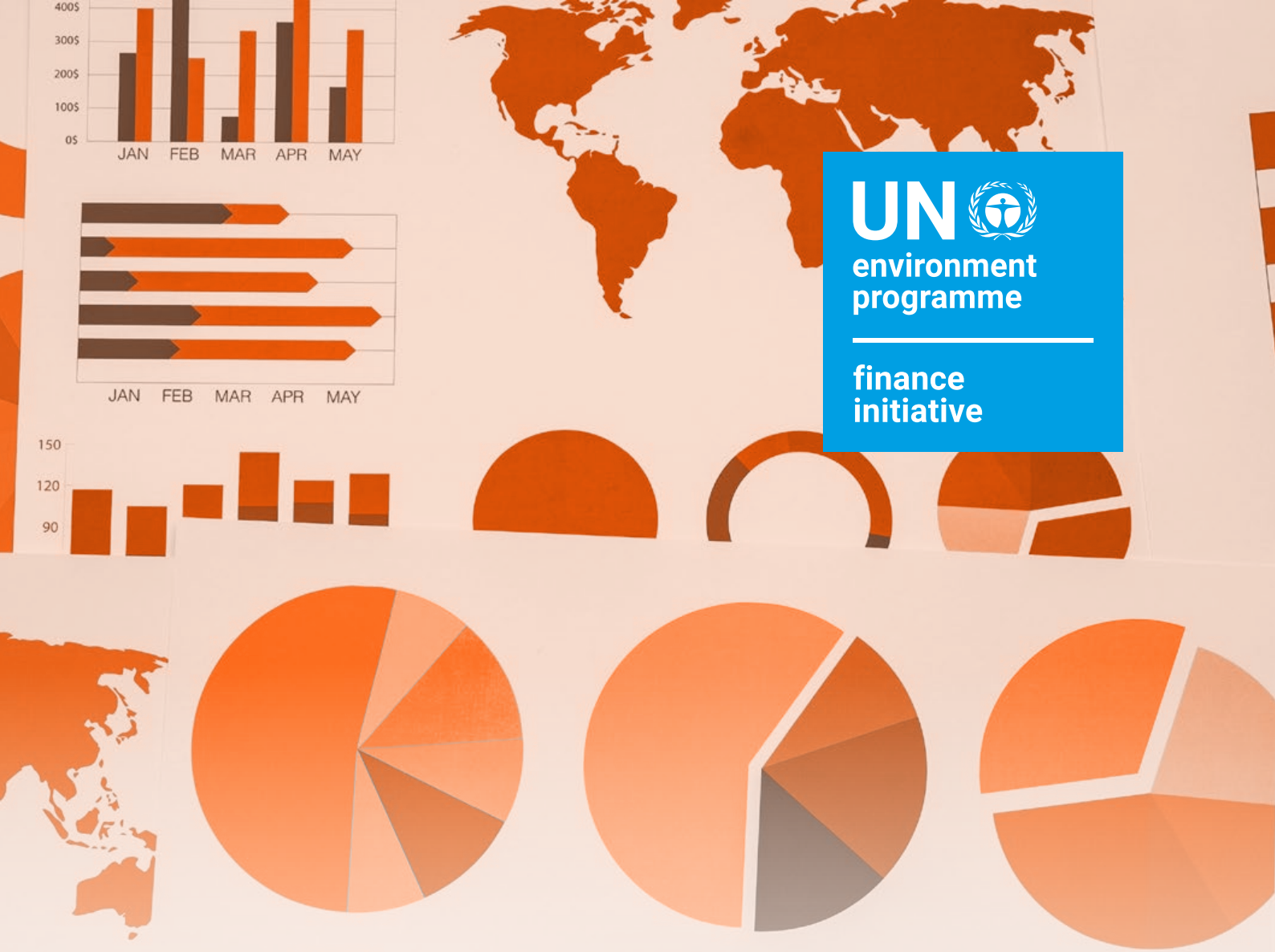

UN environment programme

finance initiative

Navigating Data Challenges:

A Guide to Data Collection for Climate Stress Testing

July 2024

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Authors

UNEP FI

David Carlin
Maheen Arshad
Aoife Martin

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Bemnet Getachew Mengistu, Williams College

Project Management

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Executive summary

Reliable and comparable data for climate stress testing is a major concern for financial institutions, regulators, central banks, and policymakers. Climate stress testing is a crucial forward-looking approach for assessing the potential impact of climate change on financial institutions and identifying climate risks as systematic risks. In this context, robust data plays a key role in enabling financial institutions to manage and identify climate-related risks and opportunities, facilitating more informed decision-making amid evolving climate challenges.

However, the development of climate stress testing and its integration into the strategy of firms has been hindered by a lack of standardised data with the necessary quality to effectively assess and model the potential financial impact of climate risks. Current data limitations often lead to underestimation and only partial measurement of climate-related risks.

Accompanying the United Nations Environment Programme Finance Initiative's report "A Comprehensive Review of Global Supervisory Climate Stress Tests", this supporting document aims to enhance the abilities of financial actors to conduct climate stress testing by effectively navigating data challenges. It does so by providing a comprehensive overview of the climate stress test data types, as well as by sharing insights into current best practices and data sources. This document emphasises the crucial role of reliable and comparable data for climate stress testing. Key takeaways from this document include the following:

- Data required for climate stress testing can fit into two broad categories; traditional macro-financial data and climate data.
- The former includes portfolio data (e.g. portfolio composition by sector and geography, balance sheets composition, clients, and counterparty data), credit data (e.g. probability of default (PD), loss given default (LGD)), macroeconomic data (e.g. GDP, interest rates, and exchange rates), and forward-looking data (e.g. financial performance analysis, market data, macroeconomic forecasts and scenarios). Climate data includes transition (e.g. transition risk drivers' data, emissions data, alignment, and transition data) and physical climate-related (e.g. climate hazards data, climate-related client data).
- While progress has been made in recent years, many challenges remain in processing climate-related data in the context of climate stress testing exercises. These challenges include data coverage, dependency on third-party data providers and consultancies, lack of historical data and time inconsistencies, comparability, granularity, cost, and internal capacity requirements.

- To better address these data challenges, financial institutions may take the following practical steps: fill critical skillset gaps by hiring, partnering, or training; explore and incubate tech-enabled possibilities; benchmark internal processes against industry practices and regulatory expectations; identify which pieces of data are most relevant; adopt an agile approach to data-related processes by revisiting data strategy on a regular basis; leverage synergies by identifying data variables that may be useful in other contexts; and develop or acquire climate-ready data capability.
- In addition, the quality and coverage of climate-related data can be further improved by exploring avenues, such as: leveraging structured data; improving data accessibility with alternative data; enhancing data integration and reliability with machine learning; applying high standards of transparency and acknowledging limitations in current methodologies; streamlining internal data collection processes; collaborating within and across organizations; and leveraging guidance by (inter)-governmental organisations, non-governmental organisations (NGOs), and academia.

1. Data needs for climate stress testing

Reliable and comparable climate-related data are crucial for financial institutions (including central banks and supervisors), investors, and policymakers to assess financial stability risks, manage climate-related risks, and take advantage of the opportunities arising from the transition to a low-carbon economy. These assessments can encompass a range of methodologies, including scenario analysis, sensitivity testing, and forward-looking modelling. Scenario analysis involves constructing plausible climate-related scenarios that simulate potential impacts on financial portfolios, helping institutions understand how their assets and liabilities will be impacted by climate change. Sensitivity testing evaluates the sensitivity of financial positions to changes in key climate risk drivers, such as shifts in carbon pricing or extreme weather events. Forward-looking modelling employs predictive models to project the long-term financial implications of different climate pathways. Connecting these assessment types to climate stress testing, institutions then apply severe or adverse scenario analysis to quantify the financial impacts of climate risks.

