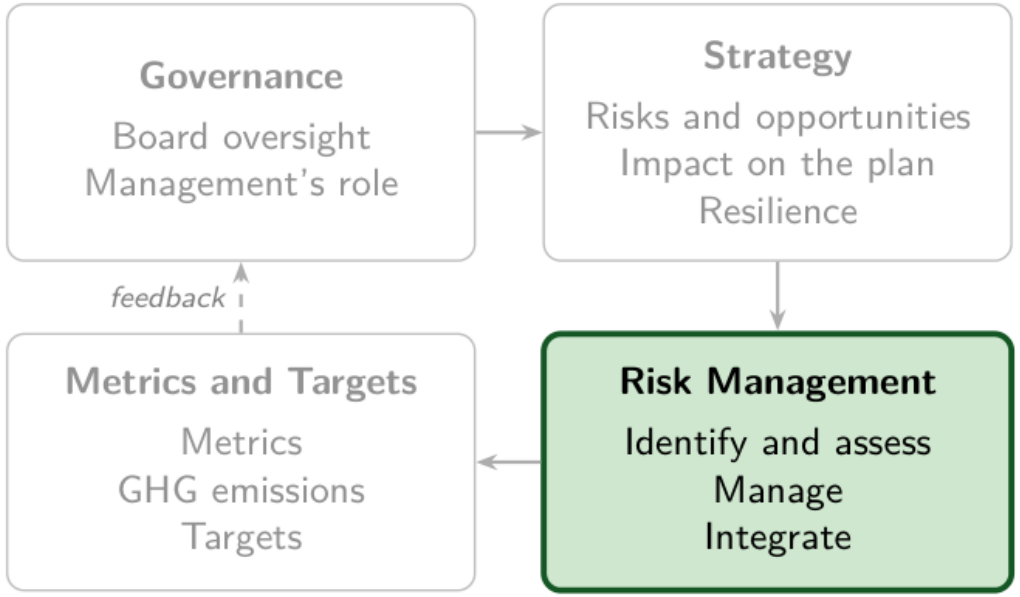
How the bank identifies, assesses and manages climate risk, and integrates it into its ERM

In a bank

Exposure mapped by business line and region, scenario PD and LGD, thresholds applied in lending

Basel expects

Principle 6: identify, monitor and manage all material climate-related financial risks



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 6, paragraphs 27 to 30; TCFD (2017), Final Report, Figures 2 and 4.

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Metrics and Targets: what the bank measures and the goals it sets

Metrics and Targets: the metrics and targets used to assess and manage relevant climate-related risks and opportunities.

TCFD asks

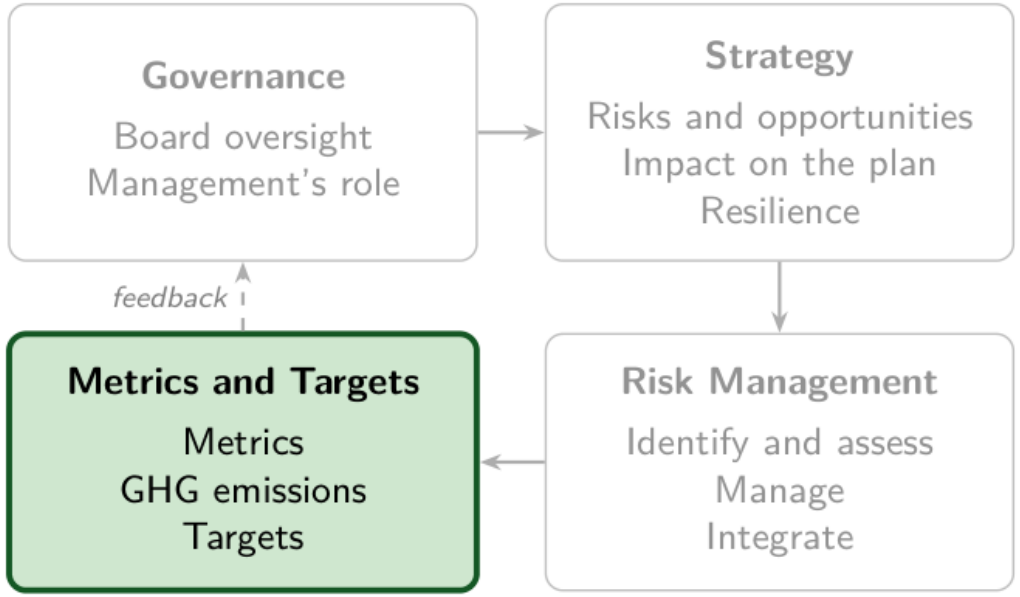
The metrics in use; Scope 1, Scope 2 and, if appropriate, Scope 3 emissions; targets and results

In a bank

Financed emissions and carbon intensity of the loan book, and a target for each

Basel expects

Principle 7: risk data and internal reports that track material climate risks



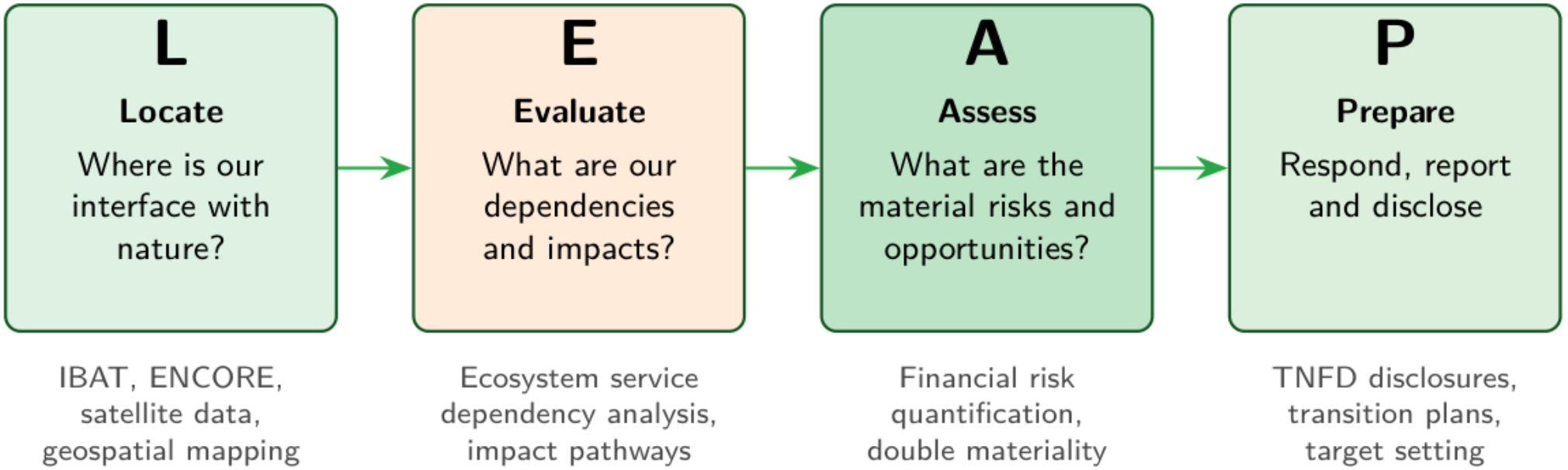
Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 7, paragraphs 31 to 34; TCFD (2017), Final Report, Figures 2 and 4.

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TNFD assesses nature risk in four steps: Locate, Evaluate, Assess, Prepare

TNFD, September 2023: the four pillars of TCFD, and LEAP, which starts where a borrower meets nature.

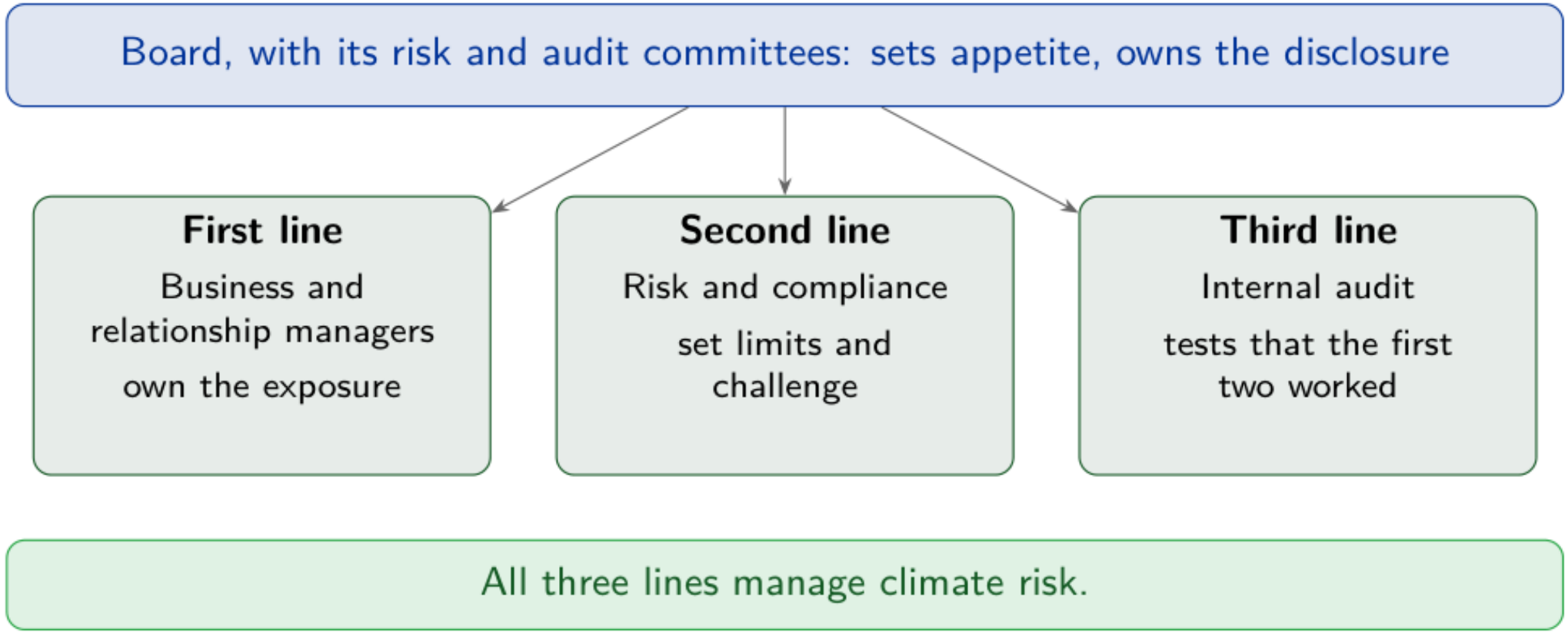


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All three lines of defence manage climate risk

The board sets appetite; business lines own the exposure, risk sets limits and challenges, audit tests both.



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The first line owns the exposure and collects the borrower's climate data

First line: the business units and relationship managers who originate, price and hold the exposure.

