



Caribbean Economic
Research Team

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Regional Approaches to Climate Risk Analysis

CERT Workstream 1 – Climate Change and Climate-Related Risks

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1.0 INTRODUCTION

Regional central banks have made important strides over the past two years (2023-2024) in building out internal frameworks to assess the economic and financial stability implications of climate risks. These efforts have centred on acute physical risks. This is understandable, given that the Caribbean is one of the most natural disaster-prone regions in the world. Damages often represent significant shares of a country's gross domestic product (GDP). As an example, according to the World Bank's Global Rapid Post-Disaster Damage Estimate (GRADE) Report, the total economic damages inflicted by Hurricane Beryl in July 2024 to Grenada and St. Vincent and the Grenadines were estimated at 16.5 per cent and 22 per cent of GDP, respectively (World Bank 2024). More broadly, annual global damages from weather-related hazards have more than doubled in real terms over the past twenty years, reaching US\$275 billion in 2022 (NGFS 2024).

Building economic and financial resilience to these catastrophic occurrences is a regional imperative, since these events are happening at a higher frequency and intensity. The results of a climate change and climate-related risk survey indicated that no regional central bank had yet begun to collect data in order to adequately analyse climate-related risks (CERT 2023). The working paper made several recommendations to close the data gaps and outlined a roadmap for implementation. In just over a year, the climate risk assessment landscape has changed for the better. A number of central banks have dedicated resources to capacity building through the engagement of external consultants or support from traditional partners such as the International Monetary Fund's (IMF's) Caribbean Regional Technical Assistance Centre (CARTAC).

Internationally, work on climate change has branched off into many work streams, with recent forays into the impact of climate change on monetary policy. Given the multidimensional nature of climate change, Central banks in major economies have also expanded their talent pool beyond the conventional, hiring climate scientists to work alongside economists. For example, in May 2022 the European Central Bank (ECB) hired a climate scientist who reports directly to the President of the ECB. As a result of such progressive actions, climate risk assessment frameworks within central banks have been evolving rapidly. In order to find commonalities that can be used as a basis for the creation of regional climate scenarios, the aim of this paper is to describe the progress made by central banks and government organizations in evaluating climate risks. This paper is structured as follows. [Section 2](#) highlights some of the approaches to climate risk assessment utilised by major central banks. [Section 3](#) outlines the strides made by Caribbean central banks to develop climate risk assessment frameworks. The paper concludes in [Section 4](#). In this section, the approaches are evaluated to determine opportunities for harmonisation and to identify potential building blocks for the design of common climate scenarios.

2.0 CLIMATE RISK ASSESSMENT APPROACHES BY GLOBAL CENTRAL BANKS

Climate stress tests and scenario analysis have been the tools of choice for central banks and other regulators to conduct climate risk analyses. Stress testing and scenario analysis regimes employed by selected jurisdictions are discussed below¹.

The Bank of Canada and the Office of the Superintendent of Financial Institutions Pilot Project

In January 2022, the Bank of Canada (BoC) and the Office of the Superintendent of Financial Institutions (OSFI) completed a climate scenario analysis pilot project. Six Canadian financial institutions participated in the pilot. The project aimed to increase understanding of the financial sector's potential exposure to risks in transitioning to a low-carbon economy and to help build the capabilities of authorities and financial institutions in assessing climate-related risks (Bank of Canada 2022). The BoC developed a set of global climate transition scenarios to capture a range of risk outcomes that could adversely affect the Canadian financial system and economy. The analysis covered the 10 most emissions-intensive sectors in the economy, including agriculture, primary energy, electricity, energy-intensive industries and transportation. Credit and market risks were assessed, informed by the financial impacts generated by the climate transition scenarios. According to Hosseini et al. (2022), the methodology was as follows:

“The method to assess credit risk combined top-down and bottom-up approaches. Variables from the climate transition scenarios were first translated into sector-level financial impacts. The financial institutions then used these impacts to estimate the implications on credit outcomes through borrower-level assessments. Using the transition scenarios' financial impacts, and the stressed credit outcomes, the project estimated a relationship between climate transition information and credit risk. This was used to calculate expected credit losses at the portfolio level. The method to assess market risk was solely top-down. Using the scenario analysis, the project used a dividend discount model to estimate sectoral equity revaluations, which it then applied to equity portfolio holdings.”

In addition, the potential risks to macroeconomic outcomes were instructive for commodity-exporting economies given that Canada, like Guyana, Trinidad and Tobago and Suriname, is a commodity-exporting country.

¹ See “Central Bank Data Strategies to support Climate Risk Assessment,” (CERT WP 01/2023), for further details.

The European Central Bank Stress Testing Framework

The climate stress test conducted by the ECB in 2022, evaluated how well banks were set up to tackle climate-related risks in different scenarios that assessed physical risks, such as heatwaves, droughts and floods, as well as short and long-term risks stemming from the transition to a greener economy. The exercise was a constrained bottom-up stress test. Such that, banks under its supervision provided the qualitative and quantitative inputs for the exercise, while complying with a common methodology and applying a common set of scenarios as stipulated by the ECB. The scope of the exercise was limited to a selection of climate-related risk transmission channels, asset classes and scenarios to keep the exercise manageable at an operational level. Not covered in this exercise were the interlinkages between climate risk and banks' balance sheets. The ECB described the bottom-up methodology and related scenarios, as a selective approach (ECB, 2022).

The methodology consisted of three distinct modules:

1. Framework questionnaire (a comprehensive qualitative questionnaire on 11 sections);
2. Stock-take on emissions (estimation of two climate risk metrics: to provide insight into the sensitivity of banks' income to transition risk and their exposure to carbon emission-intensive industries);
3. Bottom-up climate stress test (these stress tests and projections were provided by the individual banks for different scenarios and risk areas provided by the ECB, covering both physical and transition risk).

The US Federal Reserve Pilot Climate Scenario Analysis (CSA) Exercise

In January of 2023, the United States Board of Governors of the Federal Reserve System (US Fed), embarked on a bottom-up Pilot Climate Scenario Analysis (CSA) Exercise. According to US Fed the exercise had two primary objectives – firstly, to learn about large banking operations' climate risk management practices and challenges and secondly, to enhance the ability of both large banking organisations and supervisors to identify measures, monitor and manage climate-related financial risks. Further, the exercise was described as exploratory in nature, with no intended consequences for bank capital or supervisory implications. Featured were six large banking organisations, all with material commercial and residential real estate exposures located in the North East Region of the United States, as defined as by the 'Fourth National Climate Assessment' (NCA4).

This CSA exercise comprised two modules, assessing both qualitative and quantitative, physical and transition risk exposures of the participating banks. Data templates and qualitative questionnaires were supplied to all participants along with supporting documents (describing internal governance, risk management practices, measurement methodologies, portfolio specific results and lessons learnt). US Fed (2023) stated that the exercise placed emphasis on the changes to broad credit risk parameters, such as probability of default (PD), internal risk rating grade (RRG), and loss given default (LGD), rather than on estimates of losses. This would provide information about how the relative riskiness of exposures within participants' credit portfolios may evolve over time in response to different climate scenarios, given the partial nature of the exercise, which focuses on specific regions and certain portfolios for the six participants.

For both modules, the participating banks were provided with forward-looking scenarios leveraged from the existing work of the UNEP IPCC and the Network for Greening the Financial System (NGFS), including core climate, economic and financial variables. Participants were to estimate the effects of the scenarios on the relevant subset of their loan portfolios over a time horizon of 2022 to 2032. Two scenarios were used to assess both physical and transition risk; (1) A 'Baseline (NiGEM)', assuming all currently implemented policies and the adoption of no new policies, inclusive of those already announced, and (2) A 'Net Zero 2050' scenario, where global warming is limited to 1.5 °C and immediate stringent policies to achieve Net Zero CO₂ emissions by 2025. Additionally, carbon prices increase over the time horizon, alongside a relative rapid change in the technological landscape, with the medium-to-high use of CO₂ removal technology. Of the three integrated assessment mechanisms (IAMs) available from the NGFS, REMIND-MAgPIE was selected, with the NiGEM macroeconomic model utilised.

The Central Bank of Brazil

According to the 2022 Financial Stability Report, the Central Bank of Brazil's (BCB) methodology to assess physical climate risks (extreme drought) is divided into three parts:

1. projection of climatic changes effects;
2. estimation of climatic impact risks in each municipality in the stressed scenario;
3. identification of economic activities with most intense use of water in its production processes or services.