Robust climate stress test data allows institutions to identify vulnerabilities, optimise resource allocation, and implement risk mitigation strategies. Ultimately, this contributes to more informed decision-making within the evolving landscape of climate-related challenges and opportunities. However, data limitations (e.g. coverage, quality, comparability, availability) often pose a major challenge to climate stress testing by financial institutions.

As illustrated in Figure 1, collecting, processing, and assessing climate data for climate stress testing requires involvement at every level of the organization. Integrating and embedding climate-related data management processes is therefore essential.

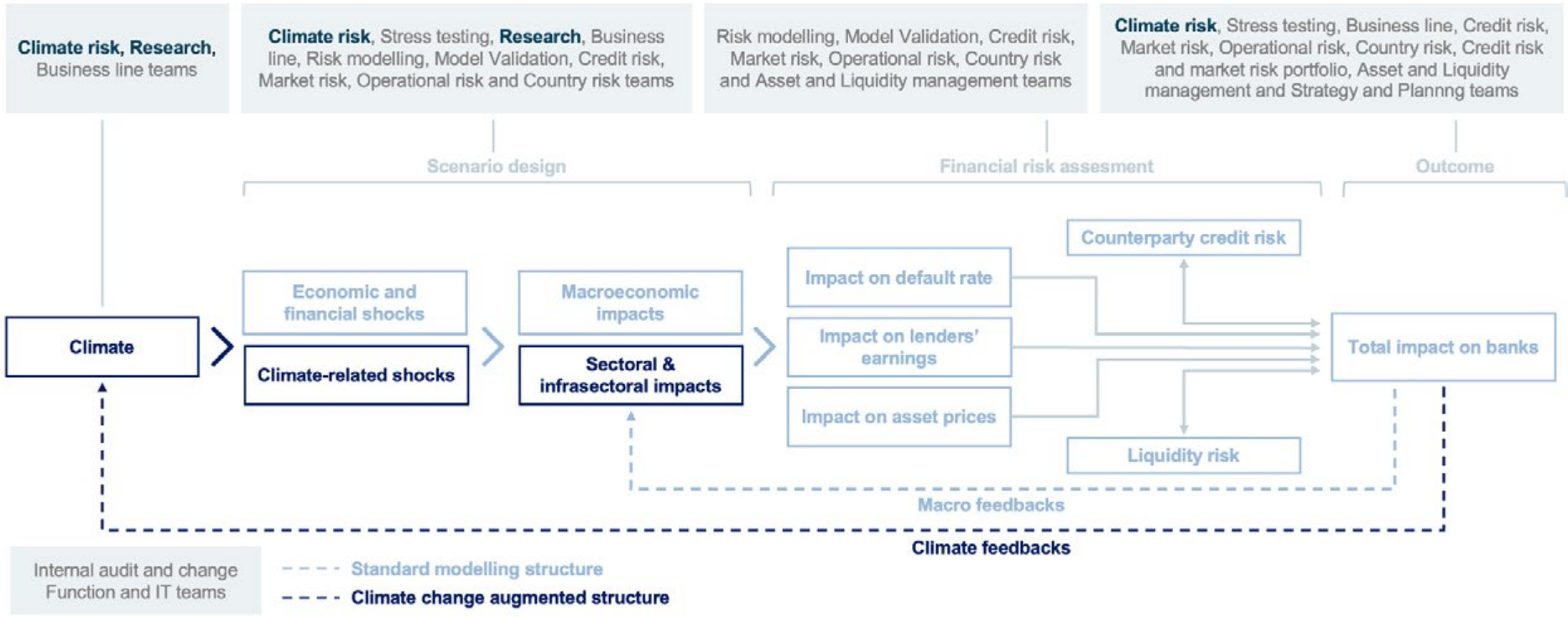

Figure 1: Integration of climate risk across an institution for climate stress testing (own depiction, based on UNEP FI, 2021 & ACPR, 2020)

Financial institutions increasingly require high-quality data to meet their needs. They seek forward-looking data as past trends often fail to fully capture the nature and scope of climate-related risks. There is a demand for extensive, granular data, particularly regarding asset locations for assessing physical risks and emissions details across countries and sectors along value chains (NGFS, 2021). The inability to capture robust data in these areas leads to partial measurement of climate risks, potentially leading to understated results (BoE, 2022).

The initial round of supervisory climate stress tests has shed light on industry trends in relation to data needs, collection processes, and their associated challenges. For instance, the results of the ECB's 2022 Climate Risk Stress Test, conducted as part of its annual stress tests on supervised entities within its Supervisory Review and Evaluation Process, clearly demonstrate the necessity for enhanced client engagement to gather relevant counterparty information for improved climate risk assessments. Different practices followed by institutions to approximate greenhouse gas (GHG) emissions, coupled with possible recourse to different data providers with diverse modelling practices to fill data gaps, have led banks to report heterogeneous emissions estimates. This is the case even for the same counterparties (ECB, 2022a).

When executing a climate stress test, financial institutions need to also consider the uncertainty linked to the complexity of the dataset. When assessing physical risks, some historical data may not fully capture the complexity and magnitude of future climate hazard impacts. Moreover, since scenarios over long time frames often span several decades, uncertainties increase as the projection horizon extends. This makes it challenging to accurately estimate the future impacts of climate change.

The data required for climate stress testing fit into two categories: traditional macro-financial data, and climate data. Table 1 below provides an overview of data that may be used in the context of climate stress.

Table 1: Data required for climate stress testing (own depiction, adapted from UNEP FI, 2021)

	Data type	*Data required*	*Data Sources*
MACRO-FINANCIAL DATA	**Portfolio data**	▪ Portfolio composition by sector and geography ▪ Balance sheets composition ▪ Clients and counterparty data	▪ Internal systems ▪ Clients
	Credit data	▪ Probability of Default (PD) ▪ Loss Given Default (LGD)	▪ Internal system ▪ External providers
	Macroeconomic data	▪ GDP, unemployment, population growth, inflation, (long- and short-term) interest rates, and exchange rates	▪ Official statistics ▪ Scenarios
	Forward-looking data	▪ Financial performance analysis, market data ▪ Macroeconomic forecasts and scenarios	▪ Internal systems ▪ Scenarios
CLIMATE-SPECIFIC DATA	**Climate hazard data**	▪ Historical data on acute and chronic physical risks. ▪ Projections of future acute and chronic physical risks, including their severity and frequency. ▪ Adaptive capacity data to determine client resilience and sensitivity to climate hazards, including current adaptation strategies of clients. ▪ Climate hazard data based on geography, sector and industry, including economic losses from past climate hazards.	▪ Scenarios ▪ Clients ▪ External providers
	Transition risk drivers data	▪ Data on transition risk drivers including policy implementation, market shifts, technological changes and reputation.	▪ Scenarios
	Emissions data	▪ Energy and carbon mix of counterparties. ▪ Published or estimated GHG emissions produced by portfolios and assets of clients. ▪ GHG emissions data by region, sector or industry. ▪ Energy efficiency data (e.g., Energy Performance Certificate Rating in real estate) ▪ Data on carbon pricing by jurisdiction.	▪ Clients ▪ External providers Internal systems
	Climate-related client data	▪ Identification of the physical assets owned by clients. ▪ Detailed and granular geographical/geolocational data of assets.	▪ Clients ▪ External providers
	Alignment and transition data	▪ Transition pathways set by clients in accordance with the Paris Climate Change Agreement. ▪ Science-based emission reduction targets set by clients. ▪ Climate policies and pledges of countries.	▪ Clients ▪ External providers

Traditional macro-financial data (i.e. macroeconomic as well as financial) is already needed to conduct traditional stress tests and evaluate portfolio and client risks. These data include a variety of financial information that enables the evaluation of portfolio-level (and sometimes counterparty-level) risk models (UNEP, 2021). In addition to firm-level financial data, macroeconomic data are also required. Such data can be gathered through various sources, as illustrated for Europe in Table 2, which provides an overview of the sources of macro-financial data used by the European Central Bank (ECB) in its 2023 economy-wide climate stress test.