Its climate tasks

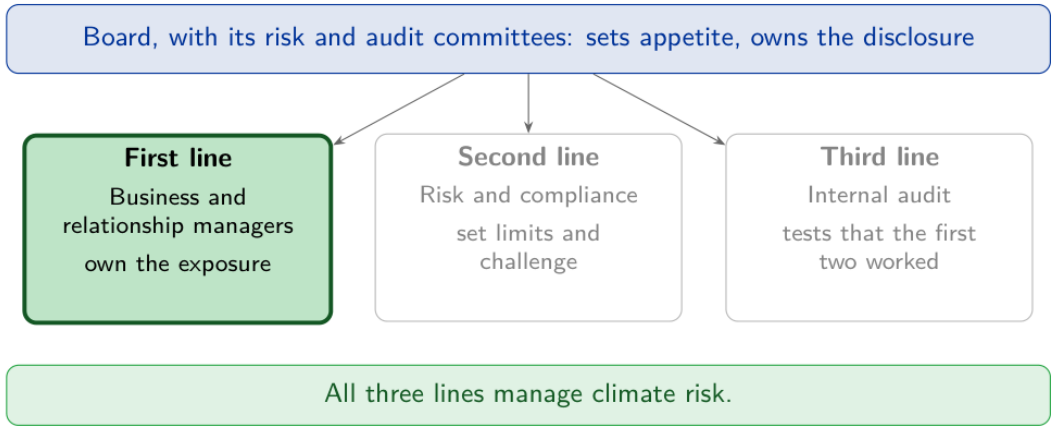
Assess climate risk at onboarding, credit application, credit review and monitoring

In a credit memo

A flood-map check of the collateral and the borrower's transition plan

Basel expects

Principle 4: first-line staff able to recognise climate risk



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 4, paragraphs 19 to 22.

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The second line sets limits and challenges the first line's assessment

Second line: the risk function and compliance, independent of the business they oversee.

Its climate tasks

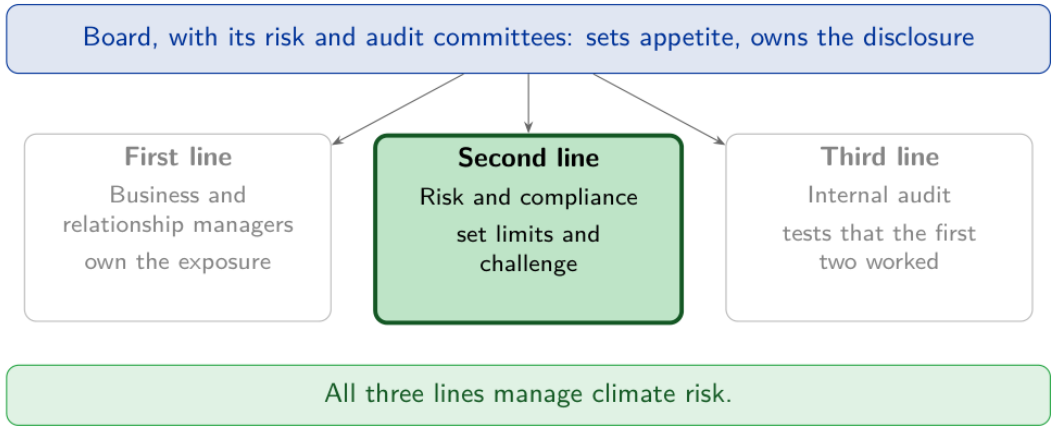
Set climate limits by sector and region, build the scenario PD and LGD methods, monitor the book

Challenge

Re-examine the first line's climate assessment; compliance checks green claims against the rules

Basel expects

Principle 4: climate risk assessed and monitored independently of the first line



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 4, paragraphs 19 to 22.

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The third line tests whether the first two lines worked

Third line: internal audit, independent of both other lines and reporting to the board's audit committee.

Its climate tasks

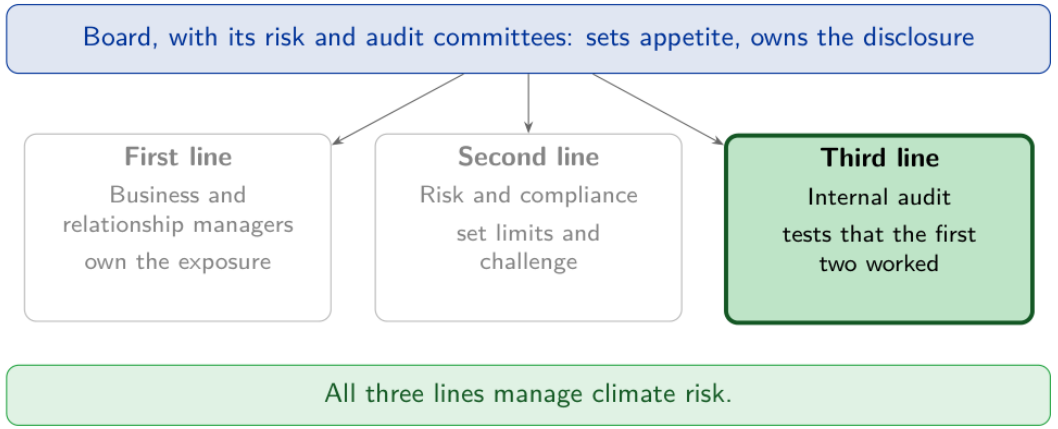
Test the climate data, the models and the limits, and whether the disclosure matches practice

When to look again

After a change of method, business, risk profile or data quality

Basel expects

Principle 4: objective assurance on the control framework and on the first and second lines



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 4, paragraphs 19 to 22.

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A maturity rubric scores four dimensions from 0 to 3

> Score = Identify + Assess + Manage + Integrate

Each dimension scores from 0 to 3, so the total runs from 0 to 12.

0 to 3	4 to 6	7 to 9	10 to 12
Absent	Basic	Developing	Advanced

Teaching rubric of chapter 2, chosen by the module.

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A hypothetical Thai commercial bank, scored on four dimensions

Identify	2 of 3
Assess	1 of 3: qualitative only, limited scenario work
Manage	2 of 3: sector policies, no portfolio steering
Integrate	1 of 3: reported apart from enterprise risk management

> **Predict** Add the four scores and name the band. Then name the two moves that would raise the total most.

Hypothetical Thai commercial bank of chapter 2, illustrative scores. Teaching rubric of chapter 2, chosen by the module.

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Six of twelve is basic

1. Total = 2 + 1 + 2 + 1 = 6
2. 6 is in the 4 to 6 band: basic
3. Assess scores 1, lowest with Integrate: run NGFS scenario analysis on the loan book
4. Integrate scores 1, lowest with Assess: put climate risk into the board's risk-appetite statement

6 of 12, basic; the two moves raise Assess and Integrate

Hypothetical Thai commercial bank of chapter 2, illustrative scores. Teaching rubric of chapter 2, chosen by the module.

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Financed emissions published, credit limits set without climate risk

A bank publishes its financed emissions every year and feeds no climate risk into its credit limits. Which TCFD pillar has the gap?

A	Risk Management
B	Metrics and Targets
C	Governance
D	Strategy

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Risk Management is the gap

A Risk Management

Why

Credit limits are where a bank manages credit risk. Limits set without climate risk leave the Risk Management pillar with no climate content, whatever the bank publishes.

Tempting: B, Metrics and Targets

The bank publishes financed emissions, so Metrics and Targets has content. The weakness is upstream of the numbers.

> **Takeaway** A supervisor reads a climate report for its risk management first.

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3

Scenario analysis and climate modeling

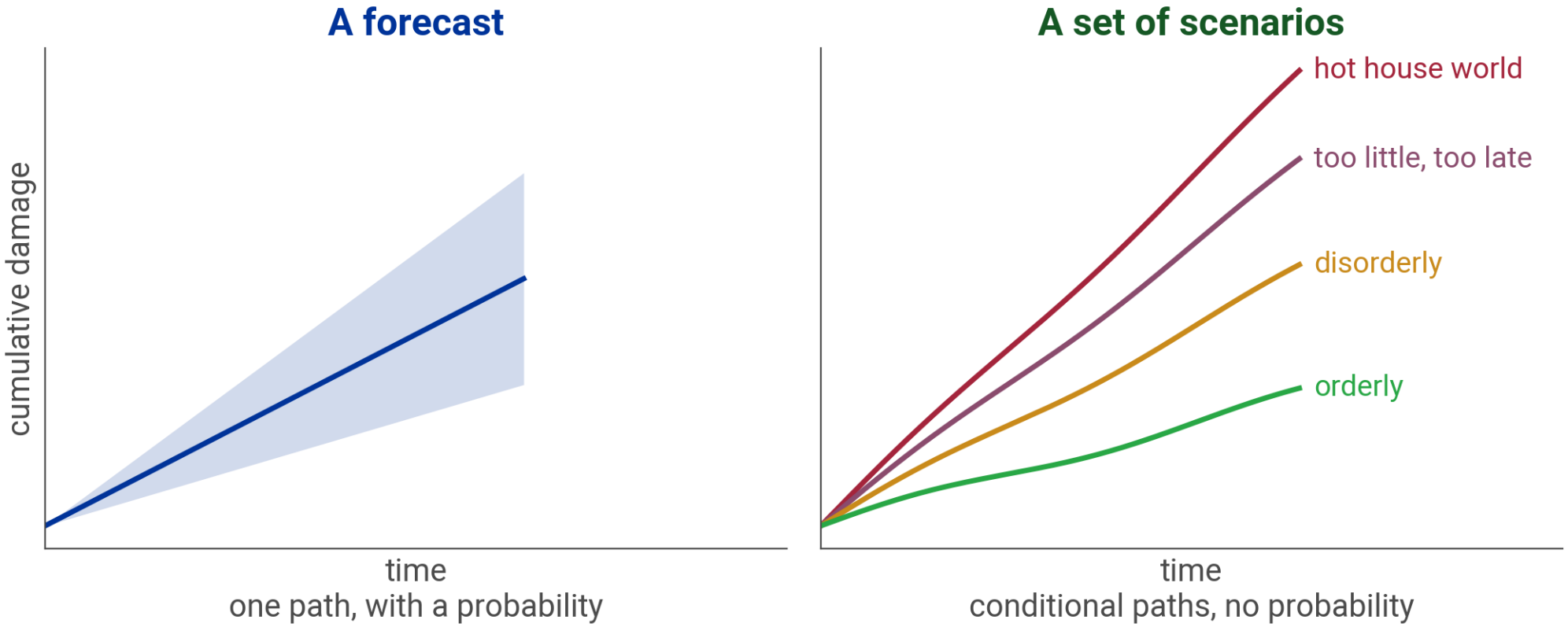
Nobody can attach a probability to a hot house world. How does a bank plan for one?

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A forecast has a probability; a scenario set has none

A forecast is one path with a probability attached; a scenario set is conditional paths with none. The shapes are schematic.