The BCB ran a simulation which evaluated institutions' credit exposures to episodes of extreme drought domestically. The analysis measured the proportion of current credit portfolios which were loans granted

to debtors located in municipalities and economic sectors which will be significantly affected in a scenario of extreme drought projected to occur between 2030 and 2050. These loans' contribution to banks' interest income were evaluated. Other aspects, such as impacts on solvency and liquidity risks were however not assessed (BCB 2022). The results suggested that the percentage of loans in the credit book granted to debtors in municipalities with high risk of severe drought would increase in the timeframes projected. A portion of financial institutions could suffer increases in their exposures to physical risk.

Hong Kong Monetary Authority Climate Risk Stress test (CRST) 2023 and 2024

The Hong Kong Monetary Authority (HKMA) has developed a comprehensive Climate Risk Stress Test (CRST) for 2023-2024, building on the foundation of a pilot exercise conducted in 2021, (Hong Kong Monetary Authority 2023). This updated framework aims to evaluate the resilience of banks under various climate-related scenarios, with over 30 Authorized Institutions (AIs) participating. The new CRST includes significant enhancements, such as the introduction of a five-year scenario, which aligns with banks' internal stress testing practices, and more detailed reporting requirements that enable more consistent and granular analysis across institutions. The HKMA's CRST helps banks identify vulnerabilities and manage risks associated with both physical and transition climate risks, ultimately strengthening the sector's overall preparedness, (Hong Kong Monetary Authority 2023).

The CRST scenarios include both physical risks, which refer to the direct impacts of climate events (e.g., hurricanes, floods, and rising temperatures), and transition risks, which involve the financial implications of a shift towards a low-carbon economy (e.g., carbon taxes, regulatory changes, and shifts in consumer preferences). Physical risk scenarios in the CRST are designed to assess the potential damage to assets and operations due to severe weather events, with particular attention to high-risk geographies and sectors. The models simulate short-term shocks from extreme weather events, as well as long-term changes, such as gradual sea-level rise. Transition risk scenarios, on the other hand, explore the financial impact of policy changes and market shifts as economies transition to more sustainable practices. These scenarios include orderly transitions, where policies are implemented gradually, as well as more abrupt, delayed transitions, which could cause significant market disruptions.

One of the key aspects of the CRST is its use of sector-specific analysis. During the 2021 pilot, high-emission sectors such as energy, steel, and manufacturing were identified as particularly vulnerable to transition risks, especially under scenarios with stringent carbon pricing mechanisms. The exercise demonstrated that carbon taxes and other regulatory measures could significantly increase operating costs for these sectors,

leading to higher credit risk for banks with significant exposure to these industries. The 2023-2024 CRST extends this analysis by incorporating more granular data, such as sector-specific emission reduction targets, to provide a clearer picture of risk distribution across different parts of the economy.

Additionally, the CRST incorporates a new five-year scenario, which enhances the realism of the stress tests by simulating prolonged periods of climate stress, including continuous regulatory changes, evolving market trends, and changing investor sentiment towards sustainability. The goal is to give AIs the ability to identify and mitigate risks over a medium-term horizon, rather than just preparing for short-term shocks. This approach aligns the CRST with global best practices, where financial institutions are increasingly required to incorporate climate considerations into their broader risk management frameworks.

Despite the advancements, the HKMA acknowledges that there are challenges in conducting robust climate risk analysis, especially in relation to data availability and the complexity of modeling future climate conditions. Accurate climate modeling requires detailed data on factors such as weather patterns, emission pathways, and economic dependencies, which are not always readily available. The HKMA, therefore, encourages AIs to adopt a pragmatic approach, using available data to build the most comprehensive models possible while acknowledging the limitations and uncertainties inherent in this type of stress testing.

Project Viridis: A Climate Risk Platform for Financial Authorities

Launched in 2024 as a collaboration between the Bank for International Settlements (BIS) Innovation Hub and the Monetary Authority of Singapore (MAS), Project Viridis, is an online climate risk platform designed to help central banks and authorities identify and assess material climate-related financial risks. Project Viridis, which is still in development and built on a modular platform (allowing climate/data metrics to be updated over time), aims to provide supervisors with early insights into climate risks by analysing existing data sources. This would intern allow supervisors to identify entities more vulnerable to financial risks and potential systemic exposure to sectors and geographies. The Viridis platform offers regulators a comprehensive dashboard view of climate-related risk for financial institutions and the financial system as a whole, based on the risks faced by the entities to which the financial institutions are exposed.

The project builds on the work of BIS Innovation Hub's Project Ellipse², using the Ellipse Data and Knowledge Platform (EDKP) as the foundational architecture for integrating regulatory exposures and climate data, and employing natural language processing techniques to identify, extract, and process climate-relevant information from corporate disclosures. Project Viridis will be a module added onto the EDKP and made available to EDKP community members. The platform is split into five main categories covering transition risks, physical risks, asset and economic data, systemic macro views, and essential user capabilities.

IMF Climate Risk Analysis in Financial Sector Assessment Program (FSAP)

Guided by its 2021 Climate Strategy, the IMF began incorporating climate change considerations in risk analysis, regulation and supervision, and monetary policy operations. Including climate risk analyses into the Financial Sector Assessment Program (FSAP) is the main way the IMF assesses risks to financial systems and policies to mitigate and manage said risks. According to the IMF, climate risk analysis cannot be treated as a standard stress test because of the level of uncertainty in climate modelling and long-term simulated horizons.

IMF's Standard FSAP risk analysis involves scenario-based stress tests to assess bank solvency and liquidity. These top-down exercises, involving sectoral breakdown, evaluate credit, market, interest, and foreign exchange risks over a three (3) to five (5) year stress-testing horizon. Adverse scenarios are used to predict country-specific linkages between macro drivers and risk indicators, influencing bank income and capital based on their historical association. Granular data for individual company and household balance sheets can be used in solvency examinations to analyse the impact of unfavourable scenarios and model risks at a more aggregated top-down level to help discover threshold effects and provide a more accurate understanding of financial situations (IMF, 2022).

The IMF's climate risk FSAP methodology uses the NGFS reference scenarios for emissions and temperature, along with pathways for physical and transition risk, to analyse climate change. It uses IPCC pathways up to 2100, climate impacts projections, GDP, population, and urbanization rate to contextualize each emission pathway and make a range of assumptions about technology evolution. Climate change hazards projections are sourced from private vendors or country authorities, covering various risks like

² Project Ellipse allows authorities to test solutions in their own environments, fostering innovation and collaboration among the global regulatory community to develop common solutions for future-proofing supervisors' data and analytical capabilities. https://www.bis.org/about/bisih/topics/suptech_regtech/ellipse.htm

precipitation, cyclones, floods, droughts, wildfires, heatwaves, and chronic physical risks. These projections align with NGFS scenarios, providing country-level aggregate risk indicators and location-specific data.

IMF's Climate Risk Analysis Approach involves:

1. Standard top-down FSAP Risk Analyses provide the starting point.
2. Climate Risk Analysis modules are then included by identifying the most relevant climate risks and hazards for a country. This evaluation is based on a climate risk assessment matrix (C-RAM), which includes both transition and physical risk metrics and provides a narrative of transmission pathways.
3. Estimating the impact of projected hazards on damages and productivity, as well as their effects on bank stability. These scenarios are then used to estimate the impact on bank solvency using the standard approach for banks' stress tests.
4. Conduct of bank stability assessments using one of two approaches: A Macro approach that incorporates analysis of capital and productivity shocks due to hazard damages and; a Micro-macro approach which relies on an analysis of firms and households using micro models to estimate the impact of physical risk on individual balance sheets.

An important pillar of a climate stress testing framework is scenario design and selection. **Table 1** highlights the different climate scenarios adopted by regulators. It is evident that the scenarios developed by the NGFS are heavily utilised, with other regulators modifying these scenarios according to their own unique needs. However, these scenarios are more long term in nature and do not offer much assistance with evaluating climate risks with shorter impact horizons. In October 2023, the NGFS issued a conceptual note on shorter-term climate scenarios, which consists of five narratives (**Figure 1**).