Table 2: Macro-financial data used in ECB (2023a)

Source of historical data	Variable	Granularity
ECB statistical data	Real GDP	Country
Eurostat FIGARO I/O Tables	Real GVA	Country-sector
ECB statistical data	Inflation	Country
ECB statistical data	Long-term interest rates	Country
NGFS Database	Real-estate prices	Country
Eurostat	Gas prices	Country
NGFS Database	Oil prices	EU

Beyond macro-financial data, Table 3 below lists climate-related data used by the ECB (2023a) for designing climate stress testing scenarios.

Table 3: Climate-related data used in ECB (2023a)

Source of historical data	Variable	Granularity
Urgentem/ICE	GHG emissions	Firm
Eurostat	Energy mix	Country & Sector
Internal calculations	Energy consumption	Country & Sector
Eurostat	Electricity prices	Country

In practice, regulatory exercises demand the use of both climate-related and financial data to appropriately translate climate risks into financial risks. Box 1 below illustrates an example from Denmark's National Bank where climate and financial data are leveraged together to assess climate-related risks associated with lending to emission-intensive sectors (UNEP FI, 2021).

Box 1: Danmarks National Bank interlinking of climate and financial data.

In its 2020 report, "A Gradual Green Transition Supports Financial Stability", Danmarks Nationalbank highlighted the results of its sensitivity analyses as a precursor to a fully developed climate stress test. For its analysis, the regulator used microdata to analyse the impact of climate risks on corporate and mortgage loans given by banks. For corporate lending, Danmarks National bank linked accounting data of firms and emissions data at the industry level to credit register data for bank lending. For mortgage loans, the regulator linked lending to energy label data. Figure 2 below illustrates the linking of bank lending data to emissions data for emission-intensive sectors to understand the impact of climate risks across the financial sector (Danmarks Nationalbank, 2020).

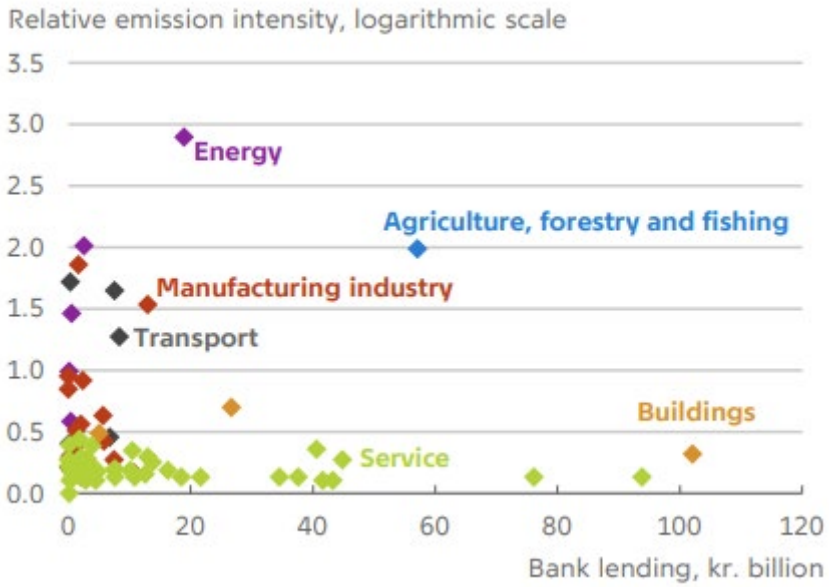

Figure 2: Bank lending for carbon-intensive sectors (Danmarks Nationalbank, 2020).

2. Financial and macroeconomic data

The analysis of climate-related risks at portfolio- and/or asset-level requires extensive macro-financial data. Relevant macro-financial data may include portfolio data (e.g. information on portfolio composition, balance sheets composition, and clients/counterparty data), credit data (e.g. PD, LGD), macroeconomic data (gross domestic product (GDP), long- and short-term interest rates, exchange rates), and forward-looking data (e.g. financial performance analysis and market data, macroeconomic forecasts and scenarios).

In the context of macroeconomic scenario development and impact modelling, relevant macroeconomic variables/data points to be considered include; consumer price indices, trade flows, government spending, depreciation rates of physical capital, household consumption, unemployment rate, productivity data, GDP, and/or gross value added (GVA) (NGFS, 2022a). In addition, incorporating financial data such as credit ratings, corporate borrowing rates, and financial market indices is essential to develop a comprehensive understanding of the interplay between economic and financial dynamics.

In this context, Table 4 below summarises data points relevant to the assessment of climate-related risks' macro-financial impacts.

Table 4: Macro-financial data variables for risk assessment (NGFS, 2022a)

	Type	Variables
Financial data	Capital adequacy	▪ Primary capital ▪ Total capital ▪ Total loans and credit growth
	Assets and liabilities	▪ Adjusted assets ▪ Total assets ▪ Gross assets ▪ Non-performing loans ▪ Non-interest-accruing assets ▪ Restructured loans ▪ Charged-off loans ▪ International asset position by countries/regions

Financial data cont...	Management	▪ Construction loans ▪ Agricultural loans ▪ Loans past due ▪ Loans to bank insiders ▪ Management overhead
	Earnings	▪ Net interest income ▪ Returns
	Liquidity	▪ Liquidity coverage ratio ▪ Net loans
	Sensitivity to risk	▪ Total income from interest rates ▪ Change in interest rate income ▪ Change in total assets
Macroeconomic data	National accounts	▪ Current accounts ▪ Financial accounts ▪ Capital accounts ▪ Balance sheets
	Physical capital	▪ Stock of physical capital (in terms of value and volume; i.e. in current price and constant price) ▪ Physical capital depreciation rate
	Household consumption	▪ Household final consumption by sector
	Informal sector	▪ Contribution of informal sector to GDP ▪ Number of households working in the informal sector
	Regional GDP/GVA	▪ Regional GDP/GVA (including sector breakdown)
	Labour and productivity	▪ Mean/median wage, by sector and region ▪ Mean/median hours worked, by sector and region ▪ Employment rate by sector ▪ Number of jobs by sector
	Trade flow	▪ Import/export trades by sector (in value and in volume)
	Government spending and revenue	▪ Aggregate public investment ▪ Total assistance and transfer to households ▪ Tax revenue by source (income, capital gains, sales/consumption, tariffs/duties) ▪ Bond issuance (volume)
	National accounts	▪ Current accounts ▪ Financial accounts ▪ Capital accounts ▪ Balance sheets

3. Climate-related data

Climate-related data includes additional components beyond traditional financial data that are essential for conducting a comprehensive assessment. Climate-related data may be divided into two main groups: **transition** and **physical** data.

Physical risk data include information on (potential) damages to assets and associated losses incurred by financial institutions as a result of extreme weather events caused by climate change. Physical risk data should cover both acute and chronic physical risks, including their severity and frequency. In contrast to macro-financial data, historical (physical) climate-related data are rather scarce and often insufficient to reflect future developments. In this context, catastrophe risk models and macro-financial models are often combined with hazards, exposure, and vulnerability data in order to more fully assess physical climate-related risks (NGFS, 2022a).

Transition risk data describe the effects of a transition towards a less carbon-intensive economy on financial institutions. Transition risks are particularly significant for carbon-intensive sectors as policies aimed at curbing emissions and facilitating the transition to a greener economy are likely to be particularly stringent for these sectors (ECB, 2021).