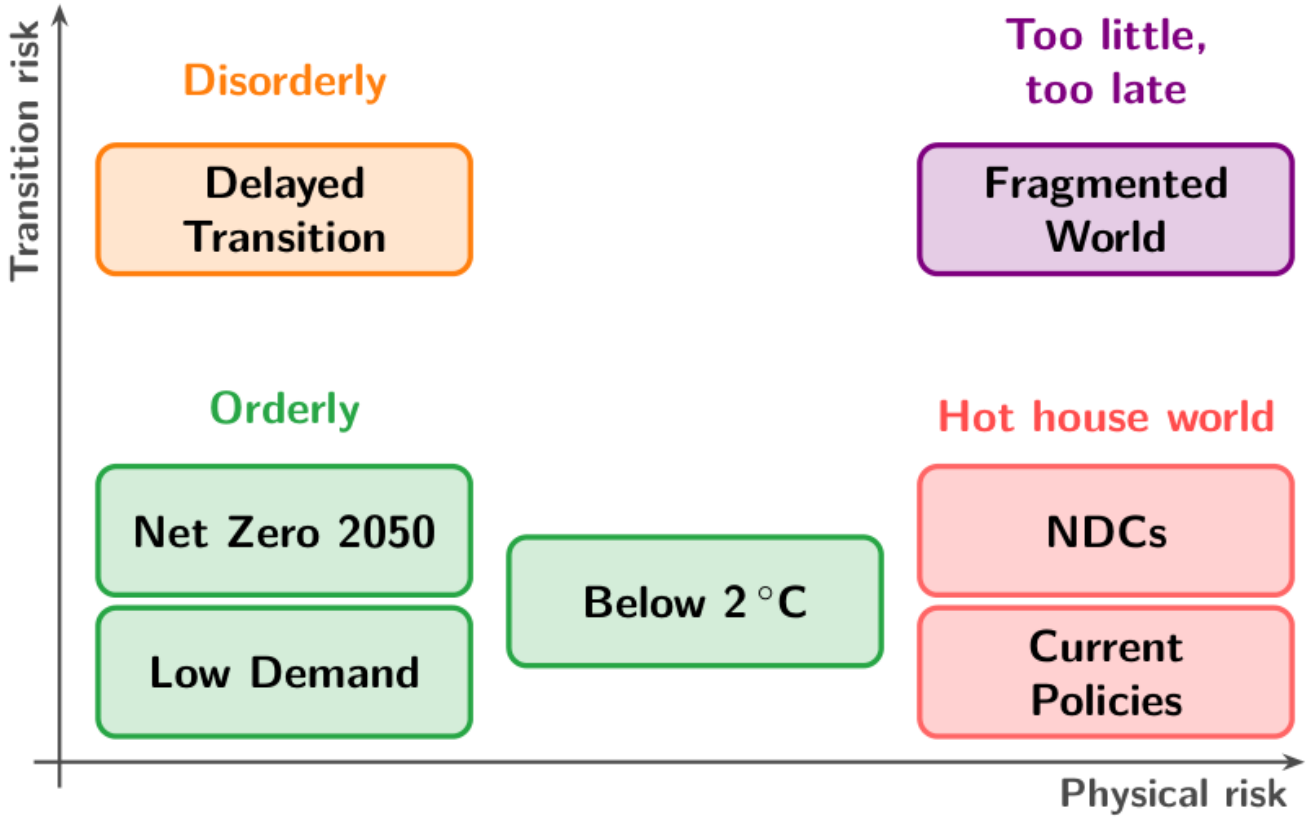


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The NGFS scenarios are ordered by physical and transition risk

The seven NGFS scenarios of results version 5.0, November 2024, placed by physical and transition risk.



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Orderly scenarios: early, gradual policy keeps both risks subdued

Orderly: ambitious climate policies introduced early and made gradually more stringent; both risks relatively subdued.

Scenarios

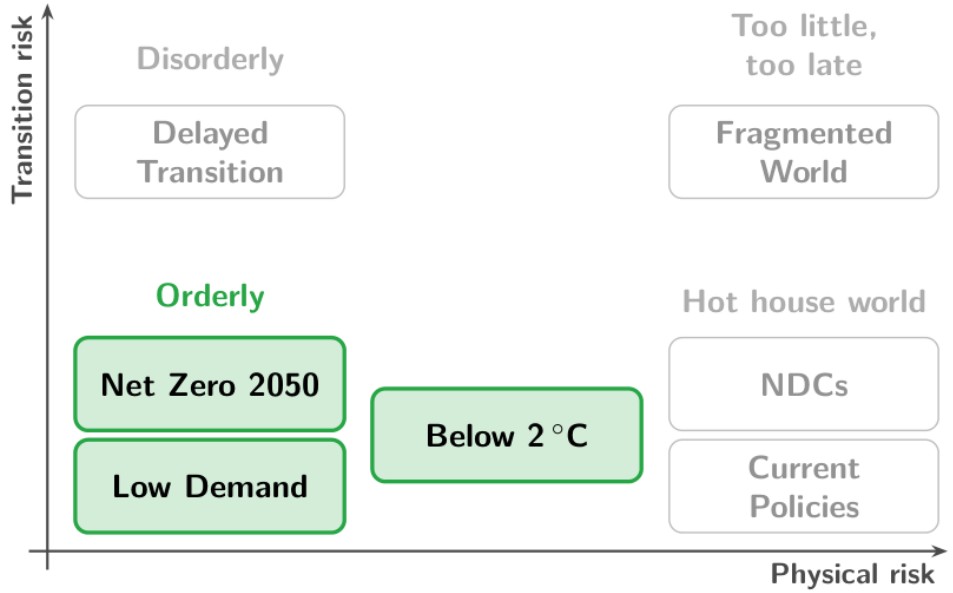
Net Zero 2050, Below 2 °C and Low Demand

Policy

Starts now and tightens gradually, so carbon prices rise on a known path

Risk that dominates

Transition cost, spread over decades, with physical risk relatively subdued



Source: NGFS (2024), Climate Scenarios Technical Documentation V5.0.

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Disorderly scenarios: late or divergent policy raises transition risk

Disorderly: climate policies delayed or divergent across countries and sectors; subdued physical but high transition risk.

Scenario

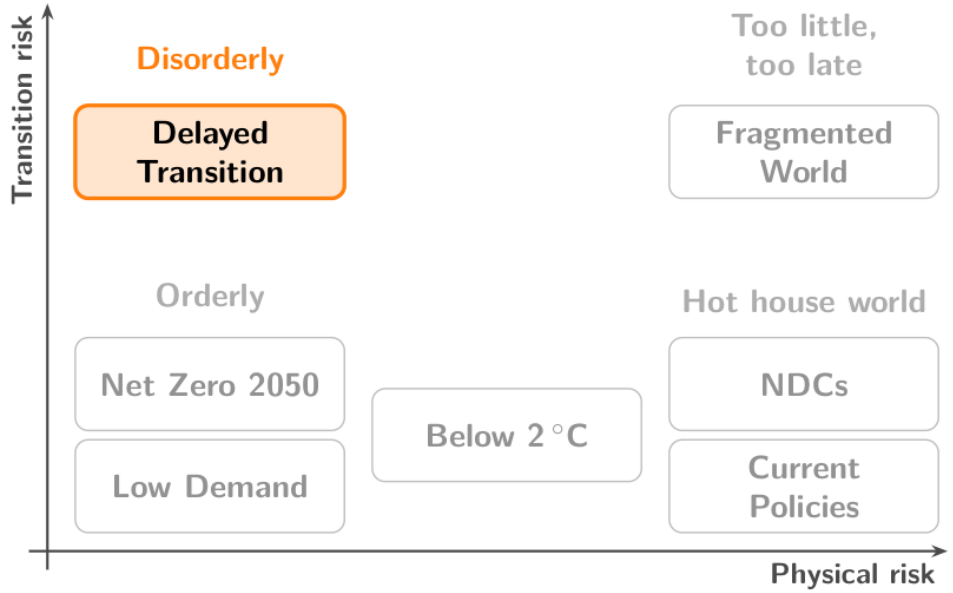
Delayed Transition

Policy

Global emissions do not fall until 2030, then carbon prices rise sharply and abruptly

Risk that dominates

Transition, arriving abruptly: carbon-heavy borrowers reprice within a few years



Source: NGFS (2024), Climate Scenarios Technical Documentation V5.0.

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Hot house world: policy stops short and physical risk grows severe

Hot house world: some climate policies in some jurisdictions, and global efforts insufficient to halt significant warming.

Scenarios

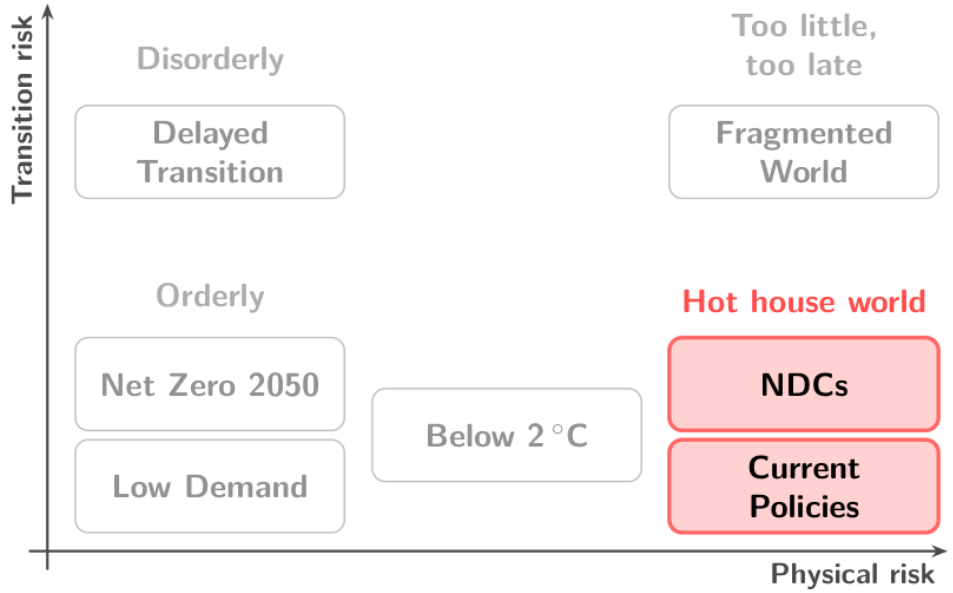
Nationally Determined Contributions (NDCs), the pledges; Current Policies, the policies in force

Policy

No tightening beyond pledged targets, some not yet backed by policy, or beyond current law

Risk that dominates

Physical, rising through the century, with the least transition cost



Source: NGFS (2025), NGFS Scenarios: narratives and key findings.

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Too little, too late: a late, uneven transition leaves physical risk high

Too little, too late: a late and uncoordinated transition that fails to limit physical risks.

Scenario

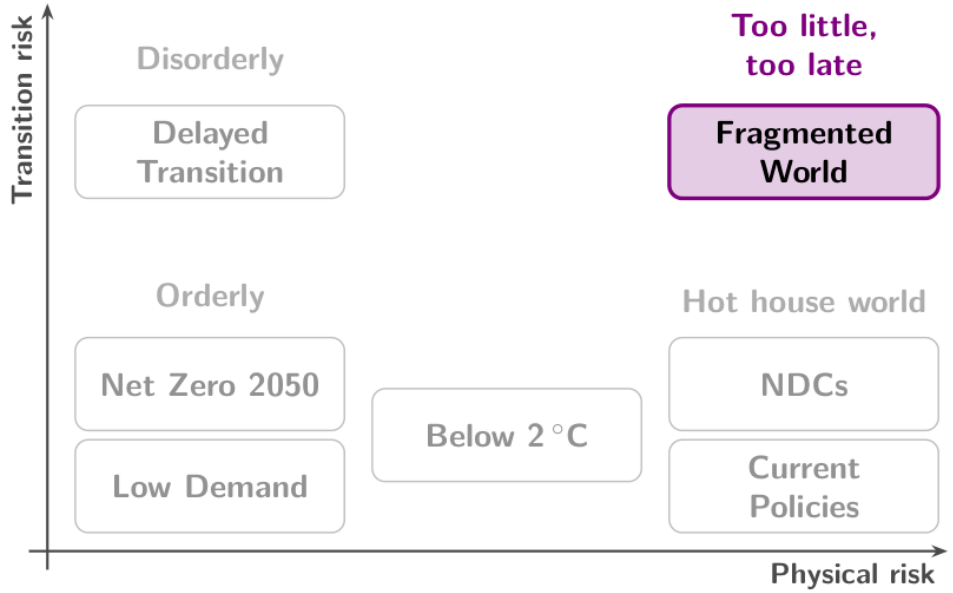
Fragmented World

Policy

Climate action delayed and uneven across countries

Risk that dominates

Both: transition risk where policy tightens late, physical risk everywhere



Source: NGFS (2025), NGFS Scenarios: narratives and key findings.