Table 1: Climate Scenario Analysis and Stress-Testing Exercises

Jurisdiction	Organization	Scenarios	Description	Corresponding scenarios	Example macro outcome
Australia	Australian Prudential Regulation Authority	Scenario 1	A delayed but then rapid reduction in emissions by 2050	Disorderly Transition: Delayed Transition scenario (NGFS 2020)	No data
		Scenario 2	A continuation of current global policies and forecasts	Hot House World: Current Policies scenario (NGFS 2020)	No data
Canada	Bank of Canada	Baseline scenario: business as usual	No further action to limit global warming is taken; emissions rise unabated and cause a substantial increase in average global temperatures	Hot House World: Current Policies scenario (NGFS 2020)	No data
		NDCs scenario	Beginning in 2020, countries act according to their pledges under the Paris Agreement, but actions are not enough to limit warming to 2°C by 2100	Hot House World: NDCs scenario (NGFS 2020)	A 4% reduction in annual GDP compared with baseline scenario by 2050
		2°C (consistent) scenario	Countries act to limit global warming to 2°C by 2100	Orderly Transition: Net Zero 2050 scenario (NGFS 2020)	A 13% reduction in annual GDP compared with baseline scenario by 2050
		2°C (delayed action) scenario	New policies will not be implemented until 2030; by 2100, global warming is limited to 2°C	Disorderly Transition: Below 2°C scenario (NGFS 2020)	A 21% reduction in annual GDP compared with baseline scenario by 2050
European Union	European Central Bank	Transition: long-term Orderly scenario	Climate policies are introduced early and gradually become more stringent	Orderly Transition: Net Zero 2050 scenario (NGFS 2020)	EU cumulative GDP growth in 2050 versus 2021 is 65%
		Transition: long-term Disorderly scenario	New climate policies are not introduced until 2030; limit warming to below 2°C	Disorderly Transition: Delayed Transition scenario (NGFS 2020)	EU cumulative GDP growth in 2050 versus 2021 is 58%
		Transition: long-term Hot House World scenario	No new climate policies are implemented; emissions grow until 2080, leading to ~3°C of warming	Hot House World: Current Policies scenario (NGFS 2020)	EU cumulative GDP growth in 2050 versus 2021 is 57%

Table 1: Climate Scenario Analysis and Stress-Testing Exercises (Continued)

Jurisdiction	Organization	Scenarios	Description	Corresponding scenarios	Example macro outcome
		Transition: short-term Disorderly risk scenario	Carbon price increase is frontloaded to 2022, 2023, and 2024	Disorderly Transition: Delayed Transition scenario (NGFS 2020)	EU GDP grows cumulatively by ~7.4% in the period 2021–2024, compared with 10.5% in a baseline scenario
		Physical: drought and heat scenario	Severe drought and heat wave are assumed to hit Europe on January 1, 2022	Not applicable	No data
		Physical: flood risk scenario	Severe floods take place across Europe on January 1, 2022	Not applicable	No data
France	Autorité de Contrôle Prudentiel et de Résolution–Banque de France	Reference scenario	Transition starts as early as 2020; limit rise of temperatures below 2°C	Orderly scenario (NGFS 2019)	Average annual growth rate of the real GDP stabilizes in 2050 at ~1%
		Variant 1: late reaction scenario	More stringent measures will be implemented in 2030	Disorderly scenario (NGFS 2019)	Volume of GDP in 2050 is down 2.1% compared with the reference scenario
		Variant 2: scenario of a swift and abrupt transition	Renewable energy technologies are not as mature as expected in the reference scenario, resulting in higher energy prices	Alternative Disorderly scenario (NGFS 2019)	Volume of GDP in 2050 is down 5.5% compared with the reference scenario
		Physical risk scenario	A society with medium population growth and income, high emissions, technological progress, production, and consumption patterns is a continuation of past trends	SSP2 & RCP8.5 scenario (IPCC 2019)	No data
Hong Kong (China)	Hong Kong Monetary Authority	Physical scenario	High-emissions pathway	RCP8.5 scenario (IPCC 2019)	No data
		Orderly Transition scenario	Early and progressive actions to achieve the climate goals of the Paris Agreement	Orderly scenario (NGFS 2019)	CO ₂ emission will be around 5 billion tonnes per year in 2050; CO ₂ price will reach around \$300 per tonne

Table 1: Climate Scenario Analysis and Stress-Testing Exercises (Continued)

Jurisdiction	Organization	Scenarios	Description	Corresponding scenarios	Example macro outcome
		Disorderly Transition scenario	Climate policies will not be implemented until 2030	Disorderly scenario (NGFS 2019)	CO ₂ emission will be zero in 2050; CO ₂ price will reach around \$750 per tonne
Netherlands	De Nederlandsche Bank	Technology shock scenario	The share of renewable energy in the energy mix doubles due to a technological breakthrough	Not applicable	A 2.0% increase in GDP level compared with the baseline model in the fifth year after the shock
		Double-shock scenario	The carbon price rises globally by \$100 per ton due to additional policy measures; the share of renewable energy in the energy mix doubles due to a technological breakthrough	Not applicable	A 0.9% increase in GDP level compared with the baseline model in the fifth year after the shock
		Confidence shock scenario	Corporations and households postpone investments and consumption due to uncertainty about policy measures and technology	Not applicable	A 0.6% reduction in GDP level compared with the baseline model in the fifth year after the shock
		Policy shock scenario	The carbon price rises globally by \$100 per ton due to additional policy measures	Not applicable	A 0.5% reduction in GDP level compared with the baseline model in the fifth year after the shock
United Kingdom	Bank of England	Early Action	Transition to a net-zero economy starts in 2021; by 2050, carbon emissions are reduced to net zero. Global warming is limited to 1.8°C	Orderly Transition: Net Zero 2050 scenario (NGFS 2020)	By 2050, UK GDP is around 1.4% below a counterfactual path in which there are no additional headwinds from climate risks
		Late Action	New policies will not be implemented until 2031 and are then more sudden and disorderly; by 2050, global warming is limited to 1.8°C	Disorderly Transition: Delayed Transition scenario (NGFS 2020)	By 2050, UK GDP is around 4.6% below a counterfactual path

Table 1: Climate Scenario Analysis and Stress-Testing Exercises (Continued)

Jurisdiction	Organization	Scenarios	Description	Corresponding scenarios	Example macro outcome
		No additional action	No new climate policies introduced beyond those already implemented; by 2050, global temperature levels reach 3.3°C	Hot House World: Current Policies scenario (NGFS 2020)	By 2050, UK GDP is around 7.8% below a counterfactual path
United States	Federal Reserve	Current Policies	No new climate policies introduced beyond those already implemented; by 2100, global temperature levels reach 3°C	Hot House World: Current Policies scenario (NGFS 2020)	By 2030, US GDP is around \$24,030 billion (in 2012 prices); carbon price reaches \$17 per tonne (in 2010 prices)
		Net Zero 2050	Transition to a net-zero economy starts in 2023; by 2050, carbon emissions are reduced to net zero. Global warming is limited to 1.5°C	Orderly Transition: Net Zero 2050 scenario (NGFS 2020)	By 2030, US GDP is around \$23,574 billion (in 2012 prices); carbon price reaches \$162 per tonne (in 2010 prices)
		Physical risk scenario (common shock)	A severe hurricane resulting in both storm surge- and precipitation-induced flooding in the US Northeast	SSP2-4.5 & RCP4.5 scenario and SSP5-8.5 & RCP8.5 scenario (IPCC 2019)	No data
		Physical risk scenario (idiosyncratic shock)	Participants should select a hazard event and geographic regions based on materiality to their business models and exposures	SSP2-4.5 & RCP4.5 scenario and SSP5-8.5 & RCP8.5 scenario (IPCC 2019)	No data

Abbreviations: NDCs, Nationally Determined Contributions; RCP, Representative Concentration Pathway; SSP, Shared Socioeconomic Pathway.

Source: Acharya et al., 2024 and Acharya, 2023.

Figure 1: Overview of NGFS Narratives

Scenario	Narrative
Highway to Paris	Elevated levels of uncertainty related to fossil energy supply lead governments to implement an ambitious mitigation pathway in a timely and anticipated fashion. There is a boom in green public investment leading to a rapid reallocation of capital and across sectors as well as internationally via cross-country capital flows and lending patterns. Technology shocks lead to a faster-than-anticipated transition, inducing disorderliness. Green prudential policies prevent financial turmoil albeit with losses in some sectors due to stranded assets. <u>In line</u> with reaching net zero by 2050.
Green bubble	Elevated levels of uncertainty related to fossil energy supply limits governments in their ability to implement ambitious mitigation policy. Green regulation overtakes government policies in driving the transition, leading to a glut of green private investment and the build-up of a green credit bubble. A sunspot (i.e., an unrelated random event) leads to the burst of the bubble, a sharp rise in risk premia and a confidence crisis. <u>In line</u> with reaching net zero by 2050.
Sudden wake-up call	Elevated levels of uncertainty related to fossil energy supply limits governments in their ability to implement ambitious mitigation policy. Driven by an event that triggers a sudden change in public opinion (e.g. a severe natural disaster), an unanticipated and accelerated transition occurs.¹ The abrupt policy change sets off shock waves through the economy and financial system: stranded assets in polluting sectors cause severe financial stress which propagates internationally via capital, trade and financial flows. <u>In line</u> with reaching net zero by 2050.
Low Policy Ambition and Disasters	Severe acute physical disasters hit exposed jurisdictions. Investors price in a sizeable risk premium, which freezes private investment, and reduce their exposure to the jurisdictions and sectors whose assets are at greatest risk of disaster losses. Households consume less and save more due to the increase in uncertainty and insurance costs increase. NOT in line with reaching net zero by 2050.
Diverging realities	The world as a whole aims to avoid the worst impacts of global warming. However, severe natural disasters in the EMDEs and LICs and a lack of external financing lead to recovery traps, i.e., a lack of fiscal space for affected regions to transition. Meanwhile, the disruption of transition-critical mineral supply chains originating in disaster-prone regions hampers the speed of the global transition.² The sudden realization that the global transition is too slow to avoid a Hot House World leads to a sudden re-assessment of future physical impacts globally. As a result, risk premia rise sharply. NOT in line with reaching net zero by 2050.