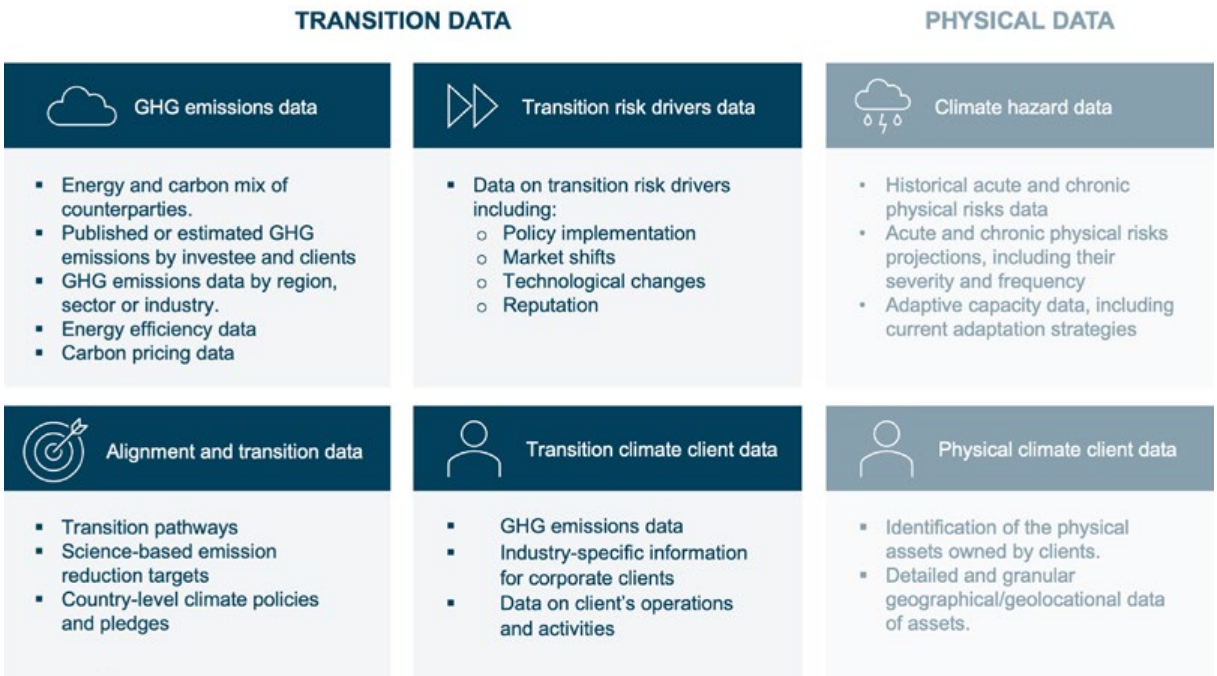

Figure 3: Physical and transition climate data (Own depiction)

3.1 Physical: Climate hazards data

Climate hazards data serve as a basis for developing realistic and relevant climate stress testing scenarios. Climate hazards data should cover both chronic and acute physical risks, including their severity and frequency.

In order to properly assess the exposure to physical risks, climate hazards data should also include information on the client's and assets' resilience and sensitivity to climate hazards (e.g. adaptation and mitigation strategies implemented by clients or within the financial institution's internal processes).

Physical risks, and climate hazards especially, are highly location- and sector-dependent. Hence, it is essential to gather granular information on assets' geolocations as well as on the industries where clients and investee companies are active.

Examples of climate hazards data include:

- Region-specific historical data on extreme weather events (including information on particularly vulnerable areas, frequency, probability distribution, and severity levels).
- Projections on the evolution of extreme weather events/acute physical risks (including information on particularly vulnerable areas, probability distribution, and expected severity levels); these projections should be based on a set of likely scenarios and temperature pathways.
- Projections on the evolution of chronic physical risks (including information on particularly vulnerable areas, probability distribution, and expected severity levels); these projections should be based on a set of likely scenarios and temperature pathways.
- Granular information on the location of assets (including those of clients and investee companies), including the location of main operating facilities and key supply chain components (where available).

Box 2: In the 2021 Climate Biennial Exploratory Scenario (CBES) exercise by the Bank of England (BoE), participants were provided with a table of climate-related perils under a 3.3°C warming level till 2080. Participants were able to select relevant perils for analysis based on the geographic location of their exposure and the impact of rising temperatures on each peril. The table, informed by literature review and industry input, provided benchmark hazard data for events like tropical cyclones, wildfires, heatwaves, and rainfall changes. Data covered the United Kingdom and a select set of other countries, sourced through the NGFS, the UK Met Office, Oasis Hub and academic literature. Participants were also provided with additional "optional" climate data. Participants were also able to incorporate their own climate data, given that it was consistent with the specifications of the supervisor (NGFS, 2022a).

3.2 Transition: Transition risk drivers data

Data on transition risk drivers are likely to take the form of scenarios. These scenarios should aim to reflect the various implications of shifts in policy, changes in investor sentiments, and technological development for various transition pathways.

Considering the complexity and multidimensionality of transition risk drivers, proxies may be used as a basis for identifying transition risk drivers, as illustrated in Box 3 below.

Box 3: In the context of its 2024 Climate Risk Stress Testing Exercise, the Bank Negara Malaysia (BNM) proposed to capture transition risk drivers by using a shadow carbon price as a proxy for required policy intensity (possibly covering a range of financial institutional and regulatory policies, such as carbon taxation, cap-and-trade schemes, and subsidies) (BNM, 2022). The shadow carbon price allows the bank to incorporate assumptions on climate policy (in terms of ambition, timing, and distribution across sectors), and technology change (regarding energy sources and efficiency, as well as carbon sequestration, including measures related to agriculture, forestry, and land use) in a single metric (BNM, 2022).

3.3 Transition: GHG emissions data

GHG emissions data are crucial for assessing the impact of economic activities on the environment. In the context of stress testing, emissions data are relevant in order to compute the exposure of a firm to transition risks, such as changes in regulation (e.g. the implementation of stringent carbon taxes or GHG emissions cap) or the cost of mitigating action (e.g. through carbon offsets, investment in carbon-capture, or emission reduction technologies).

Emissions data may also be used to identify carbon-intensive investments and serve as a basis for defining a divestment strategy.

Examples of emissions data include:

- Scope 1, 2, and 3 (including financed) GHG emissions—provided by clients, external providers, or internal processes
- Information on energy mix and energy consumption emissions—provided by clients, external providers, or internal processes
- Aggregate GHG emissions data by region or sector—provided by external providers
- Energy efficiency data for real estate assets—provided by clients, external providers, or internal processes
- Data on carbon prices and regulations by jurisdiction—provided by external providers, regulatory stress testing exercises, or internal scenarios

Box 4: To perform its climate stress testing exercise, the French Prudential and Supervision and Resolution Authority (known by its French abbreviation, ACPR) and the Banque de France relied on the guidelines published by the NGFS and retained three transition scenarios. The transition scenarios include a baseline scenario, corresponding to an orderly transition, and two disorderly transition scenarios. Each of these scenarios combines different assumptions in terms of: (i) the trajectory of the carbon tax; and (ii) the total productivity levels of factors (ACPR, 2021).

The exercise only partially shed light on the implementation of portfolio reallocation strategies as participants generally maintained a stable asset allocation. As such, the value of the assets held in the portfolio mainly varies due to assumptions regarding the pace of carbon tax developments and technological progress required to achieve the objectives of the Paris Agreement. Measured as a deviation from the initial market value in 2025 and 2050, Figure 4 shows (by asset class) the sectoral impact of the two disorderly transition scenarios deviating from the baseline scenario (orderly transition).