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An integrated assessment model couples economy, energy and climate

Integrated assessment model (IAM): an economic, an energy and a climate module solved together, each feeding the next.

Three NGFS models

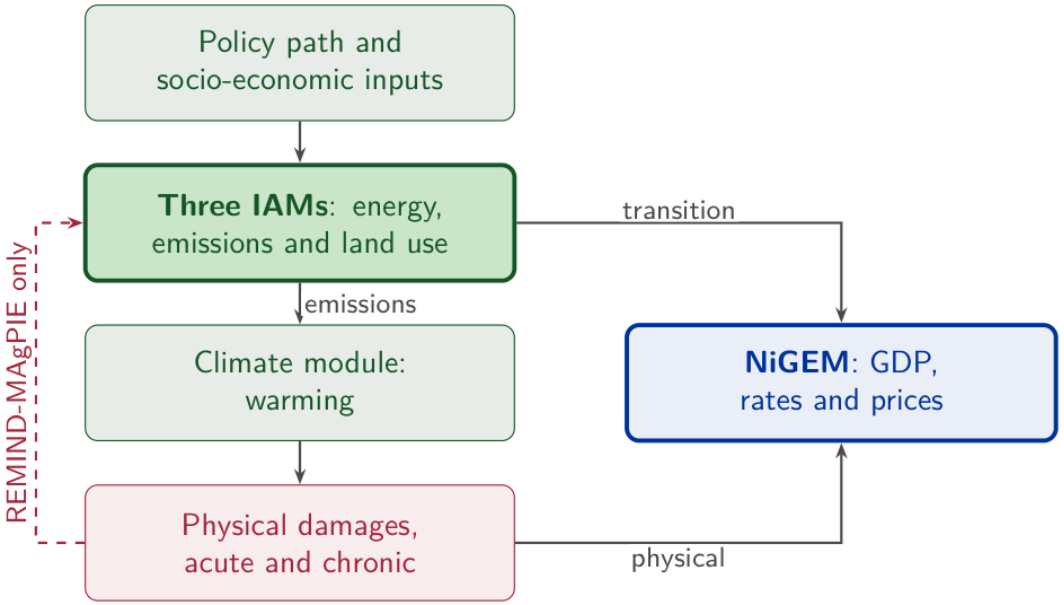
REMIND-MAgPIE, GCAM and MESSAGEix-GLOBIOM turn a policy path into energy use, emissions and land use

Physical damage

Enters the transition paths only in REMIND-MAgPIE's runs with integrated damages

To the economy

NiGEM, a macroeconomic model, turns the transition and the physical shocks into GDP, rates and prices



Source: NGFS (2024), Technical Documentation V5.0.

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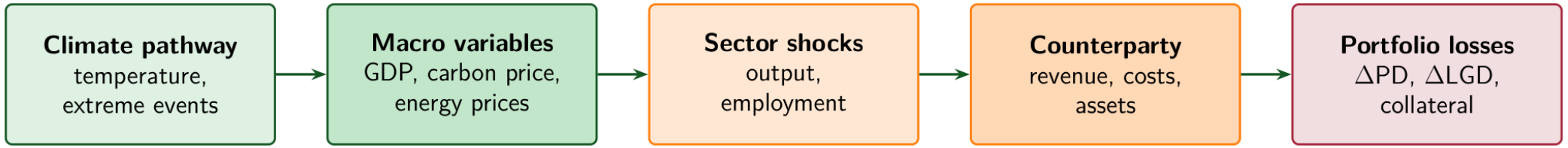
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Scenario variables become default and loss rates

$$\Delta PD_{sector} = -\gamma_{sector} \times \Delta GDP_{scenario}$$

$$LGD_{climate} = LGD_{base} + (1 - insurance) \times damage$$

$\Delta GDP_{scenario}$: the scenario's deviation of output from its baseline. γ_{sector}: the sector's default sensitivity to output. insurance: the insured share of physical damage. damage: the physical damage rate on collateral.



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Philippine agriculture when GDP falls 8 percent on a hot house path

GDP deviation, ΔGDP	−8 %
Default sensitivity, γ	1.5
Loss given default today	45 %
Share of damage insured	30 %
Physical damage rate	25 %

> **Predict** Which rises by more percentage points: the default probability or the loss given default?

Illustrative Philippine agriculture calibration of chapter 3, chosen for teaching.

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Loss given default rises 17.5 points, default probability 12 points

1. $\Delta PD = -1.5 \times (-8\ \%) = +12$ points
2. Uninsured share = $1 - 0.30 = 0.70$
3. $LGD_{climate} = 45\ \% + 0.70 \times 25\ \% = 62.5\ \%$
4. LGD rises $62.5 - 45 = 17.5$ points

LGD up 17.5 points, PD up 12 points

Illustrative Philippine agriculture calibration of chapter 3, chosen for teaching.

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The NGFS scenario with the largest losses for an ASEAN loan book

For a typical ASEAN loan book, which of these NGFS scenarios gives the largest credit losses over the rest of the century?

A	Net Zero 2050, an orderly transition
B	Low Demand, an orderly transition
C	Delayed Transition, a disorderly path
D	Current Policies, a hot house world on today's policies

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In ASEAN the hot house world is the severe case

D Current Policies, a hot house world on today's policies

Why

Tropical, coastal, agriculture-dependent economies with thin insurance lose most to physical damage, and a hot house world has the most physical damage and the least transition cost.

Tempting: C, Delayed Transition, a disorderly path

Delayed Transition is the severe case for fossil-heavy developed markets, where transition risk dominates. ASEAN loan books lean towards physical risk.

> **Takeaway** A bank runs several scenarios, among them the one its own book fears most.

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4

Carbon metrics and Climate Value-at-Risk

A bank lends to a steel mill. How much of the mill's carbon is the bank's?

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Financed emissions: the lender's share of a borrower's emissions

Financed emissions: the share of a borrower's emissions attributed to a lender, Scope 3 category 15 of its footprint.

Attribution

Outstanding loan ÷ EVIC, the borrower's enterprise value including cash, × the borrower's emissions

Three scopes

Scope 1, its own operations; Scope 2, purchased energy; Scope 3 category 15, its loans and investments

Data quality

PCAF scores run from 1, verified company emissions, to 5, sector factors per unit of revenue or asset

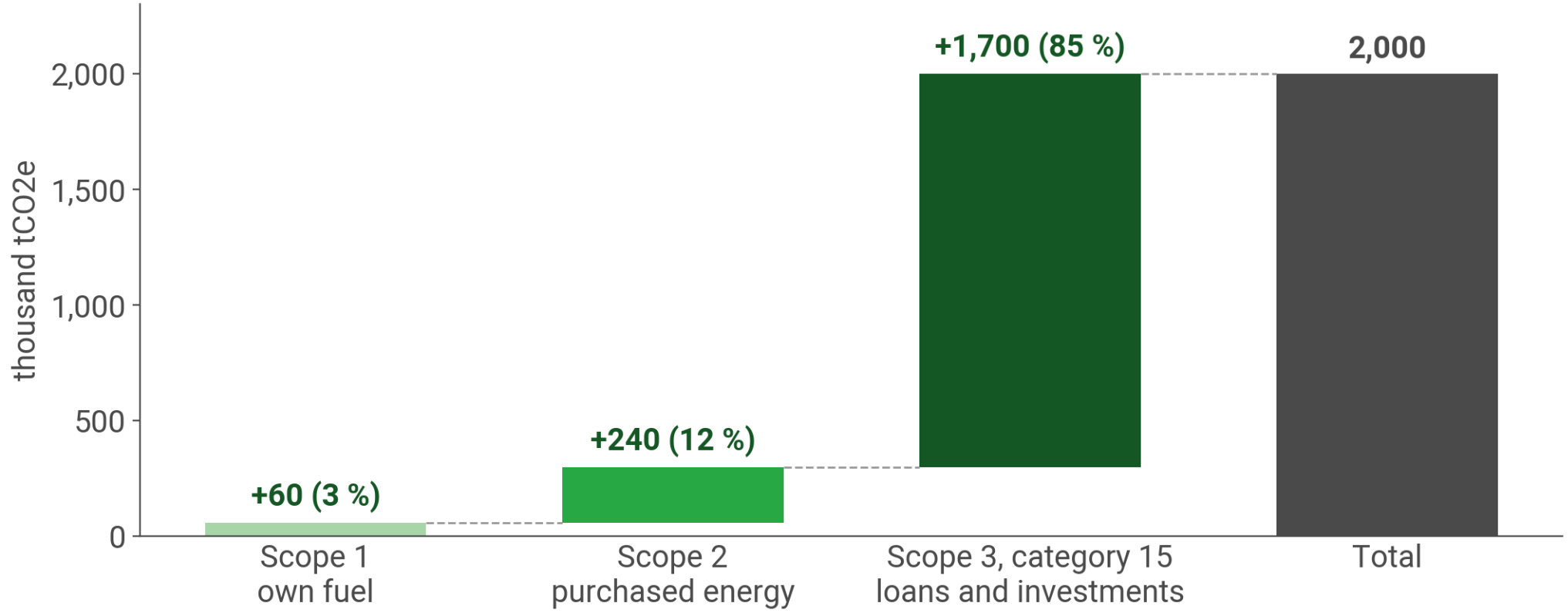
Source: PCAF (2022), Standard Part A; GHG Protocol (2011), Scope 3 Standard.

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Financed emissions are 85 percent of the illustrative bank's footprint

The bank's own fuel, its purchased energy, and its loans and investments, in thousand tCO2e, for an illustrative ASEAN bank.

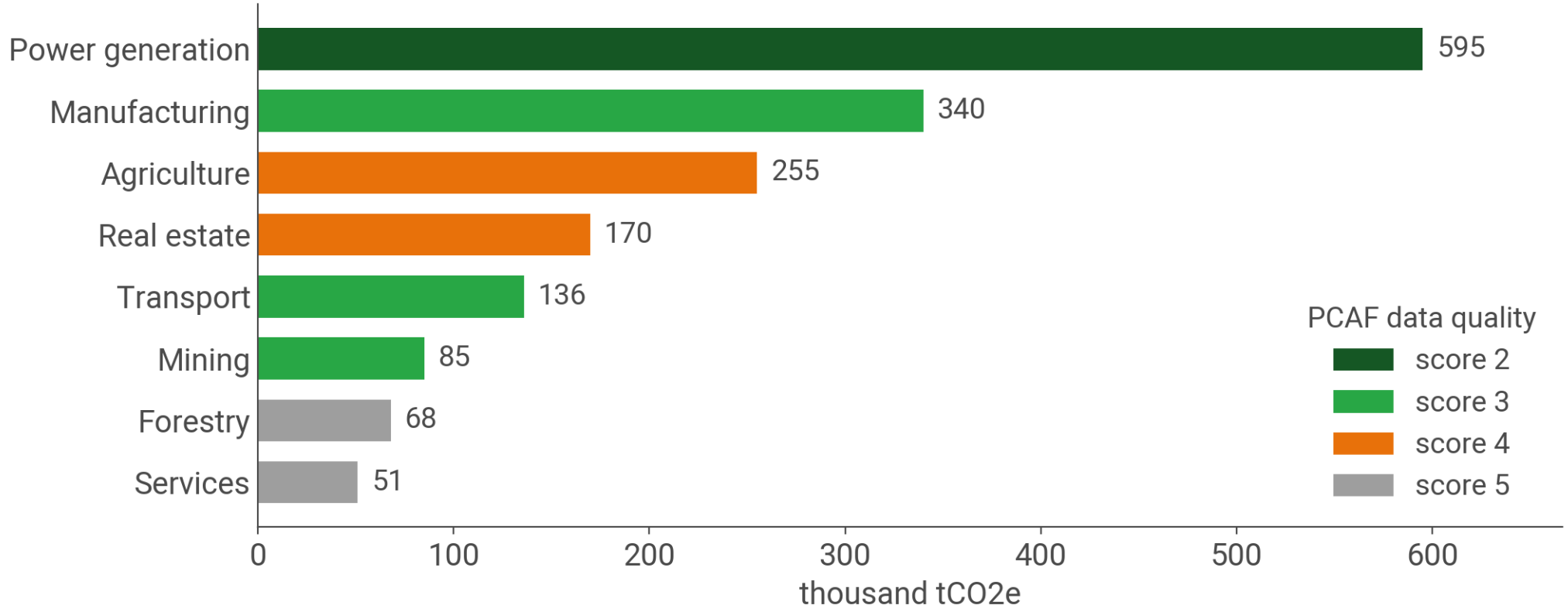


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Financed emissions concentrate in power, manufacturing and agriculture

Financed emissions by sector in the loan book of the same illustrative ASEAN bank. Colour gives the PCAF data quality score.