Source: NGFS Technical Document “Conceptual Note on Short-term Climate Scenarios”, October 2023.

3.0 REGIONAL STOCKTAKING OF CLIMATE RISK ANALYSES

Caribbean economies and central banks have been increasingly focused on integrating climate risks into their financial system assessment frameworks. Several countries and central banks have launched initiatives aimed at developing climate-related stress tests, often in collaboration with international organisations. These initiatives include peer-to-peer collaborations, policy formulation, and development of frameworks aimed at improving resilience and sustainability in the face of climate-related risks.

A number of Caribbean central banks are in the early stages of developing climate-related stress testing frameworks. These frameworks are focused on understanding both physical and transition risks as follows:

1. Physical Risk: Stress testing for natural disasters such as hurricanes, floods, and rising sea levels, which have a direct impact on infrastructure and financial stability.
2. Transition Risk: Evaluating risks associated with the shift to a low-carbon economy, including policy changes and market dynamics affecting industries reliant on fossil fuels.

To achieve their objectives, Caribbean central banks are working with international bodies and regional networks, such as the NGFS and the Caribbean Group of Banking Supervisors (CGBS) to develop comprehensive and standardised approaches to climate stress testing.

This section provides details of the ongoing work in six regional central banks. The institutions have been grouped into two categories: 'Initiation & Planning' and 'Execution'. The central banks falling under the former category include Aruba, Curaçao and Sint Maarten, and Trinidad and Tobago. These three countries are in the early phases of developing frameworks for climate-related stress testing. Those in the execution phase are more advanced and, in some cases, have conducted preliminary climate stress tests. The three institutions in the 'execution phase' are the Central Bank of Barbados, the Eastern Caribbean Central Bank and the Bank of Jamaica. [Table 2](#) summarises their risk assessment approaches.

3.1 INITIATION AND PLANNING

Aruba

Aruba, through the Central Bank of Aruba (CBA), is starting to address the financial risks posed by climate change. IMF (July 2023) recommended that Aruba improve its risk assessments and build capacities for climate stress testing to better understand potential economic shocks caused by climate risks. Although Aruba has not yet fully implemented formal climate-related financial stress testing, steps are being taken to build a framework for financial stability in the face of climate change.

Sustainability and ecosystem resilience have been included as a strategic pillar in the CBA 2021-2025 plan. This strategic plan includes focus areas relating to sustainable practices, ethical investment, social responsibility, and dynamic resilience. While the CBA does not yet have an explicit structure or arrangement for climate work, climate change and climate risks have become part of its research agenda. The Research department of the CBA has produced and is currently working on papers covering the macroeconomic impacts of climate change, recommendations for inclusive energy transition, and energy security relating to the transition. This research has been mainly based on literature reviews and interrogation of available energy data from utility companies and the balance of payments. Assessments have been ongoing on how climate risks could impact the financial system, focusing on vulnerabilities such as rising sea levels, storms, and other environmental challenges typical of small island nations. The CBA is also researching and building knowledge and foresight on climate change risks indicators for measuring climate change resilience in the context of monetary and prudential policies. Climate risk frameworks are also being investigated.

The Aruban government is in the process of installing a national committee on climate adaptation, which will include stakeholders from the public and private sectors. In connection with this, the government has developed a general roadmap for climate adaptation, (Sustainable Development Goals, United Nations 2017). This includes the identification of climate and ocean risk vulnerabilities through the development of a CORVI index³. Once the priority items have been determined, the intention is to engage the IMF to determine the required investment per indicator. The next step will be to secure financing. Subsequently, Aruba will enter the phase of implementation and continuous monitoring and evaluation. The development of the CORVI index is scheduled for 2024.

Curaçao and Sint Maarten

Curaçao and Sint Maarten, guided by the Central Bank of Curaçao and Sint Maarten (CBCS), have been addressing financial risks related to climate change. The CBCS is focused on ensuring that the financial sector of Curaçao and Sint Maarten is aware, prepared, and resilient for the impending risks brought on by climate change. Recognising their vulnerability to climate change, especially due to rising sea levels, increased hurricanes, and other severe weather events, the CBCS has integrated climate risk into its strategic agenda for 2025.

The CBCS' strategic agenda 2025, launched in 2022, aims to address climate risk by focusing on three pillars:

³ CORVICorvi is a baseline evaluation that produces over a 100 indicators with each indicator mapped on a climate and ocean risk index. The index identifies the action list and priority items.

1. Expand cooperation and dialogue with local and international institutions.
2. Broaden and update CBCS data and information by researching climate risks and surveying the financial sector.
3. Develop a Roadmap towards a supervisory framework for climate change.

The CBCS has taken a risk management approach to climate change. Its strategic actions aim to ensure that the financial system in Curaçao and Sint Maarten is resilient to climate risk (Central Bank of Curaçao and Sint Maarten 2023).

Pillar 1: Collaboration with local and international institutions. As part of the IMF Article IV consultations, the CBCS requested the IMF conduct an initial study on the impact of climate change in Curaçao and Sint Maarten. The study focused on estimating the impact of climate change on GDP and consumption, emphasizing the need for a long-term national adaptation strategy (Doornbosch 2024). The IMF used a dynamic general equilibrium model specifically developed for this purpose. The study highlighted the risks of rising sea levels, which could potentially lead to GDP losses of up to 14 per cent by 2050 due to real estate damage and other economic impacts (International Monetary Fund, September 2024).

The CBCS is coordinating the CGBS technical working group on climate risk with other jurisdictions including Belize, Barbados, Trinidad and Tobago, Suriname, Jamaica, and Guyana. Additionally, the CBCS joined the NGFS in 2024. The Netherlands, Aruba, Curaçao, Sint Maarten, Bonaire, Saba, and Sint Eustatius have jointly developed a climate agenda to address climate change. This agenda aims to enhance cooperation, financing, and knowledge sharing on climate change and sustainability within the Kingdom. The climate agenda includes agreements on climate mitigation, adaptation, and financing.

Pillar 2: Researching climate risks and surveying the financial sector. The CBCS developed a climate risk supervisory framework, which includes guidelines for risk management and disclosure by financial institutions, with an emphasis on stress testing to assess vulnerabilities to both physical and transition risks. In 2024 the CBCS conducted a survey to obtain a baseline for the climate risk research project. This survey targeted banks, pension funds, and insurance companies and aimed to improve the CBCS' understanding of the exposure of financial institutions to physical climate risks. Institutions were surveyed on their climate risk management strategies, insights and gaps. The survey participants were asked to provide actual data or estimates of their exposures to climate risks for loans and insured objects and what role the institutions saw for the CBCS in climate risk.

The CBCS is currently addressing significant data gaps related to climate risks by conducting surveys of banks, insurance companies and pension funds. These surveys are designed to assess exposure to climate risks, including real estate and in loan portfolios. The collection of data and research into the impact on financial stability in the monetary union represents the initial phase in the CBCS' forthcoming roadmap towards a supervisory framework. As guidelines and requirements to advance an enhanced climate risk dataset and analyses are developed, the goal is to ensure that financial institutions have the capability to identify, measure, monitor, and control climate risks.

Pillar 3: The Roadmap. The CBCS is working on a home-grown roadmap for a supervisory framework for climate risk. The Climate Working Group, charged with executing the roadmap, will in the coming years initially focus on information and data. This will help the CBCS find the right mix to address climate risk and promote green financing. The roadmap will cover the following areas:

1. Research and identify climate risks and exposure of the financial sector to climate risk.
2. Identify how climate risks affect financial stability.
3. Research possible macroeconomic implications of climate risks.
4. Map carbon biases in investment portfolios.
5. Investigate how to adapt monetary policy to accommodate transition and physical risks.
6. Issue communiques, guidelines, and recommendations on integrating climate risks in financial institutions' governance, on climate risk disclosure.
7. Participate in development of climate scenario analysis and stress testing.
8. In the medium-term, work on a supervisory framework for climate risk.

Ultimately, the supervisory framework will include tools to ensure that the financial sector has a good understanding of the climate-related risks they face, guidance on climate risk disclosure and integrating climate risks into risk management frameworks.