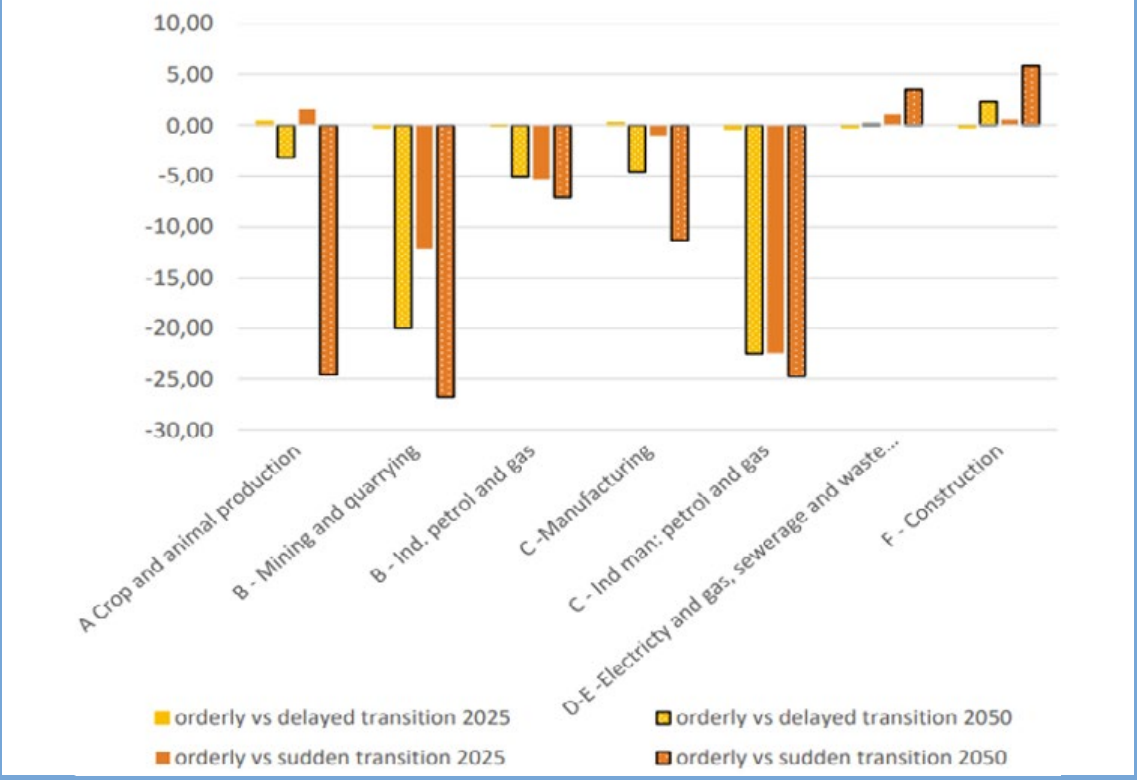

Figure 4: Impact of alternative scenarios on the equity portfolio as deviations from the baseline scenario (ACPR, 2021)

In this context, the ECB's analytical indicators on carbon emissions can be a useful source for GHG emissions data. The dataset provides information on the carbon intensity of the securities and loan portfolios of financial institutions and on the financial sector's exposure to counterparties with carbon-intensive business models (ECB, 2024). The carbon emissions indicators help users to assess the role of the financial sector in financing carbon-related activities, and thus to evaluate the associated transition risks with regard to sectors with carbon-intensive operations (ECB, 2024).

Nonetheless, data limitation continues to pose a challenge when quantifying GHG emissions. To address these data gaps, financial institutions may need to rely on estimated or proxy data as a basis for calculating financed emissions (PCAF, 2022).

Table 5: Data types for GHG emissions

Data type	Examples (non-exhaustive)	Example Usage
Company emissions data	▪ Company-level Scope 1, 2 and 3 emission data ▪ Other GHG emission data	▪ Used directly to determine emissions amount
Company's primary physical activity data	▪ Activity-based data ▫ Oil and Gas firm: number of barrels of oil produced ▪ Asset-level data ▫ Number of airplanes owned	▪ Convert activity/assets data via emission factors to estimate data
Company economic data	▪ Income statement: Revenue, Earnings Before Interest and Taxes (EBIT), Total Cost of Goods Sold (COGS) ▪ Balance sheet: total current assets, Property Plants and Equipment (PP&E) ▪ Cash flow: Investment cashflow, community spending	▪ Convert economic data via emission factors to estimate emissions ▪ Calculation of carbon intensity/emission intensity; i.e. ton of CO2e per unit of product produced or value-added
Internal portfolio data	▪ Internal dataset ▫ Credit metrics: Exposure, Probability of Default (PD), Risk-Weighted Assets (RWA) ▫ Facilities' collateral info: Guarantee type, property value	▪ Determine the distribution of portfolio to aggregate portfolio emissions
Industry data	▪ Aggregate industry emissions data ▪ Disclosures by other firms active in the same industry/with a similar business model	▪ Use as proxies ▪ Benchmark own activities with other firms having a similar business model ▪ Benchmark own activities with other firms in the same industry ▪ Top-down estimation using aggregate industry emissions data combined with market share

3.4 Transition: Alignment and transition data

Transition plans encompass a strategic roadmap detailing how an organization intends to shift its operations, investments, and practices toward climate-resilient pathways. These plans include timelines, resource allocations, and adaptive strategies to ensure a smooth transition to a low-carbon or climate-resilient future.

Commitment data, on the other hand, provide a comprehensive view of an entity's dedication to climate mitigation and adaptation efforts. These data encompass existing commitments, such as emissions reduction targets, renewable energy adoption goals, and sustainable supply chain initiatives. Additionally, it outlines the entity's willingness to invest in research, development, and innovation to drive environmentally conscious practices.

Information on transition plans and commitments allows the development of more realistic scenarios while providing insights into financial institutions' future/potential vulnerability to transition risks.

Alignment and transition data include:

- Transition pathways set by clients in accordance with the Paris Climate Change Agreement
- Science-based emissions reduction targets set by clients
- Climate policies and pledges of countries

Box 5: The qualitative questionnaire of the BoE's 2021 Climate Biennial Exploratory Scenario (CBES) exercise devolves into various aspects of climate risk management approaches (including transition plans and mitigation commitment). It inquires about strategies and policies, along with their progress towards achieving associated targets. It also seeks information about how climate-related considerations are integrated into investment strategies and the financial institution's broader risk management framework. Table 6 below provides an overview of some questions included in the qualitative questionnaire assessing participants' climate risk management strategies.

Table 6: Selected questions from BoE's (2021a) CBES qualitative questionnaire

Category	Type	Question
Current climate risk management	Banks, insurers	What strategies or policies do you currently have in place to mitigate climate risk? Outline your progress against any targets or objectives for improving climate risk management.
Current climate risk management	Banks, insurers	Explain how climate risks are managed in your organization (i.e. at staff level), with reference to the three lines of defence. You could provide an organogram if useful.
Current climate risk management	Banks, insurers	Do you integrate considerations of the risks (e.g. physical and transition) and opportunities posed by climate change into your current investment strategy? If not, do you plan to integrate such climate considerations into your future investment strategy? If you do integrate these considerations, what products (e.g. green bonds) and/or strategies (e.g. screening investments based on climate performance ratings) do you use to do this?

Current climate risk management	Banks, insurers	Have climate-related targets (i.e. science-based targets, green financing etc.) been set for business units, risk management functions and/or operations?
Current climate risk management	Banks, insurers	Do climate-related targets feed through to the variable remuneration of board members, executives, or senior management, and if so, how?
Current climate risk management	Banks, insurers	Which committee has oversight of climate-related risks? Provide evidence of any discussions by this committee that have taken place since 1 January 2019 that pertain to climate risk management, e.g. by providing relevant minutes or agendas.
Current climate risk management	Banks, insurers	Is climate change included in the most recent firm-wide strategy document or has the board approved a separate climate strategy?
Current climate risk management	Banks, insurers	Are climate risks captured in your firm-wide risk register? If yes, provide the relevant extract of your risk register.
Current climate risk management	Banks, insurers	Does the board receive regular reporting / management information which sets out the climate risks the firm is exposed to and impacts of the firm's activities, such as: ▪ Direct emissions from physical operational activities ▪ Emissions associated with its financial activities with clients i.e. "Scope 3 emissions" ▪ Estimates of value at risk or potential losses arising from the consequences of climate change

3.5 Physical & transition: Climate-related client data

Involving clients in the data collection process allows financial institutions to include information in the exercise that may not otherwise be accessible and to further improve the granularity of the data available for climate stress testing. It must be pointed out that client data may include data types mentioned above (e.g. alignment and transition data).