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Carbon intensity: emissions per USD million of revenue, weighted by holding

WACI, weighted average carbon intensity: each holding's emissions per USD million of revenue, weighted by its share.

Answers

How exposed the book is to carbon-intensive companies, whatever the size of the whole book

Unit

Tonnes of CO2 equivalent, tCO2e, per USD million of the borrower's revenue

Scopes counted

The borrower's Scope 1 and Scope 2 emissions

Source: TCFD (2021), Implementing the Recommendations, Table 3.

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Climate VaR: the loss of portfolio value under one named scenario

Climate Value-at-Risk: the expected loss of portfolio value under a specified climate scenario.

Unlike VaR

VaR is a quantile at a confidence level; Climate VaR is a loss given one scenario, with no probability

Two parts

Physical and transition losses, and the scenario decides which of the two is larger

For a loan book

Exposure × rise in default probability × the scenario's loss given default, summed

Source: UNEP FI (2019), Changing Course, page 38.

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Three measures: financed emissions, carbon intensity and Climate VaR

$$FE_i = Outstanding_i \,/\, EVIC_i \times Emissions_i$$

$$WACI = \Sigma_i \, w_i \times Emissions_i \,/\, Revenue_i$$

$$Climate\ VaR = \Sigma_i \, Exposure_i \times \Delta PD_i \times LGD_i$$

$EVIC_i$: the borrower's enterprise value including cash. w_i: the borrower's weight in the portfolio. $Revenue_i$: in USD million. ΔPD_i: the scenario's rise in default probability. LGD_i: loss given default in the scenario.

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The carbon of a steel loan and of a three-company portfolio

Loan to the steel mill	USD 50 million
Mill's enterprise value, EVIC	USD 500 million
Mill's emissions	200,000 tCO2e
Power utility	40 % of the portfolio, 800 tCO2e per USD million
Manufacturer	35 %, 200 tCO2e per USD million
Technology firm	25 %, 15 tCO2e per USD million

> **Predict** How many tonnes of the mill's carbon are the bank's, and what share of the portfolio's WACI comes from the utility?

Illustrative steel loan and three-company portfolio of chapter 4, chosen for teaching.

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The utility is 40 percent of value and 81 percent of carbon intensity

1. Financed emissions = 50 / 500 × 200,000 = 20,000 tCO2e
2. WACI = 0.40 × 800 + 0.35 × 200 + 0.25 × 15
3. = 320 + 70 + 3.75 = 393.75, about 394 tCO2e per USD million
4. Utility share = 320 / 394 = 81 %

20,000 tCO2e for the steel loan; WACI about 394, 81 % of it from the utility

Illustrative steel loan and three-company portfolio of chapter 4, chosen for teaching.

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18 percent of the book in agriculture, 3 percent in coal and power

Agriculture's default probability rises 8 points, coal and power's 15 points. Which book of the Vietnamese bank has the larger Climate VaR?

A Coal and power lending

B Agriculture lending

C The two are about equal

D Neither can be ranked without emissions data

Illustrative bank portfolio, not measured Vietnamese sector data.

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Vietnamese agriculture outranks coal on Climate VaR

B Agriculture lending

Why

Physical, agriculture: USD 5.4 billion × 8 % × 65 % = USD 281 million. Transition, coal and power: USD 0.9 billion × 15 % × 55 % = USD 74 million.

Tempting: A, Coal and power lending

Coal and power is the carbon-intensive book. Climate VaR multiplies exposure, default shift and loss severity, and agriculture's exposure is six times larger.

Takeaway Exposure and physical vulnerability outweigh carbon intensity.

Illustrative bank portfolio, not measured Vietnamese sector data.

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5

Climate stress testing

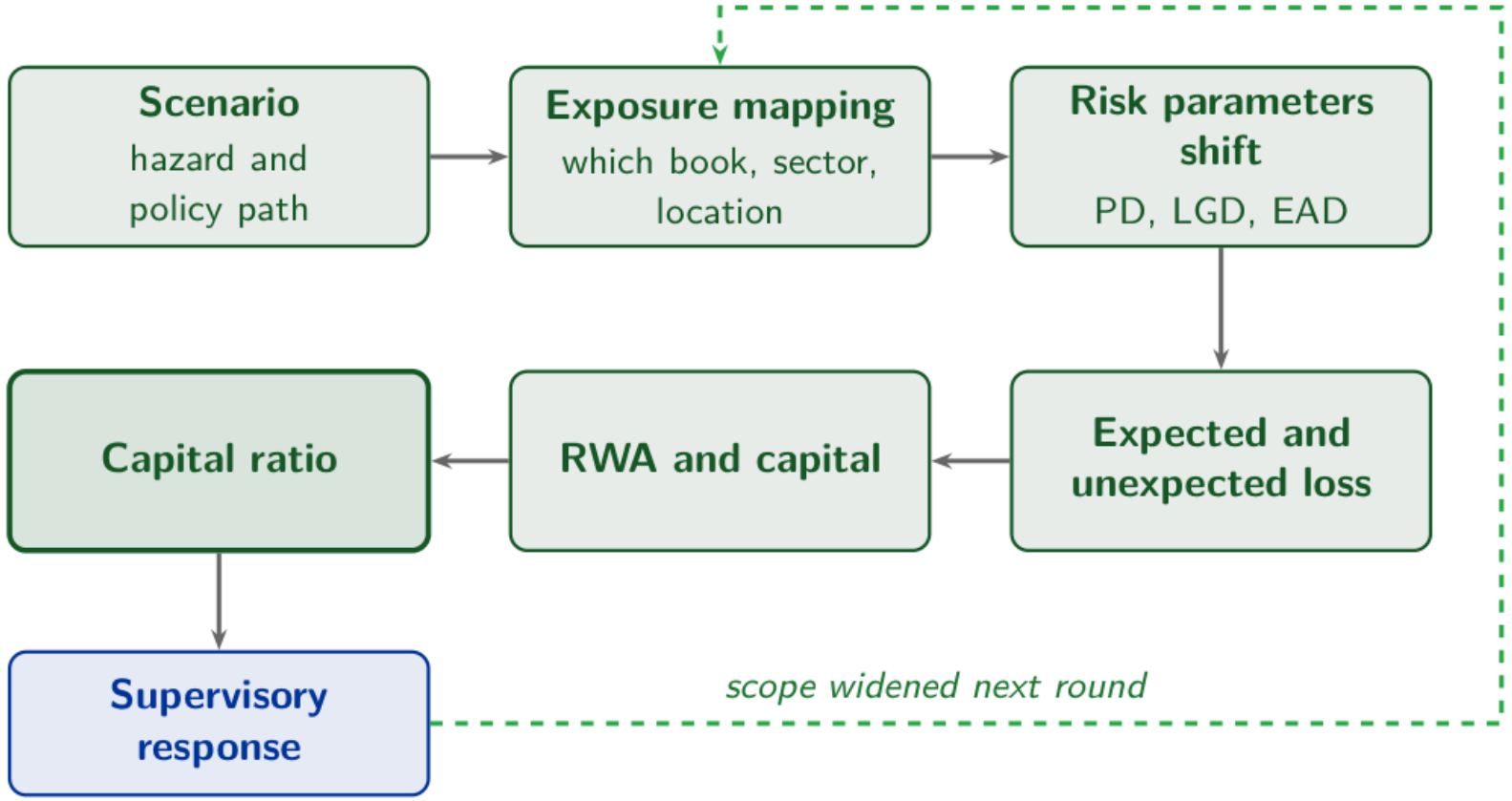
How large a climate loss takes the Thai bank of the opening to the Basel III floor?

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A stress test is a pipeline with a supervisor at the end

Scenario, exposure mapping, risk parameters, losses, capital and the ratio; the supervisor's response widens the next round.



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Scenario: the hazard and policy path every later stage takes as given

Scenario: a plausible path of climate hazards, carbon policy and the economy over a stated horizon.

How it works

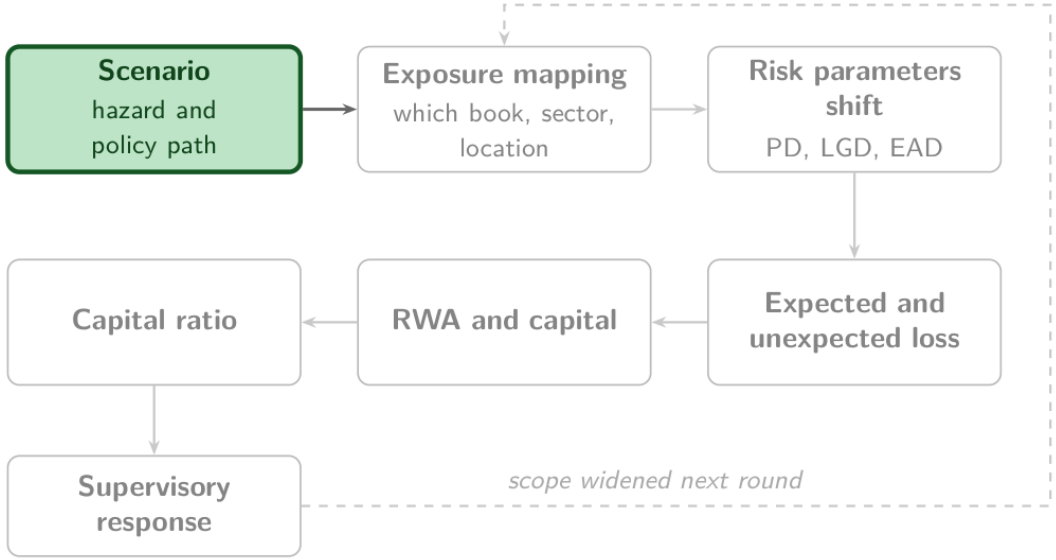
NGFS pathways or a bespoke event such as a flood, over a planning cycle or over decades

In the Thai bank

Delayed Transition, an NGFS disorderly scenario: policy starts late and then moves fast

Basel expects

Principle 12: a range of plausible pathways, physical and transition, over several horizons



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 12, paragraphs 44 to 48.

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Exposure mapping: each loan gets a sector, a location and a borrower

Exposure mapping: assigning each loan, bond and holding to the sectors and places the scenario strikes.