Trinidad and Tobago

The Central Bank of Trinidad and Tobago (CBTT) has included a number of climate-related objectives in its strategic plan and is engaging with many international agencies to further its understanding and treatment of climate-related issues. One of the key projects under CBTT's 2021/22 – 2025/26 strategic plan is to Integrate environmental issues and climate change into policy considerations. The project's main components include:

1. Play an active role in The Network for Greening the Financial System.

2. Collaborate with local financial institutions and other agencies in assessing environment/climate change developments and relevant financial measures.
3. Calculate the Central Bank's carbon footprint and determine appropriate changes.

Trinidad Tobago joined the NGFS in February 2021 and participates in the Scenario Design & Analysis and Micro-prudential Supervision work-streams. CBTT's Deputy Governor (Monetary Operations and Policy) and the Manager of Research are CBTT's NGFS plenary representatives. CBTT's Governor and Inspector of Financial Institutions are members of the Financial Stability Board Regional Consultative Group Americas. In this role they contributed to the development on a FSB Roadmap to address financial risks from climate change.

Following technical assistance from CARTAC in January 2019, the CBTT continued to execute its Basel II/III Implementation Plan with the introduction of Pillar 2 under Basel II – the Internal Capital Adequacy Assessment Process (ICAAP) – on November 16, 2020. ICAAP calls for banking institutions to take into account climate considerations in assessing their capital requirements. ICAAP reporting commenced January 31, 2022 following CARTAC TA in October 2021 to prepare for the supervisory review of submissions. To date, one banking institution has indicated that physical climate risks have not had a material impact on its risk-based capital position.

CBTT developed a Climate Change and Risk Policy which was approved by the Governor and Senior Management in July 2022. Since then they have measured its carbon footprint, consistent with the Greenhouse Gas (GHG) Protocol methodology, for 2019 (base year) and 2022. The Bank's internal Audit department is currently reviewing the measurement methodology used for calculating the carbon footprint, with a view to formalising the measurement process for regular updates and reporting.

Climate-related matters have been, and continue to be, an integral part of CBTT's research agenda. As early as 2017, a working paper and policy notes were completed, exploring the impact and role of environmental shocks on the domestic financial sector as well as fiscal and monetary policy considerations. The most recent research (2024) focuses on integrating climate variables in inflation forecasting and outlining considerations for the insurance industry from acute physical risks. A project to develop a climate risk assessment framework has commenced, with the drafting of a climate risk survey for financial institutions. Based on the project plan, the CBTT expects to operationalise climate stress tests in 2026.

3.2 EXECUTION PHASE

Barbados

Barbados has made major strides in assessing climate-related risk in its financial sector and across the broader economy. Both the Financial Services Commission (FSC) and the Central Bank of Barbados (CBB) have incorporated climate risk into financial sector performance assessment and monitoring. The FSC performs top-down stress testing at the regulatory level. It forms part of the macro-prudential toolkit and is key in assessing financial vulnerabilities which may trigger systemic events. As it relates to the bottom-up stress testing, it is included as part of financial risk management for insurers and allows both the institutions and the supervisors to identify risks and vulnerabilities. However, from the regulatory perspective, scenario analysis is not technically feasible given the data and capacity constraints.

The FSC developed a Natural Disaster Stress Testing Guideline in 2021 with the assistance of the World Bank. This applies to insurers registered to conduct business in Barbados, writing third party business to the Barbadian public. Its purpose is to assess the resilience to climate-related shocks and identify factors that can potentially affect financial stability. The design consists of three broad scenarios (a baseline and two stress scenarios) that are dynamic in nature and produces projection for up to two years. Under the baseline, insurers are required to provide the current financial information as well as projections for future years under normal circumstances. Under the stressed scenarios, insurers are required to provide the impact on the current year and the expected/projected financial outturn post-shock.

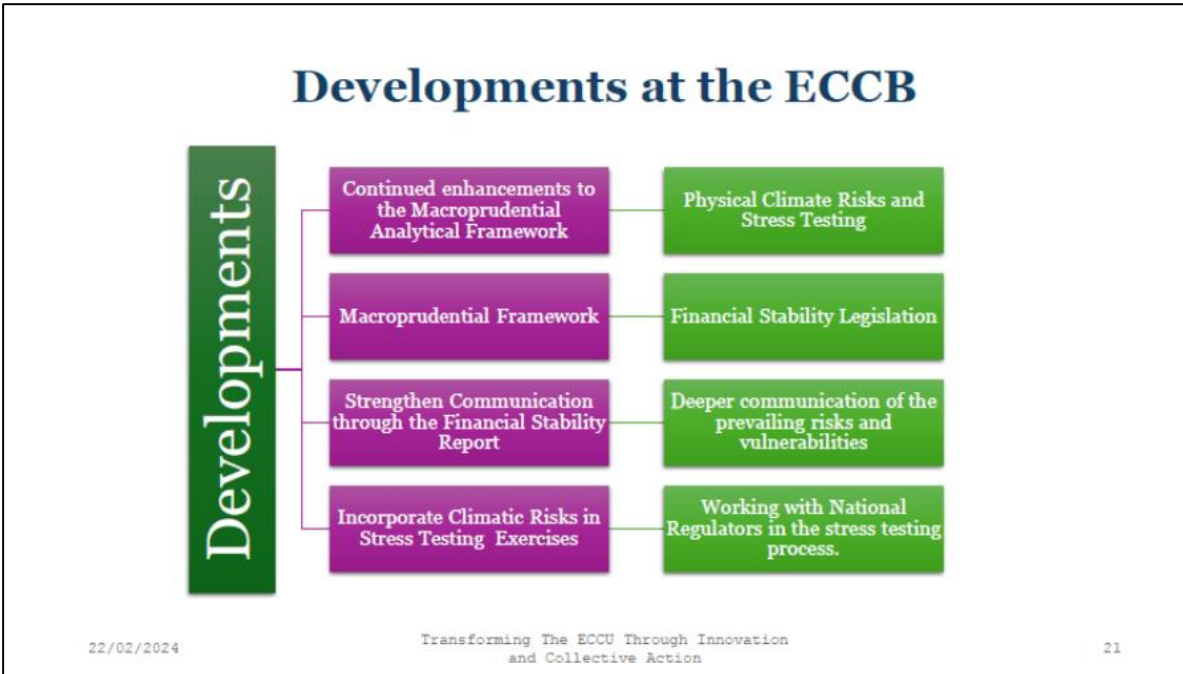
Meanwhile, the CBB utilised its Macroeconomic Forecasting Model (CBB-MFM), to assess the impact of six climate scenarios on the Barbadian economy based on a drop in tourism sector activity. The model consists of four main components: The Real Sector, which also accounts for the impact of inflation on aggregate demand; the Fiscal Sector; the Balance of Payments (BoP); and the Financial Sector. For the analysis, the CBB relied on estimated damage data provided by the Coastal Zone Management Unit⁴. By tracing the effect of moderate and severe shock scenarios on tourism and GDP, the results highlighted potential contractions in economic activity and the country's fiscal and external balance positions.

⁴ Barbados' Coastal Zone Management Unit, through its Coastal Risk Assessment and Management Programme (CRMP), provided comprehensive risk evaluation using baseline studies and information. The CRMP developed Climate Change Assessment, Hazard Modelling, Risk Assessment and National Coastal Risk Information. [Coastal Risk Assessment and Management Programme – Coastal Zone Management Unit](#)

The Eastern Caribbean Currency Union

The Eastern Caribbean Central Bank (ECCB) has been actively involved in climate-related financial stress testing initiatives, particularly to address the region’s vulnerability to climate change (Figure 2). The ECCB’s climate risk analysis requires detailed data, including information on credit extended to households and businesses, geographic data (locations/addresses), non-performing loans (by maturity buckets), and loan locations. The ECCB’s work on climate-related financial stress testing has been primarily focused on commercial banks due to limitations in obtaining granular data for insurance companies and credit unions. Table 2 has details on the stress testing conducted for commercial banks.

Figure 2: The ECCB’s Financial Stability Developments, 2024



Source: Financial Stability Analysis, ECCU Perspective. Presentation done by Shernelle Thompson at the Financial Stability Analysis, 18 – 20, September 2024.

Several stress testing exercises were conducted by the ECCB to assess the vulnerability of the region’s financial system to climate and other macroeconomic shocks (International Monetary Fund April 2024). The general framework of the ECCB’s stress testing includes a focus on:

1. Natural Disaster Scenarios: ECCB stress tests simulate the effects of extreme weather events such as hurricanes. These tests model the potential impacts of such disasters on the banking system, including increases in non-performing loans (NPLs), reduced liquidity, and damage to

infrastructure. The goal is to assess how banks and other financial institutions can withstand shocks from such physical climate risks (United Nations Environment Programme Finance Initiative 2021).