Climate-relevant client data may include:

- Location of physical assets owned by clients
- GHG emissions data
- Industry-specific information for corporate clients
- Data on client's operations, activities, and the characteristics of their assets

Box 7: In the context of the Hong Kong Monetary Authority's (HKMA) 2021 climate stress test exercise participants were required to collect the following information from their clients:

- GHG emissions data
- Awareness climate-related issues
- Transition plan to a low-carbon business model
- Track records in implementing the transition plan
- Environmental, Social and Governance (ESG) score, if available

4. Collecting climate-related data

4.1 Physical risks data sources

A wide array of open-source datasets are available to financial institutions, including physical hazards data, forward-looking temperature data, and data on emissions pathways.

For physical risk data specifically, institutions may use datasets released by climatological and geological survey agencies that forecast climate hazards, such as flooding and wildfires (BIS, 2021).

Table 7: Physical risk data sources (UNEP FI, 2023)

Data Source	Physical hazards covered	Geographical coverage
CDP Open Data Portal	Storms, extreme heat, seawater intrusion, droughts, floods, and forest fires	1,224 cities, states, and regions
Climate Central	Extreme sea levels, storm surge data, high tide events, coastal flooding, sea level changes, and severe winds	Global
Climate Impact Explorer by Climate Analytics	Temperature rise, seasonal precipitation, sea level rise, and extreme weather events, such as floods, droughts, and heatwaves	Global
GFDRR ThinkHazard!	Extreme heat, floods, earthquakes, landslides, sea level rise, water scarcity, and wildfires	Global
Google Dataset Search	Hurricanes, sea level rise, and temperature rise	Global
INFORM index	Variety of quantitative factors and resources to support physical risk assessments	Global
IPCC Assessment Report 6: Impacts, Adaptation, Vulnerability	Latest report on impacts of physical hazards, adaptation, and vulnerabilities to climate change	Global
IPCC Assessment Report 6: The Physical Science Basis	All major physical risk hazards	Global
KNMI—Climate Explorer	Temperature rise, droughts, cyclones, and precipitation	Global

Data Source	Physical hazards covered	Geographical coverage
Oasis Hub	Flooding, cyclones, earthquakes, extreme weather, and landslides	Global
PREPdata	Temperature rise, precipitation, coastal risks, water risks, and other extreme events	Global
UNEP Global Risk Data Platform	Tropical cyclones, storm surges, droughts, earthquakes, fires, floods, and landslides	Global
World Bank Climate Change Knowledge Portal	Temperature rise, seasonal precipitation, sea level rise, extreme weather events, such as floods, droughts, and heatwaves	Global
WRI Aqueduct Water Risk Atlas	Water risks, including flooding and droughts	Global
UNFCC Adaptation and Resiliency Resources	Database of databases on relevant adaptation and resiliency studies and measures	Global and national

4.2 Transition risks data sources

Firms can use open-source datasets as a starting point for sourcing climate data, such as GHG emissions data and climate transition scenario pathways.

Open-source platforms help format various datasets into user-friendly formats and can consist of data based on both past events and forward-looking projections from climate models.

Table 8: Transition risk data sources (UNEP FI, 2023)

Data source	Transition risks covered	Geographical coverage
CAIT Climate Data Explorer (by WRI)	GHG emissions, emission pathways, pledges, and targets	Global
CDP Open Data Portal	GHG emissions	Global
En-ROADS simulator	Different emissions pathways and drivers of temperature rise	Global
Greenhouse Gas Protocol	Product life cycle and corporate value chain (Scope 3) GHG inventories	Global
IEA Net Zero 2050 Scenario	Policy, technology, and market risks based on the IEA's Net Zero 2050 scenario	Global, with breakouts by region at a high level
IIASA scenario explorer	Policy, technology, and market risks based on a wide range of IPCC 1.5°C scenarios	Global, regional, and national at varying degrees of specificity

Data source	Transition risks covered	Geographical coverage
IMF World Economic Outlook	Macroeconomic forecasts & scenarios that can be used to understand potential policy, technology, and market shifts	Global, regional, and national
IPCC emissions factor database	Emissions factors for various activities	Global, with some regional variation
NGFS scenario portal	Policy, technology, and market risks based on the NGFS scenarios	Global, breakout into specific regions and national level downscaling
SENSES project on climate scenarios	Policy, technology, and market risks based on a wide range of IPCC 1.5°C scenarios	Global
The Lowdown v2.0	Coal capacity for countries	Global
UN data	Methane, CO2, HFCs, Nitrous Oxide, Nitrogen Trifluoride, PFCs, and Sulphur Hexafluoride	Data for 43 countries, available for 29 years

5. Challenges associated with climate risk data

Highly standardised but granular data across institutions are crucial for conducting adequate climate risk management. However, despite the importance of data in the context of climate stress testing, significant gaps remain in data availability, reliability, and comparability (NGFS, 2022b; NGFS, 2021).

5.1 Coverage

Available data can be limited in terms of coverage; for example, most available datasets only cover a limited set of indicators and firms, with commercial data providers often focusing on larger public corporations rather than small and medium-sized companies. Similarly, available data sets can largely cover regions such as Europe and North America, with limited coverage for other regions (Doll & Werb, 2023).

5.2 Dependency on third-party data providers

While commercial data providers may provide reasonably reliable data, the usage of such data comes at a significant cost for firms and may imply long-run dependencies. In addition, the market for proprietary data is characterised by semi-monopolies and a lack of published methodological and quality frameworks (Eurostat, 2022). The use of external auditing is currently marginal, implying limited quality assurance (BIS, 2021).

5.3 Time lag of data

Firms typically report climate-related data on a yearly basis in a process that may take several months after the respective financial year-end. As a result, such time lags may be unable to capture more recent developments and trends. Time lags are a particular challenge for third-party data providers as they require some time to process and implement new information into their existing data products (Doll & Werb, 2023).

5.4 Lack of data availability

As (mandatory) climate-related disclosures and globally recognised reporting standards are relatively new, only a limited number of firms disclosed consistent and comprehensive climate-related data in the past decade (Doll & Werb, 2023). This makes the collection of historical data difficult, even impossible, in some instances.

Data on clients' emissions, the location of their assets, and other forward-looking information can often be limited. Stakeholders reported that they need to understand the point-in-time performance of an exposure against a transition pathway—hence the need for firms to disclose their transition plans—as well as the impact of adaptation and mitigation measures on the evolution of the risks (NGFS, 2021).

In addition, financial institutions whose portfolio is mostly composed of small, non-listed counterparties with limited resources to execute environment-related disclosures may find it particularly challenging to gather the available data or build the internal resources required for data collection.

In the context of physical climate-related data, considering the large geospatial differences in the manifestation and evolution of physical risks, it is critical to make asset location data accurate to determine the variety and severity of the physical threats of climate change. Due to the absence or limited use of data auditing, coupled with the limited disclosure of methodologies/processes underlying the dataset, the physical risks data may not meet the standards set by the Taskforce on Climate-related Financial Disclosures (TCFD) (BIS, 2021). Whilst third-party data may sometimes undergo interpolation, extrapolation, or other gap-filling processes, this is not always transparently communicated to data users (UNEP FI, 2021).