How it works

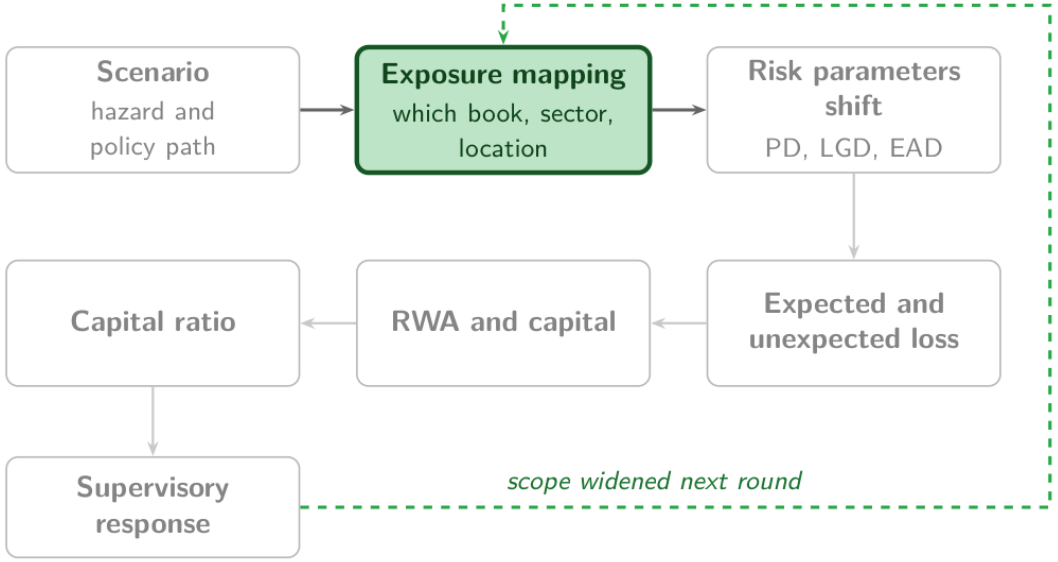
Match each exposure to a sector code and a location, then hold the book fixed or let it change

In the Thai bank

THB 500 billion in five sectors, THB 100 billion of it in agriculture

Basel expects

Principle 12: weigh the limits of the scenarios and of the balance sheet assumption



Illustrative bank, not a real institution. Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 12, paragraphs 44 to 48.

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Risk parameters shift: the scenario raises PD and LGD and can move EAD

Risk parameters: default probability (PD), loss given default (LGD) and exposure at default (EAD).

How it works

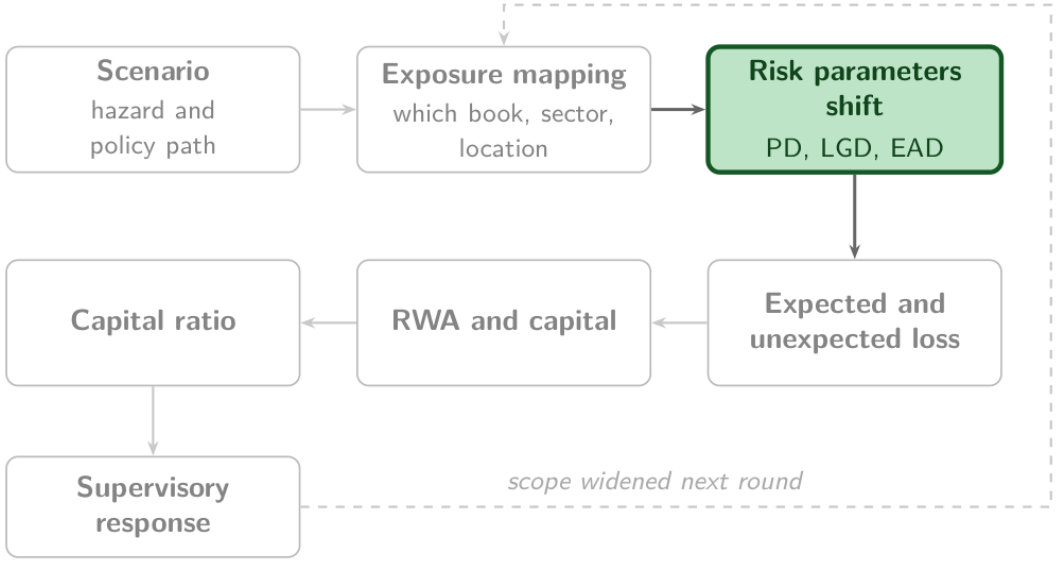
PD scales with a stress multiplier; LGD adds the physical damage to the collateral

In the Thai bank

Agriculture: PD 5.0 % to 9.0 %, LGD 45 % to 65 %

Basel expects

Principle 12: physical and transition risk as drivers of credit, market, operational and liquidity risk



Illustrative bank, not a real institution. Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 12, paragraphs 44 to 48.

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Expected loss is met by provisions, unexpected loss by capital

Expected loss: PD × LGD × EAD, the average loss. Unexpected loss: the loss above it in a bad year.

How it works

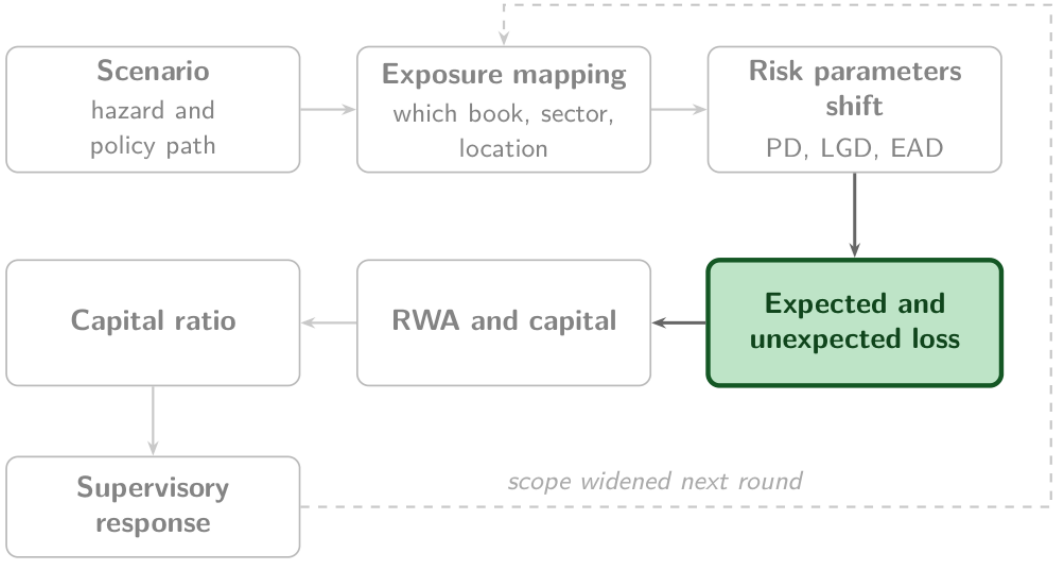
Expected loss per sector under the stressed parameters, summed over the book and set against the baseline

In the Thai bank

Expected credit loss on the five sectors rises from THB 6.5 to 14.1 billion

Basel expects

Basel III: provisions against expected losses, capital against unexpected losses



Illustrative bank, not a real institution. Source: BCBS (2011), Basel III, paragraph 31.

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RWA and capital: losses cut capital, and downgrades raise the risk weights

Capital and RWA under stress: equity net of the scenario's losses, and exposures reweighted after downgrades.

How it works

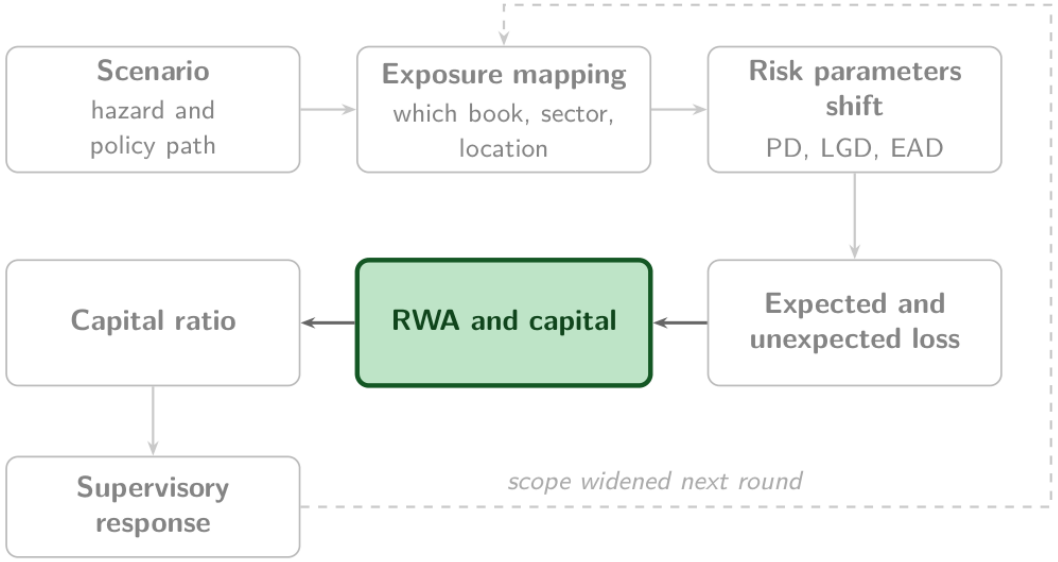
Deduct losses beyond the provisions from common equity; reweight the exposures the scenario downgrades

In the Thai bank

The worked example holds risk-weighted assets fixed, so the loss moves capital alone

Basel expects

Principle 18: over short horizons, assess the impact on regulatory capital



Source: BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 18, paragraphs 63 to 69.

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Capital ratio: the one number the supervisor compares with the floor

Capital ratio: regulatory capital over risk-weighted assets, compared with the minimum and the buffer.

How it works

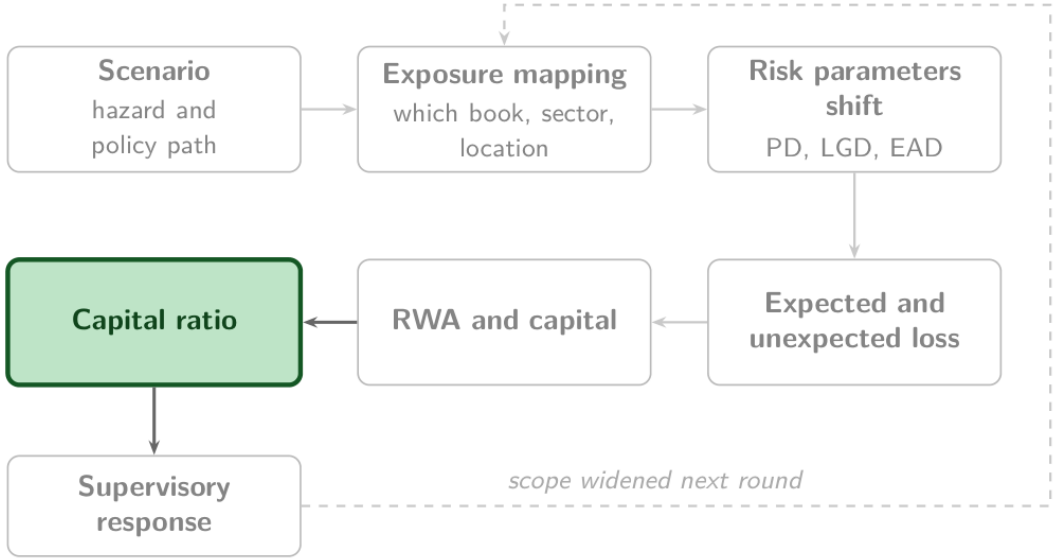
One ratio per bank, scenario and year; the distance to the floor is the bank's headroom

In the Thai bank

Compared with Basel III's 10.5 %, the minimum and the buffer together

Basel expects

Principle 18: stress tests evaluate the bank's financial position under severe but plausible scenarios



Source: BCBS, Basel III: A global regulatory framework for more resilient banks and banking systems (rev. June 2011), para 64; BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 18, paragraphs 63 to 69.