2. **Banking Sector Stability:** Stress tests conducted by the ECCB evaluate how key banking sector indicators, such as capital adequacy ratios, would hold up under various adverse climate scenarios. This includes assessing whether the banks have sufficient capital buffers to absorb losses caused by both direct and indirect effects of climate change.
3. **Transition Risk Scenarios:** In line with global trends towards a lower-carbon economy, ECCB stress tests also examine transition risks. These include scenarios where policy changes, such as carbon taxes or shifts in global energy markets, affect sectors dependent on fossil fuels. The tests assess how banks could be impacted by changes in the value of assets or shifts in market demands, helping them prepare for longer-term economic adjustments.

As part of a broader regional strategy, ECCB has participated in various initiatives to integrate climate-related risks into financial regulations and supervision. One key effort is the collaboration with the United Nations Environment Programme (UNEP) and Agence Française de Développement (AFD) under the Adapt'Action Facility (Agence Française de Développement Group 2022). This partnership has led to a series of training workshops aimed at building capacity within the financial sector across the Eastern Caribbean to manage climate-related risks. The workshops focus on integrating climate risk into financial systems by developing climate risk indicators, building prudential standards, and enhancing reporting and disclosure processes.

The ECCB is a member of the Sustainable Banking and Finance Network (SBFN) and works with global networks such as the NGFS. These partnerships enable the ECCB to stay informed on best practices and collaborate with other central banks on climate-related financial stress testing. The ECCB's involvement in these networks help in establishing frameworks for climate finance and climate risk management, with a focus on encouraging banks and other financial institutions to adopt sustainable finance practices.

The ECCB has developed a macroprudential framework and a micro-prudential perspective as part of the ECCU's Optimal Regulatory Framework. The development of a macroprudential framework is a key part of the ECCU's Optimal Regulatory Framework. The ECCB Agreement implicitly mandates financial stability in the ECCU, and current efforts are underway to make this mandate explicit through the implementation of financial stability legislation. Designing and implementing macroprudential tools is a critical component of this framework.

From a micro-prudential perspective, the following developments have taken place:

1. Licensed Financial Institutions (LFIs) are in the process of implementing a climate risk supervisory framework. A climate risk survey has been conducted, and efforts are ongoing to collect data on LFIs' exposure to climate-related risks. Within a two-year period, a risk-based supervision policy for climate risk will be developed and implemented. The ECCB has issued a new Prudential Standard⁵, effective March 1, 2024, which mandates specific climate-related and environmental risk considerations and disclosures for all LFIs within the Eastern Caribbean. This standard aims to ensure that LFIs are better prepared to address risks related to climate change and aligns regional reporting with the Basel Committee on Banking Supervision principles for effective management and supervision of climate-related financial risks.
2. National Regulators are collaborating with UNEP-FI, AFD, CARTAC, and the OECS Commission to build capacity among regulators and financial institutions in the ECCU. The goal is to emphasize the importance and impacts of potential climate-related financial risks, educate on monitoring and supervising those risks, and integrating these issues into strategic plans.

Jamaica

The Bank of Jamaica (BOJ) is implementing a phased approach to assess climate-related financial risks through climate stress testing. These initiatives are designed to strengthen the resilience of the country's financial sector against climate change. There have been significant engagement and support from international institutions such as the Agence Française de Développement (AFD) and European Union Latin America and Caribbean Investment Facility (LACIF) to bolster Jamaica's efforts to address the impact of climate change on vulnerable communities.

Jamaica is the first country to complete the development of the Systemic Risk Assessment Tool⁶, the Jamaica Systemic Risk Assessment Tool (J-SRAT), which was designed by Oxford University in collaboration with the Jamaican Government and support from the Coalition for Climate Resilient Investment (CCRI), as well as the United Kingdom's (UK's) Foreign Commonwealth and Development Office. J-SRAT has been

⁵ <https://cdn.eccb-centralbank.org/documents/2024-07-30-11-23-57-Prudential-Standard-on-Climate-related-and-Environmental-Risks.pdf>

⁶ The Systemic Risk Assessment Tool (SRAT) refers to ground-breaking technology that was developed to assist countries that are most vulnerable to extreme weather events associated with climate change, to build their resilience. The SRAT was launched in Jamaica on May 3, 2022 by the global Coalition for Climate Resilient Investment (CCRI).

developed to help identify ‘hotspots’ across the country’s major infrastructure networks including, energy, water and transport, that are most vulnerable to climate risk (Ministry of Economic Growth & Job Creation, Government of Jamaica, 2022). The BOJ plans to use the J-SRAT in its climate change risk assessments to highlight areas exposed to climate risks.

BOJ has adopted a structured, two-phase approach to assessing climate-related financial risks, addressing both physical and transition risks through enhanced supervisory practices, data management, and stress testing. This initiative is driven by the increasing recognition of the significant impact that climate change can have on financial stability

Phase 1: Laying the Groundwork

Phase 1 of the project, executed with technical assistance from the Agence Française de Développement (AFD), focused on establishing the foundation for integrating climate risk into financial supervision. This phase produced several key outputs. First, a preliminary report on climate risks⁷ in December 2023, diagnosing existing procedures, mapping relevant climate risks, and providing initial guidance for embedding these risks within supervisory activities and the results of a survey instrument. This phase also included policy and regulatory analyses for implementing a climate stress-testing regime and developing a data management framework⁸ to support the necessary data collection. Additionally, an awareness campaign and training sessions were launched to build capacity and enhance the understanding of climate risks among regulators and financial institutions, ensuring the financial sector's preparedness for future climate-related challenges.

Survey instrument

A central component of Phase 1 was the development of a survey instrument to assess the preparedness of financial institutions to manage climate-related risks. The survey evaluated how institutions integrated climate risk considerations into their operations, identifying areas of strength and gaps in practices. Larger institutions generally displayed more advanced integration of climate risk management, while smaller entities required additional support to build capacity. These findings helped shape the strategic direction for the project, underscoring the need for consistent and sector-wide risk management practices.

⁷ [Climate Related Financial Risks in Jamaica \(BOJ, 2023\)](#)

⁸ [Climate Stress testing data Management Framework \(BOJ, 2024\)](#)

Data Management Framework

Another major output was the data management report, which included a comprehensive data gap analysis. The report highlighted significant deficiencies in existing climate data, which hindered accurate risk assessments. In response, the BOJ developed a data management framework designed to standardize data collection across institutions, ensuring greater consistency and accuracy. The framework emphasized collaboration with academic bodies and governmental agencies to improve data quality. Additionally, it integrated the Jamaica Systemic Risk Assessment Tool (J-SRAT) to enhance localized assessments by identifying infrastructure vulnerabilities in sectors like energy, water, and transport. The framework also established protocols for regular data updates, facilitating ongoing, dynamic risk evaluations.

Phase 2: Advancing Stress Testing and Disclosures

Building on the foundation established in Phase 1, Phase 2, supported by AFD and the European Union Latin America and Caribbean Investment Facility (LACIF), focuses on refining the BOJ's climate risk stress testing models, improving data integration, and enhancing disclosure practices.

Stress testing Models

The BOJ aims to advance the development of stress testing models by incorporating localized scenarios that address Jamaica's unique climate challenges, including hurricanes, rising sea levels, and shifts in international policy. These models will integrate both physical and transition risk data, allowing the BOJ to better quantify potential financial impacts and prepare institutions for various future climate-related scenarios. This refined approach strengthens the sector's ability to withstand a range of climate risks, ensuring a more resilient financial system. To do this, the BOJ plans to refine data collection mechanisms, ensuring that financial institutions provide consistent, high-quality data on climate risks. The data management framework from Phase 1 will be expanded to include additional sources, and the introduction of a climate risk dashboard will allow for clear visualization of stress test results. This dashboard will present data in a way that facilitates analysis and comparison across institutions, supporting informed decision-making by stakeholders.

Disclosures and Green Finance

Another critical element of Phase 2 is the BOJ's commitment to producing its own Task Force on Climate-related Financial Disclosures (TCFD) report. This report will outline the BOJ's governance, strategy, and risk management practices concerning climate risks, setting a benchmark for other financial institutions in

Jamaica. By leading with transparency, the BOJ aims to encourage broader adoption of standardized disclosure practices across the sector, promoting a culture of proactive risk management. Additionally, the integration of green finance principles into the supervisory framework will support sustainable financial practices, aligning Jamaica's financial sector with global best practices.

Capacity Building

BOJ will focus on enhancing capacity building and awareness within the financial sector to better manage climate-related risks in Phase 2. This includes a comprehensive program of training workshops for BOJ staff, the Financial Services Commission (FSC), and other financial institutions, aimed at improving understanding of climate risk assessment and management practices. Additionally, the BOJ plans to develop e-learning modules covering key topics such as stress testing, ESG considerations, and TCFD reporting standards. Public awareness campaigns will be launched to educate stakeholders on climate risk impacts, emphasizing the importance of integrating these considerations into financial planning.