5.5 Comparability

Data provided by clients and third-party sources are often not standardised, thus making comparisons both within and between financial institutions more difficult. This can be attributed to a lack of standardisation in data and climate risk reporting requirements, as well as a variation in methodologies and approaches utilised by financial institutions and data vendors (BIS, 2021; Doll & Werb, 2023).

Limited compatibility across firms can be further driven by the following shortcomings in existing practices (Ducoulombier, 2021):

i. Different sets of primary and secondary data may be used across firms for the estimation of GHG emissions in value chains.
ii. Inputs and outputs will vary depending on the assumptions and methodologies used to allocate emissions across different suppliers, which makes the resulting estimates incomparable.
iii. Methodologies, assumptions, or data sources may change across reporting periods, impeding cross-period comparability (even within the same firm).

5.6 Granularity

There are significant gaps in granular climate-specific data such as carbon emissions, forward-looking information about transition plans, and climate-related projections (ECB, 2022a). In addition, granular location and sector classification data are often unavailable (ECB, 2022a). Furthermore, the lack of granularity is particularly problematic as the severity and impacts of acute and chronic physical risks are highly location-dependent (BIS, 2021).

In terms of transition risk, on a regional level, the speed and nature of transitioning to a low-carbon economy can vary significantly, driven by factors such as government policies, technological advancements, and local market dynamics. Yet, the available data frequently fail to capture these nuances, resulting in generalised assessments that might not reflect the specific challenges and opportunities unique to regions. At a sectoral level, industries possess distinct levels of exposure and susceptibility to transition risks. Energy-intensive sectors, for example, might face greater financial implications as carbon pricing becomes more widespread. The lack of granular data thus impedes the development of sector-specific risk models, hindering accurate estimations of potential financial impacts across industries.

Similarly, it is of great importance to understand the differences in exposure to physical risks at different levels, including at sectoral, regional, and jurisdictional levels. However, a sufficient level of disaggregation of physical risk data is not often guaranteed. Examples show that climate-related data lacks granularity. In part, this is because many weather stations are located in coastal areas and thus fail to capture different temperature and precipitation outcomes in mountainous regions (BIS, 2021). Data from both country and regional levels may be required to downscale global scenarios to the individual firm under consideration (Table 9). The granularity of data by sector or geography may vary significantly.

Table 9: Levels of data granularity by type of climate-related risk

Type of risk	Level of granularity	Examples of data
Physical risk	Low	Country level
	Medium	District level
	High	Latitude/longitude, address data, postal codes

5.7 Internal capacity and data processing capabilities

To perform a climate stress test, financial institutions require accurate and up-to-date data on various climate parameters; however, accessing such data can be quite costly during the process of data collection, data processing, data integration, and model development. These financial burdens might strain the firm's budget, hindering its ability to

accurately assess climate-related risks and make informed decisions regarding its portfolio. These additional costs may be particularly significant for smaller institutions.

In the context of GHG emissions data specifically, financial institutions face difficulties in developing sound approaches due to the lack of methodological guidance, the high heterogeneity of emissions data retrieved from external providers, and the lack of a common database to retrieve the climate data needed. While proxies are a first step towards closing the availability gap, huge discrepancies across emissions data and variability of approaches warrant further methodological reflection and guidance on how to improve estimation methods and increase reliability (ECB, 2022b).

Processing and analysis of transition risk data also pose significant IT hurdles. The sheer volume of data, coupled with the intricate nature of transition risks, necessitates robust computational capabilities to model and project potential outcomes accurately. As financial institutions navigate this data challenge, investments in sophisticated IT infrastructure, data processing technologies, and analytical capabilities become imperative to enable effective evaluation of transition risks within the context of climate stress testing.

As in-house solutions tend to be highly resource-intensive and costly to implement, financial institutions often rely on third-party commercial data providers and consultancies to obtain and analyse climate data. However, relying on third-party vendors can also entail high long-term costs.

Box 6: Data gaps identified by participants of the US Federal Reserve Pilot Climate Scenario Analysis Exercise (Federal Reserve, 2024)

Topic	Examples
Real estate exposures	Property location, square footage, number of floors, construction materials, renovations, age, energy efficiency ratings, municipal regulatory data and retrofitting costs
Insurance	Levels and types of coverage, deductibles and replacement cost values
Transition risk	Obligor emissions and transition risk management
Infrastructure	Critical infrastructure, adaptation estimates, flood defense and community resiliency
Source: Federal Reserve summary of CSA participant submissions	

6. Recommendations for climate risk data collection and management

Financial institutions must seek to improve data collection and management processes to gather and leverage the climate-related data required for climate stress testing. In this context, Figure 5 below provides a list of practices that are relevant avenues for streamlining these processes.

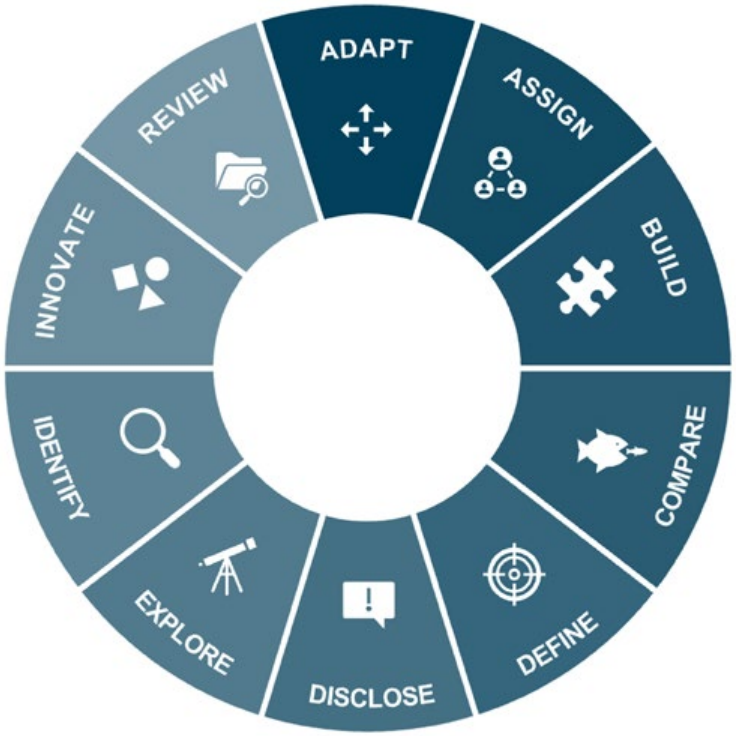

Figure 5: Improving climate data collection processes (Own depiction)

Define and adapt: Develop a clear set of procedures to implement for data collection and processing. Develop a data strategy that is relevant to the institution's level of maturity and requirements (PwC, 2023). For instance, emission quantification may differ across sectors and asset classes, likely requiring data collection and management processes that are specific to individual sectors and asset classes (PCAF, 2022).

Assign: Define the roles and responsibilities of each team involved across all the data collection and management processes internally.

Explore: Consider all available options for acquiring the relevant climate-related datasets (PwC, 2023). These may include:

- Third-party vendors data (PwC, 2023).
- Alternative data (e.g. structured ocean, weather, and atmospheric data, geospatial data such as satellite imagery, remote sensing—including indicators for changes in vegetation, water bodies, erosion, or desertification, plus indicators for detecting expansion and potential vulnerabilities in agricultural or urban areas) (Doll & Werb, 2023);
- (Publicly) available information, guidance, and data provided by regulators, NGOs, (inter)governmental agencies, multilateral organizations, and consultancies, as well as academia (Doll & Werb, 2023).

Identify: Identify the datasets available internally, those that can be gathered through client engagement, those that may be retrieved from third-party providers, those that are "must-haves" or "nice-to-haves," and those that may be useful for several purposes. A consistent data collection strategy should be developed in line with the identified datasets, and potential synergies should be leveraged.