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Supervisory response: findings in aggregate and a wider next round

Supervisory response: feedback to each bank, findings published in aggregate, and the scope of the next round.

How it works

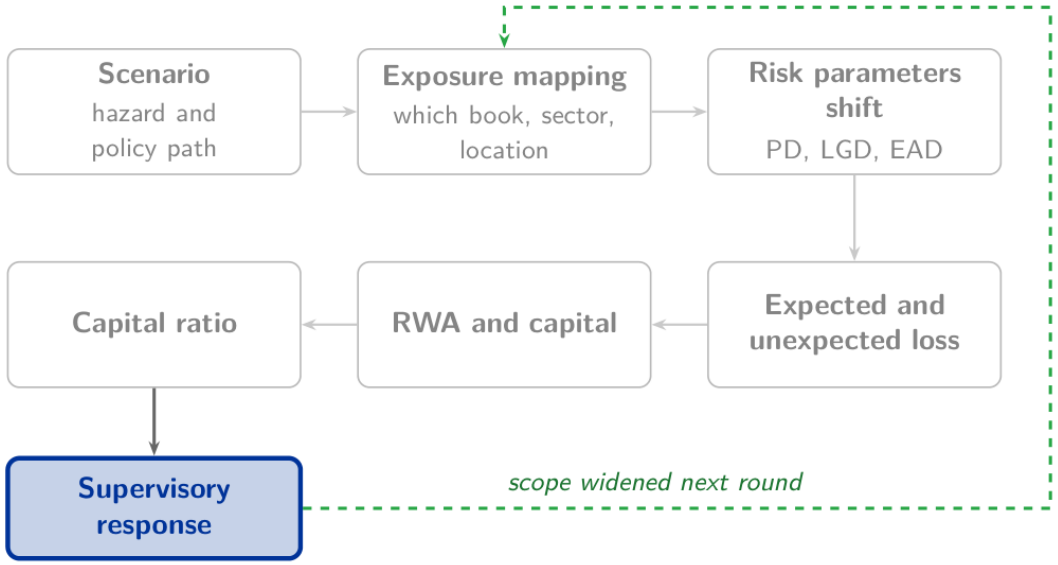
Compare the banks, name their data gaps, and add banks, risks or horizons to the next round

In the Thai bank

The Bank of Thailand reads the ratio against 11 %

Basel expects

Principle 18: disclose findings in aggregate, with methods, assumptions and uncertainty



Source: Bank of Thailand, Notification 12/2555, capital requirements; BCBS (2022), Principles for the effective management and supervision of climate-related financial risks, Principle 18, paragraphs 63 to 69.

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Four supervisory exercises differ on five design axes

No exercise reaches High on every axis, and none sets capital on its result.

	Scope	Granularity	Horizon	Disclosure	Capital consequences
ECB	High	Medium	High	Medium	Low
Bank of England	Medium	High	High	High	Low
Bank of Thailand	High	Low	High	Low	Low
MAS	Medium	High	High	Medium	Low

Module's qualitative reading of published exercise design, not an external rating.

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Regulatory capital absorbs losses, common equity first

Regulatory capital: Common Equity Tier 1, Additional Tier 1 and Tier 2, the layers Basel III counts as able to absorb losses.

Minimum and buffer

4.5 % in common equity, 6.0 % in Tier 1, 8.0 % in total, and a 2.5 % buffer on top: 10.5 %

A climate loss

Comes out of common equity first, one for one, and the capital ratio falls with it

In the Thai bank

THB 71 billion of capital against THB 500 billion of risk-weighted assets

Illustrative bank, not a real institution. Source: BCBS (2011), Basel III, paragraphs 49 and 50; BCBS (2011), Basel III, paragraph 129.

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Risk-weighted assets weigh each exposure by its risk

Risk-weighted assets (RWA): exposures weighted by credit risk, plus market and operational risk; the ratio's denominator.

What it weighs

A riskier loan of the same size has a larger weight and needs more capital

Climate reaches it

Downgraded borrowers get larger weights, so a stress raises RWA while its losses cut capital

In the Thai bank

THB 500 billion, held fixed in the worked example

Illustrative bank, not a real institution. Source: BCBS (2011), Basel III, paragraph 50; Bank of Thailand, Notification 12/2555.

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Provisions book expected credit losses before a borrower defaults

Provision: an allowance for expected credit losses, charged against profit, and so against capital, before any default.

Terms

Default probability, loss given default and exposure: the three terms of expected loss

Twelve months or life

Twelve months of expected loss, or the loan's whole life once its credit risk has risen significantly

Climate reaches it

A scenario that raises default probability raises the allowance, and capital falls by as much

Source: IFRS 9, section 5.5, Impairment.

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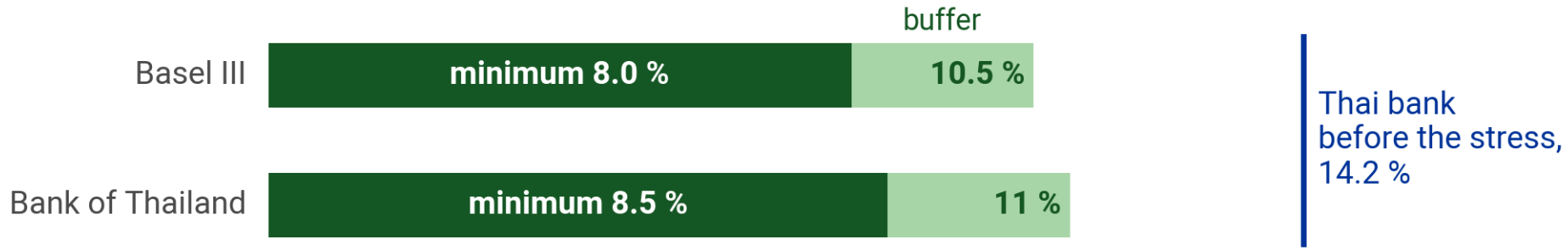
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The stress test ends in one capital ratio

$$CAR_{post} = (Capital - Climate\ losses) / RWA$$

$$CAR_{post} \geq 10.5\ \%$$

CAR: capital adequacy ratio. Capital: regulatory capital. Climate losses: the scenario's losses, all channels. RWA: risk-weighted assets. 10.5 %: Basel III's minimum with its buffer; the Bank of Thailand's is 11 %.



Source: BCBS, Basel III: A global regulatory framework for more resilient banks and banking systems (rev. June 2011), para 64; Bank of Thailand, Notification 12/2555, capital requirements.

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The Thai bank before the stress

Regulatory capital	THB 71 billion
Risk-weighted assets	THB 500 billion
Basel III minimum and buffer	10.5 %
Bank of Thailand floor	11 %: its 8.5 % minimum and the 2.5 % buffer

Predict Compute the ratio today, the capital 10.5 % requires and the loss the bank can absorb. Then compare the loss with your number from the start of the class.

Illustrative bank, not a real institution. Source: BCBS, Basel III: A global regulatory framework for more resilient banks and banking systems (rev. June 2011), para 64; Bank of Thailand, Notification 12/2555, capital requirements.

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THB 18.5 billion of climate loss takes the Thai bank to the Basel III floor

1. CAR before = 71 / 500 = 14.2 %
2. Capital required = 0.105 × 500 = THB 52.5 billion
3. Headroom = 71 − 52.5 = THB 18.5 billion
4. Check: (71 − 18.5) / 500 = 10.5 %
5. At the Bank of Thailand's 11 %: 71 − 55.0 = THB 16.0 billion

The bank absorbs THB 18.5 billion at 10.5 %, THB 16.0 billion at 11 %

Illustrative bank, not a real institution. Source: BCBS, Basel III: A global regulatory framework for more resilient banks and banking systems (rev. June 2011), para 64; Bank of Thailand, Notification 12/2555, capital requirements.

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The Thai bank of the opening takes a THB 10 billion climate loss

The same bank takes THB 10 billion of climate losses. Where does its capital ratio land?

A	14.2 %
B	16.2 %
C	12.2 %
D	2.0 %

Illustrative bank, not a real institution.

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12.2 percent, 1.7 points above the Basel III floor

C 12.2 %

Why

(71 − 10) / 500 = 61 / 500 = 12.2 %: 1.7 points above 10.5 %, 1.2 above the Bank of Thailand's 11 %.

Tempting: A, 14.2 %

14.2 % is the ratio before the stress. The loss comes out of capital, and the ratio falls by 10 / 500 = 2.0 points.

Takeaway The loss comes out of capital, and the ratio falls by the loss over RWA.

Illustrative bank, not a real institution. Source: BCBS, Basel III: A global regulatory framework for more resilient banks and banking systems (rev. June 2011), para 64; Bank of Thailand, Notification 12/2555, capital requirements.

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6

ASEAN climate vulnerability

Why is a typhoon over open ocean no risk to a bank?

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Risk is hazard, exposure and vulnerability at once

Risk needs hazard, exposure and vulnerability together.



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Hazard: the physical event or trend that can cause damage

Hazard: the potential occurrence of a natural or human-induced physical event or trend that may cause loss and damage.

In ASEAN

Typhoons and floods: about 20 cyclones enter the Philippine area a year, and 8 or 9 cross it

In a loan book

Hazard maps and storm tracks laid over the bank's sites and its collateral

A bank can change

Nothing: it chooses only where its lending meets the hazard



Source: IPCC (2022), AR6 Working Group II, Annex II: Glossary; PAGASA, Tropical Cyclone Information.

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Exposure: people and assets in places a hazard can reach

Exposure: the presence of people, livelihoods, infrastructure or economic assets in places that could be adversely affected.

In ASEAN

Long coastlines, river deltas, and agriculture as a large share of output and work

In a loan book

Loans and collateral mapped by location and by sector

A bank can change

Where it lends, and how much it lends in each place



Source: IPCC (2022), AR6 Working Group II, Annex II: Glossary.

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Vulnerability: the propensity to be harmed and a lack of capacity to cope

Vulnerability: the propensity to be adversely affected, including sensitivity to harm and lack of capacity to cope and adapt.

In ASEAN

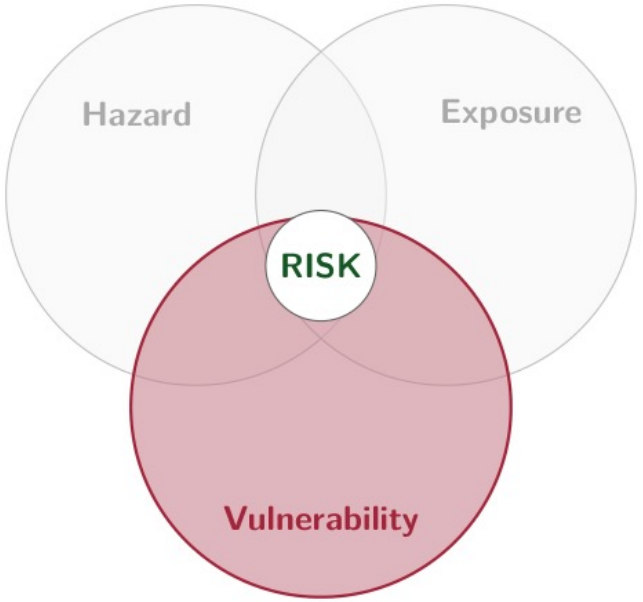
Middle incomes, thin insurance and limited early warning

In a loan book

The borrower's insurance, the building standard of the collateral, the borrower's cash buffer

A bank can change

What it finances and insures: adaptation loans and blended structures among them



Source: IPCC (2022), AR6 Working Group II, Annex II: Glossary.