The Bank of Jamaica's climate risk assessment and stress testing initiatives over 2023 and 2024 represent a proactive effort to integrate climate risks into the financial sector's supervisory practices. By enhancing data management, refining stress testing models, and fostering industry-wide awareness, BOJ aims to strengthen financial stability and ensure that the sector is well-prepared to navigate future climate challenges.

Table 2: Summary Table of Regional Approaches to Climate Risk Analysis

Country	Risks Assessed	Coverage	Modelling Approach	Data Utilised	Results
Barbados (Financial Services Commission)	Physical Risk	Insurance Companies	Bottom-Up Stress Testing Approach described as Natural Disaster Stress Testing Guidelines developed through external assistance of the World Bank in 2021 Consists of 3 broad scenarios under the themes of: General Parameters - Increase in Gross claims - General strengthening of technical provisions - Default by related by related parties - Increase in expenses - Impacts of economic downturn Institution-Specific Test - Insurer undertakes relevant natural disaster stress tests - Tests should consider simultaneous moves in risk factors Specific Event Test Tests should consider simultaneous moves in risk factors	Data collected using two reporting templates (see Appendix II): - Balance Sheet - Income Statement Stress Testing Reporting Requirements Insurers were expected to report - Baseline position and post-shock results on balance sheet and income statement items - Methodology, assumptions and variables employed - Description of exposures outside of Barbados - Perceived impacts on reinsurance arrangements - Actuarial notes regarding insurance liabilities - Areas of regulatory breach Additional supporting documents	Scenario 1: General Parameters - Insurers showed resiliency in post-shock results - No significant impacts to solvency Scenario 2: Institution Specific Tests - Different scenarios – Hurricanes, Storms, Earthquakes etc. - Mixed results in solvency position - Significant deteriorations in the year of shock, with improvement in the post-shock years for some institutions - Other insurers showed prolonged deteriorations in post shock years Scenario 3: Event Specific (Category 5 Hurricane) - Most significant impact to solvency Insurers reporting – were rendered insolvent or nearly insolvent

Country	Risks Assessed	Coverage	Modelling Approach	Data Utilised	Results
Barbados (Central Bank of Barbados)	Physical Risk	Physical Climate Risk: Scenario Analysis	Broad Macro-economy with specific emphasis on the tourism sector:	The Central Bank of Barbados' Macroeconomic Forecasting Model (CBB-MFM) used to assess six (6) climate scenarios Moderate: 1. Wind – 50 year (W50) 2. Wind – 100 year (W100) 3. Rainfall Flooding – 50 year (RF50) 4. Rainfall flooding – 100 year (RF100) Severe: 5. Storm Surge – 50 year (SS50) 6. Storm Surge – 100 year (SS100) Model consisted of 4 main components: • Real Sector (inflation and aggregate demand) • Fiscal Sector • Balance of Payments (BoP) • Financial Sector	Assessed in all six scenarios were: • Total Capital Stock in 2019 (USD Millions) • Estimated Damage (USD Millions) • New Capital Stock (USD Millions) • Scenario Damage Macro-Economic Variables • Long-stay tourist arrivals • Tourism contribution to GDP • Total Revenue • Total Expenditure • Primary Balance % GDP (US\$M) • Debt-to-GDP ratios • International reserves • Current Account Balance • Credit Growth to Non-financial Private Sector Coastal Zone Management Unit provided estimated Damage data.

Country	Risks Assessed	Coverage	Modelling Approach	Data Utilised	Results
Eastern Caribbean Central Bank	Physical Risk	Individual Commercial Banks	A dynamic panel model is estimated across a sample of individual banks in the ECCU during the period 1996 to 2015. (Brei, Mohan and Stroble 2019)	The Hurricane Destruction Index covers wind speed data of 119 km/h up to 278 km/h ,(Eric Strobl, 2024). Index uses a 10km cell for each country and wind speed is measured at the center of those cells. Non-Performing Loans (NPLs) ratios of commercial banks	The model found there is a positive and significant relationship between physical risk shocks and the NPLs ratio in the second quarter following landfall. NPLs ratios increase when storms are between Category 3 and Category 5. Storms with lower wind speeds, that is a lower on the destruction index have a positive but insignificant effect.
	Physical Risk	ECCU's Banking System	Difference-in-Difference (DiD) econometric specification to estimate the impact of the event on the ECCUs Banking system. World Bank Consultancy,2023/2024. The study produced estimates of the marginal effects on each economic sector and the average CAR of the ECCU following the hurricane.	Event Study, Historical Analysis and Stress Test of ECCU Bank portfolios. Credit Portfolio Exposures to Climate Risks .	Limited impact on the portfolio of commercial banks affected by Hurricanes Irma and Maria. For the countries affected by the hurricanes banks' stock of credit and stock of NPLs post-hurricane do not significantly differ from countries that are not affected by hurricanes. The event study of the stock of credit and NPLs show a small increase in the quarter in which the island is affected and thereafter.
	Physical Risk	Commercial Banks	Stress testing Commercial Banks in the ECCU: Sensitivity Analysis: Credit Risk Models and Response to changes in NPLs Stress-testing: Static Models, Dynamic Models and IMF Frameworks		

Country	Risks Assessed	Coverage	Modelling Approach	Data Utilised	Results
Jamaica	Physical and transition risks	Financial Sector actors within Jamaica Categorised by institution type: 1. Deposit-taking institutions 2. Securities Dealers 3. Insurers 4. Pension Plan	Climate Risk Awareness Survey Sectors Covered in Analysis: • Agriculture • Tourism • Real Estate • Mining and manufacturing • Distribution • Energy and Transportation	Survey covered climate-related financial risk awareness and activities of Jamaican financial actors Survey covered climate-related risk awareness in the areas of: • Knowledge and management of both physical Risk and transition risks • Institution-specific experience in assessing climate-related risks • Degree of familiarity by institution type, with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations. • Experience with climate risk management and scenario analysis • Progress in establishing sustainability goals. • Progress against the TCFD disclosures	• Financial institutions in Jamaica appeared to have more knowledge of physical risks than transition risks. • Level of knowledge varied significantly across firms, with the larger institutions typically having more knowledge of different CRFRs and more mature processes around their management. • Many of the institutions are already assessing climate risks or plan to do so in the next year. • Few firms showed high awareness of the recommendations of the TCFD. • Those that had better awareness were typically from organisations with international exposure where the framework has been mandated. • About half of the firms have not established sustainability goals. For those that have, their goals are typically connected to their own operations rather than to their wider financial footprint.

4.0 CONCLUSION and RECOMMENDATIONS

Caribbean central banks are moving in the right direction with regards to building capacity to conduct climate risk assessments attuned to the idiosyncrasies of their respective economies and financial sectors. Collaboration with international financial and development institutions has generally been the preferred approach. While central banks in advanced economies have a two to three-year head start on the Commonwealth Caribbean with regards to climate risk analysis, the majority of the frameworks are calibrated to assess the impact of transition risk on financial institutions. However, over the past year, entities such as the NGFS have been placing greater attention on shorter-term impact horizons synonymous with the physical risk component of climate change. Given the Caribbean region's acute vulnerability and exposure to natural disasters, the focus of climate risk analysis frameworks has understandably veered towards the assessment of physical risk.

While developments have generally been positive, not all central banks are moving at the same pace. The paper outlined two groups of countries. The first group (Aruba, Curaçao and Sint Maarten and Trinidad and Tobago) are in the Initiation and Planning phase – putting in place the strategic oversight architecture for climate issues to guide the operations of their respective central banks in this sphere. The second group (Barbados, the Eastern Caribbean Currency Union and Jamaica) are considerably more advanced and are in the Execution phase. In Barbados, the FSC conducted a bottom-up stress test of insurance companies, while the CBB constructed six climate scenarios to determine the macroeconomic effects of damage to the tourism sector. The ECCB has adopted a more econometric approach. Focusing on individual commercial banks and the banking system as a whole, the approaches include dynamic panel modelling, a difference-in-difference econometric specification, sensitivity analysis (credit risk models) and stress-testing (static models, dynamic models and IMF frameworks). Meanwhile, the BOJ is entering phase 2 of its climate project. Phase 2 focuses on climate risk stress testing and integrating green finance principles into the supervisory apparatus.

It appears that the speed of developments has been influenced by the level of external engagement, particularly the receipt of financial support from entities such as the EU and AFD. Also, climate action anchored in an overarching government policy provides impetus for a central bank to advance the green agenda given the ongoing debate on the legal mandate of central banks to tackle climate change. Movements such as the 'Bridgetown Initiative' which tackles topics such as liquidity support, debt sustainability, private capital and development lending are closer to the comfort zone of central banks, making the case for intervention sturdier.