Review: Conduct thorough model validation to ensure that vendor models comply with internal quality standards (PwC, 2023). Specifically when leveraging external data, the reliability and accuracy of third-party datasets should be considered (PwC, 2023).

Innovate: Adopt an agile approach with regards to data collection and revisit the firm's data strategy on a regular basis in line with most recent developments in novel tech-enabled approaches (Deloitte & WSJ, 2023).

Compare: Benchmark processes against industry practices and regulatory expectations.

Build: Develop or acquire infrastructure to gather and process climate-related data while addressing critical skillset gaps through hiring, partnering, or training.

Disclose: Acknowledge and disclose the limitations of the firm's data collection processes, understand the potential impact of the limitations on the results, and identify areas of improvement (ECB, 2023b).

Beyond these practical steps, financial institutions can leverage emerging technologies developed in the context of climate data and climate risk modelling, which have advanced significantly in recent years (WEF, 2024).

7. Supervisors' role in data collection and processing

Supervisors have a key role in enabling and facilitating data collection and processing among financial institutions. Below, we detail a number of next steps for supervisory authorities to help the finance sector address challenges related to climate data.

- Establish workshops, training, and certified courses for institutions to help them build institutional expertise on climate risks and climate data.
- Implement policies on disclosing required data, like emissions data, in standardised formats to allow for comparability. Standardised global taxonomies will allow firms to collect comparable data across sectors and regions.
- Initiate communication between financial institutions and climate scientists, academic and research institutions, and modellers and tool providers in order to support firms in building their capacity for climate stress tests.
- Provide free, open-source data to firms for a climate stress test.
- Engage with financial institutions to modify current systems used to run models so as to make them suitable for running climate stress tests.
- Provide data templates for supervisory exercises to help improve the standardisation of data across institutions.

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Appendix

Examples of data and sources for climate-related risk management

Data	Source	
Carbon emissions	International Energy Agency	Link
	Worldometer	Link
	European Commission (EDGAR)	Link
	Bloomberg	Link
	US Environmental Protection Agency (EPA)	Link
Energy supply	International Energy Agency	Link
ESG scores	Sustainalytics	Link
	MSCI	Link
	LSEG	Link
	S&P	Link
	Bloomberg	Link
Credit ratings	S&P Global	Link
	Fitch	Link
	Moody's	Link
Climate adaptation	European Commission, European Energy Agency (EEA)	Link
	International Monetary Fund (IMF)	Link
	CMRA (United States only)	Link
Implied temperature	Climate Action Tracker	Link
	MSCI	Link
	International Monetary Fund (IMF)	Link
	World Bank	Link
	European Commission, Copernicus	Link
Green bonds	Climate Bond Initiative	Link
	LUXSE/LGX	Link
	International Monetary Fund (IMF)	Link
	Bloomberg terminal	Link

Examples of data forms from supervisors during climate stress tests

The examples data forms listed below cover the following climate-related data types:

- Climate hazards data
- Emissions data
- Climate-related client data
- Alignment and transition data

Excerpt of the assessment templates focusing on the data required of the ECB Banking Supervision 2022 climate risk stress test (ECB, 2022c):

Question	Data
33	With regard to climate data availability for the institution's climate risk stress test framework, what climate risk-relevant information on the bank's counterparties is internally available to the relevant business areas of the institution?
33	Emissions data for corporate counterparties
33	Climate strategies and targets for corporate counterparties
33	Energy label classification for real estate
33	Likelihood of potential physical risk events (e.g. natural disasters)
33	Estimates of the severity of potential physical risk events (e.g. natural disasters)
33	Granular location data (not only location of headquarters, but also of main manufacturing facilities)
33	Other, please specify […]
34	What data can be observed directly from your counterparties (e.g. via dedicated questionnaires)?
34	Emissions data for corporate counterparties
34	Climate strategies and targets for corporate counterparties
34	Energy label classification for retail real estate
35	What data need to be purchased from external data providers?
35	Emissions data for corporate counterparties
35	Climate strategies and targets for corporate counterparties
35	Energy label classification for retail real estate
35	Likelihood of potential physical risk events (e.g. natural disasters)
35	Estimates of the severity of potential physical risk events (e.g. natural disasters)
36	Is the institution making use of any specific external data providers for the development of climate risk stress test models?
37	In order to calibrate the climate risk stress test model, what data sources are used by the institution?
37	For physical risk, internally available historic data, please specify the time period […]
37	For transition risk, internally available historic data, please specify the time period […]

37	For physical risk, data (tools) from third parties, please specify […]
37	For transition risk, data (tools) from third parties, please specify […]
37	Other, please specify […]
38	If you identify green exposures, are these based on the EU Taxonomy?

Examples of questions relates to data as part of the assessment questionnaire of the Bank of England's 2021 Climate Biennial Exploratory Scenario (CBES) (BoE, 2021b):

Category	FI	Question	Sub-question	Response options
General wholesale	Banks	Consider assets held by corporate counterparties.	What information do you typically have on the location of assets for counterparties assessed at counterparty-level compared to those assessed at portfolio-level?	1. High granularity, more than 80% of assets at a four digit postcode (or non-UK equivalent) level or higher 2. Mid granularity, more than 50% of assets at a four digit postcode level (or non-UK equivalent) or higher, and where not possible, assets are considered by region or country 3. Low granularity, assets are considered by region or country 4. Assets are not considered geographically and corporate assets are considered by headquarter location (or other single location)
General wholesale	Banks	Consider assets held by corporate counterparties.	At what geographical granularity has analysis of corporate counterparties' assets generally been undertaken when considering exposure to physical climate risk?	1. High granularity, more than 80% of assets at a four digit postcode (or non-UK equivalent) level or higher 2. Mid granularity, more than 50% of assets at a four digit postcode level (or non-UK equivalent) or higher, and where not possible, assets are considered by region or country 3. Low granularity, assets are considered by region or country 4. Assets are not considered geographically and corporate assets are considered by headquarter location (or other single location)

Category	FI	Question	Sub-question	Response options
Commercial Real Estate	Banks	How have you determined the likely physical risks (e.g. flood risk) of different CRE exposures? In your answer, outline any regions or areas of particular vulnerability you have identified and describe the geocoding level you achieved when undertaking your analysis (e.g. full postcode versus regional) as well as the vulnerability curve (e.g. how you transformed the estimated physical hazards intensity into losses) you have used.		
Mortgages	Banks and insurers	What proportion of mortgages have you been able to provide a known EPC rating for, and what proportion is estimated? For those that are estimated, outline the methodology used.		
Mortgages	Banks and insurers	Consider the assumptions you have used for the path for house prices in the scenarios.	How have these paths been adjusted from the aggregate paths provided to account for properties of different levels of physical risk?	
Mortgages	Banks and insurers	Consider the assumptions you have used for the path for house prices in the scenarios.	How have these paths been adjusted from the aggregate to account for properties of different EPC ratings?	
Mortgages	Banks and insurers	How have you determined the regional and demographic distribution of uninsured properties across your portfolio in each of the scenarios?		

UN environment programme

finance initiative

UNEP Finance Initiative brings together a large network of banks, insurers and investors that collectively catalyses action across the financial system to deliver more sustainable global economies. For more than 30 years the initiative has been connecting the UN with financial institutions from around the world to shape the sustainable finance agenda. It has established the world's foremost sustainability frameworks that help the finance industry address global environmental, social and governance (ESG) challenges. Convened by a Geneva, Switzerland-based secretariat, more than 500 banks and insurers with assets exceeding US$100 trillion work together to facilitate the implementation of UNEP FI's Principles for Responsible Banking and Principles for Sustainable Insurance. Financial institutions work with UNEP FI on a voluntary basis and the initiative helps them to apply the industry frameworks and develop practical guidance and tools to position their businesses for the transition to a sustainable and inclusive economy.

unepfi.org

unepfi.org

info@unepfi.org

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