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Vietnam, Thailand and the Philippines face different dominant hazards

An ordinal comparison from chapter 6; the ranking is stable across data vintages.

	Vietnam	Thailand	Philippines
Primary hazard	Sea-level rise, delta flooding	Subsidence-flood, drought	Typhoons, recurrent
Annual losses	Moderate and rising	Episodic but severe	Highest of the three
Insurance	Thin	Deepest of the three	Thin

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Sector shocks become one portfolio shock, then a capital ratio

$$r_{portfolio} = \Sigma_i \, w_i \times r_i$$

$$CAR_{post} = CAR_{pre} - provisions - RWA\ effect - market\ losses$$

w_i: sector i's share of the loan book. r_i: the relative rise in sector i's default probability; the sum is the book's rise when the sectors start from one default rate. CAR: capital adequacy ratio; the deductions are points of it. BSP: 10 % minimum, 12.5 % with its buffer.



Source: Bangko Sentral ng Pilipinas, Report on Recent Trends in the Philippine Financial System, Issue No. 2024-03; Bangko Sentral ng Pilipinas (2013). Circular No. 781, 15 January 2013: Basel III Implementing Guidelines on Minimum Capital Requirements. Full text: Supreme Court E-Library.

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A Haiyan-class typhoon makes landfall over Central Visayas

Agriculture	+80 % relative rise in default probability
Real estate	+40 %
Services and tourism	+25 %
Capital ratio, end-2023	16.6 %
BSP minimum and buffer	10 %, and 12.5 % with the 2.5 % buffer

> **Predict** Does the banking system stay above the BSP minimum after the typhoon? Write down the ratio you expect.

Illustrative stress scenario, not a BSP exercise. Source: Bangko Sentral ng Pilipinas, Report on Recent Trends in the Philippine Financial System, Issue No. 2024-03; Bangko Sentral ng Pilipinas (2013). Circular No. 781, 15 January 2013: Basel III Implementing Guidelines on Minimum Capital Requirements. Full text: Supreme Court E-Library.

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The system holds at 13.5 percent, 3.5 points above the BSP minimum

1. Chapter 6 assumes a weighted rise in default probability of about 22.6 %
2. Chapter 6's assumed deductions: provisions 1.8, RWA 0.9, market 0.4 points
3. CAR = 16.6 − 1.8 − 0.9 − 0.4 = 13.5 %
4. 13.5 − 10 = 3.5 points above the BSP minimum
5. 13.5 − 12.5 = 1.0 point above the minimum with the buffer

The system clears 10 % by 3.5 points and 12.5 % by 1.0

Illustrative stress scenario, not a BSP exercise. Source: Bangko Sentral ng Pilipinas, Report on Recent Trends in the Philippine Financial System, Issue No. 2024-03; Bangko Sentral ng Pilipinas (2013). Circular No. 781, 15 January 2013: Basel III Implementing Guidelines on Minimum Capital Requirements. Full text: Supreme Court E-Library.

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A system 3.5 points above its minimum

The Philippine system clears its minimum by 3.5 points after the typhoon. What does the system average hide?

A A system ratio below 12.5 %, the BSP minimum with its buffer

B A capital shortfall at the largest banks

C Losses on the banks' government bond holdings

D Capital breaches at small banks based in the Visayas

Illustrative stress scenario, not a BSP exercise. Source: Bangko Sentral ng Pilipinas, Report on Recent Trends in the Philippine Financial System, Issue No. 2024-03; Bangko Sentral ng Pilipinas (2013). Circular No. 781, 15 January 2013: Basel III Implementing Guidelines on Minimum Capital Requirements. Full text: Supreme Court E-Library.

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Banks lending mostly in the Visayas can breach while the system holds

D Capital breaches at small banks based in the Visayas

Why

The system average is 13.5 %. The typhoon strikes one region, and a bank lending mostly there takes the shocks on most of its book; chapter 6 finds a handful such banks below 10 %.

Tempting: A, A system ratio below 12.5 %, the BSP minimum with its buffer

With its 2.5 % buffer the BSP asks 12.5 %, and the system's 13.5 % clears it by 1.0 point.

Takeaway Systemic risk is concentrated: the system average hides the banks that breach.

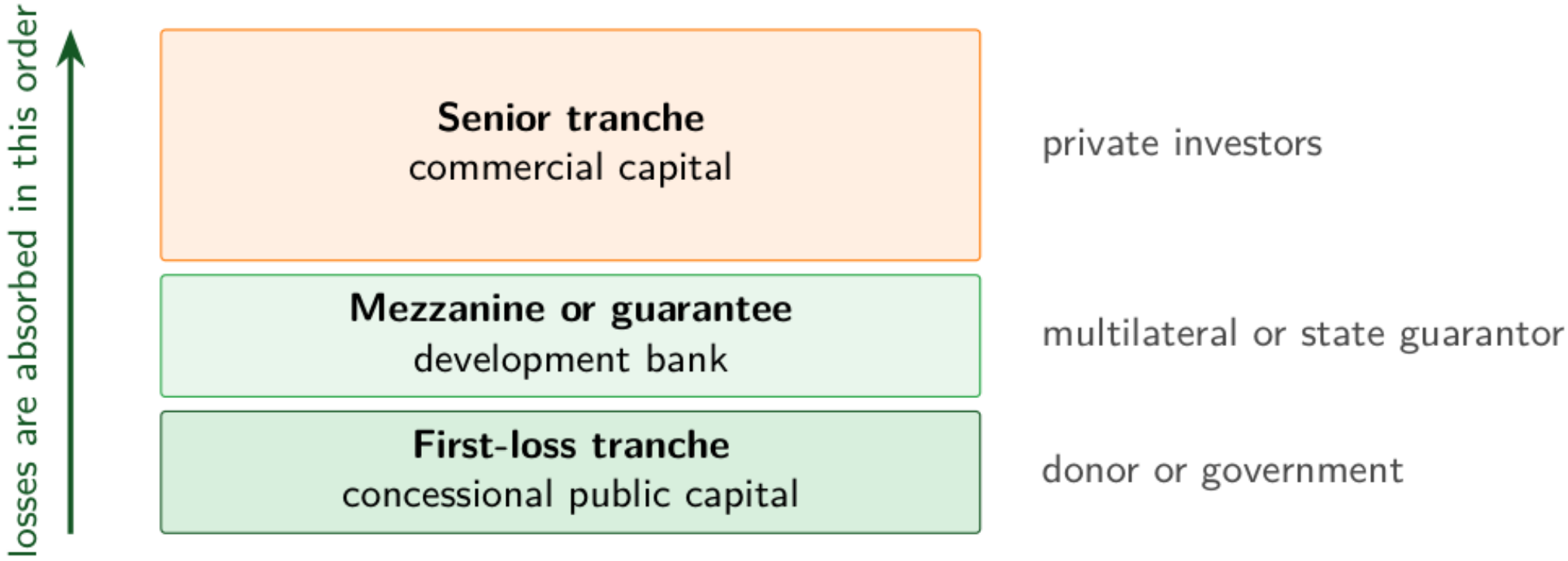
Illustrative stress scenario, not a BSP exercise. Source: Bangko Sentral ng Pilipinas, Report on Recent Trends in the Philippine Financial System, Issue No. 2024-03; Bangko Sentral ng Pilipinas (2013). Circular No. 781, 15 January 2013: Basel III Implementing Guidelines on Minimum Capital Requirements. Full text: Supreme Court E-Library.

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Blended finance puts public money in the first-loss layer

Losses fall first on concessional public capital, then on the guarantee, then on the commercial senior tranche.



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Every lesson uses a tool the credit risk function already has

1. Climate enters expected loss through its terms, and their rises multiply.
2. A bank manages climate risk before it discloses it.
3. Scenarios have no probabilities; ASEAN books lose most in a hot house world.
4. Carbon and loss differ: Vietnamese agriculture outranks coal on Climate VaR.
5. The Thai bank absorbs THB 18.5 billion of loss before it reaches 10.5 %.
6. The system average hides the concentrated banks that breach.

Illustrative bank, not a real institution. Source: BCBS, Basel III: A global regulatory framework for more resilient banks and banking systems (rev. June 2011), para 64.

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The authors remain fully responsible for accuracy, references, and conclusions

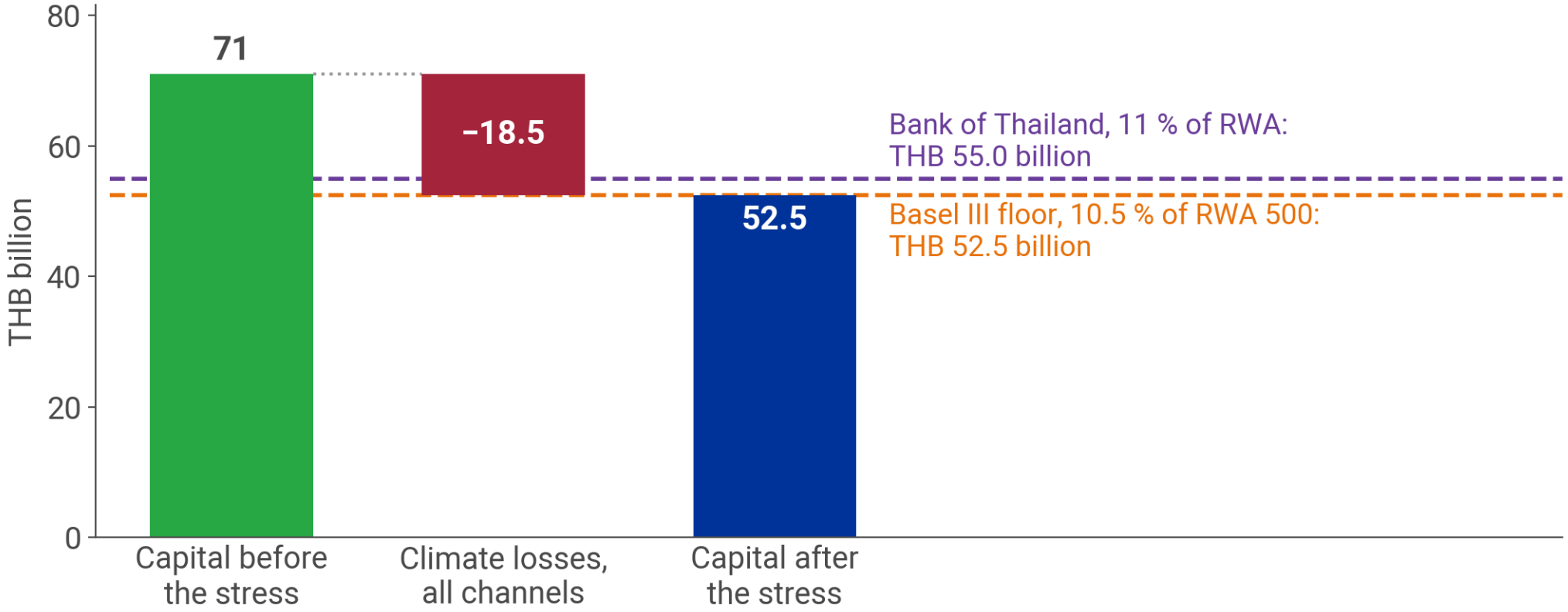
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Capital falls from THB 71 billion to the THB 52.5 billion floor

The illustrative Thai bank's capital before and after the stress, against what the Basel III and Thai floors require.



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