From this stocktaking exercise, there appears to be a degree of multi-polarity on the climate front in the Caribbean region. The approaches are not harmonized and the available climate scenarios are decidedly country-specific. Given the high level of regional financial interconnectedness (a number of financial institutions have an extensive regional footprint), regional cooperation on the climate risk front is warranted. Furthermore, collaboration should be more coordinated. For example, both CERT and the CGBS have a climate agenda but there is very little cross-pollination across these working groups. To ‘speak with one voice’ on climate risk analysis, a useful starting point would be common climate classification and evaluation criteria. According to CERT (2023), sustainability goals and/or the priorities ascribed to them differ across countries. This implies a need for taxonomies that accommodate the idiosyncrasies of regional economies. However, local taxonomies in the Caribbean context could suffer from scale disadvantages and possibly lead to “taxonomic fragmentation and taxonomy competition”, which complicates identification and classification of qualified climate activities or investments across countries.

The development of a regional climate taxonomy would be indispensable, as this forms the basis of climate change mitigation and adaptation actions, especially if Caribbean central banks are to construct common climate scenarios. The World Bank International Finance Corporation (IFC) has expertise in this area, having developed regional taxonomies in Central and South America. Initial engagements with the IFC suggest they are keen to work with the region on the development of a green taxonomy. In this regard, CERT recommends that Central Bank Governors engage the IFC to formalize a cooperation agreement in the near term. This pillar would allow for more cohesive climate work in the region and lay the groundwork for developing common climate scenarios.

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APPENDIX I: WORK BY OTHER REGIONAL REGULATORS (NON-CERT MEMBERS)

Bermuda

The Government of Bermuda and the Bermuda Monetary Authority (BMA) have focused their efforts on building resilience to climate change in terms of reducing Bermuda's vulnerability to extreme weather events⁹ ¹⁰. The BMA has also developed an Action Plan to address climate change and initiated several climate change financial stress testing and risk management initiatives aimed at enhancing resilience within the financial services sector. In 2021, a Climate Industry Survey was disseminated to insurance groups and commercial insurers¹¹, to gather information on the impact of climate change on the Bermuda insurance industry. They also gathered information on the steps being taken in response to climate risks and opportunities in the following areas: strategy and governance, underwriting, investments, stress/scenario tests, disclosures, pandemic and climate change.

Insurance groups, large commercial insurers and select Special Purpose Insurers were the target for the BMA's Climate Risk Assessment in 2022¹². This assessment sought to obtain quantitative (physical scenario analysis exercise) and qualitative footprints of exposures; identify challenges (e.g., data collection) and best practices; encourage the sector to further develop its own quantitative tools and expand qualitative assessments; enhance understanding of climate change risks and implications for business models; inform the BMA as to the nature of the information that can be requested through future annual filings; and align BMA initiatives on climate change with other regulatory bodies.

In August 2022, the BMA updated its Insurance Code of Conduct and issued guidance for commercial insurers to manage climate-related risks¹³, which emphasizes the need for comprehensive risk assessments and the integration of climate change considerations into their operations. This includes scenario analyses and stress tests to evaluate the impact of various climate change events, such as hurricanes and other natural disasters, on the financial system. These tests have indicated that Bermuda's insurers remain resilient under different stress scenarios, though the market remains exposed to significant risks, particularly from Atlantic hurricanes.

⁹ Bermuda Government (2023) *The Bermuda Difference*. November 2023. <https://www.gov.bm/sites/default/files/2023-11/The%20Bermuda%20Difference%20-%20COP28.pdf>

¹⁰ Loft, P. (2021) *The UK Overseas Territories: Climate change and biodiversity*. House of Commons Library. <https://researchbriefings.files.parliament.uk/documents/CBP-9290/CBP-9290.pdf>

¹¹ BMA (2021) *Climate Change Survey Report – March 2021*. <https://www.bma.bm/publications/bma-surveys>

¹² BMA (2022) *Climate Risk Exposure Survey Report – May 2022*. <https://www.bma.bm/publications/bma-surveys>

¹³ <https://www.bma.bm/viewPDF/documents/2023-03-09-17-03-42-Guidance-Note---Insurance---Management-of-Climate-Change-Risks-for-Commercial-Insurers.pdf>

The BMA issued a qualitative ESG Survey in August 2023 that was mandatory for all large commercial insurers and groups. The survey explored the advancements and actions taken by the insurance industry in broader ESG, Climate Risk, Protection Gap, and Diversity Equity Inclusion (DEI) topics. The plan was to publish an industry report in the first quarter of 2024. Additionally, the BMA created a specialised regulatory team focusing on climate change risks.

In 2024, the BMA will focus its efforts on providing internal training to Insurance Supervision staff on the industry advancements, and best practices observed in the year-end 2023 ORSA reports, in alignment with the Guidance Note expectations. Bermuda is a member of the International Association of Insurance Supervisors Climate Risk Steering Group (CRSG).

Cayman Islands

The Cayman Islands Monetary Authority (CIMA) has taken its signal from the national government, and begun incorporating climate-related issues into its operations. CIMA joined the NGFS in February 2022; included a chapter on Climate-Related Risks in its first Financial Stability Report in March 2023 and created an internal working group on 'Climate Change and Green Finance Initiatives'. The internal working group was charged with the responsibility to:

1. Develop a roadmap to address climate and environmental-related risks associated with the financial system;
2. Review the operational process of CIMA and setting green targets where necessary; and
3. Capacity building through the promotion of education in the fields of environmental studies.

Coming out of the working group's roadmap, the CIMA's Board of Directors approved three phases of recommendations. Phase 1 (1-6 months) will identify climate-related financial exposures, industry surveys and capacity building. In phase 2 (6-12 months), the group will develop guidance and other supervisory tools to address the identified climate-related financial risks and climate-related engagement with key stakeholders. The final phase (12+ months) will involve supervising the management of Climate-Related & Environmental Risk, advocating climate-related financial disclosures, and continuous development of capabilities for managing Climate-Related & Environmental Risk.

In June 2021, CIMA issued a circular letter to all banks, regarding: risk strategy and governance; risk management; the supervisory review process (Pillar II) and requirement to incorporate climate-related risks in their respective annual ICAAP reports. Since then, climate risks and ESG considerations were considered in the ICAAPs, though largely from a qualitative perspective. In June 2023, CIMA issued supervisory

guidance on insurance entities conducting bottom-up stress tests. This included guidance on shock effects and scenarios to be applied within their internal stress-testing framework.

Turks and Caicos

The Turks and Caicos Islands, like many other Caribbean economies, are in the early stages of integrating climate change risk into their financial systems. The Turks and Caicos Government (TCIG) is beginning to explore frameworks to incorporate climate-related risks into financial stability assessments. This includes considering both physical risks (e.g., hurricanes, rising sea levels) and transition risks (e.g., policy changes toward greener economies).

The TCIG Fiscal and Strategic Policy 2022-2026 has recognised that a primary source of risk for the Turks and Caicos is its exposure to natural disasters resulting from climate change. The negative impact on the real sector leads to heightened financial stability risks. They have identified the following areas as part of their risk management strategies:

1. Reduce vulnerability and exposure to hazards;
2. Risk financing (transfer); and
3. Residual risk management (Post-disaster/ Catastrophic event response).

The TCIG has a long-term Sustainability Development Vision 2040 aimed at developing a robust climate and environment agenda to ensure a climate-resilient infrastructure. The Turks and Caicos Financial Services Commission (TCFSC) is in the very early stages of incorporating climate-related risk into its supervisory framework. Phased implementation is planned for the banking business and then insurance. A four-pronged approach is being used to develop a supervisory response:

1. Stakeholder engagement
2. Data gathering
3. Stress Testing
4. Supervision

The objective is to integrate climate risk into the risk-based supervisory framework from governance to risk management operations and to create a consistent approach to assessing and addressing climate-related risks. They also aim to incorporate climate risk in the financial stability surveillance program through stress testing.

APPENDIX II: BARBADOS FINANCIAL SERVICES COMMISSION REPORTING TEMPLATE

Balance Sheet Template:

	Mar-21	Mar-22*	Mar-22^
1. Cash and Deposits			
2. Government Securities			
3. Company Bonds and Debentures			
4. Secured Loans			
5. Investments in Real Estate			
6. Shares			
7. Unit trusts and mutual funds			
8. Investments in Related Parties			
9. Policy Loans			
10. Other Investments			
11. Total Cash, Loans & Investments (Sum of Rows 1 to 10)			
12. Re-insurers' share of insurance provisions			
13. Accounts Receivable			
14. Fixed assets			
15. Accrued and deferred assets			
16. Other assets (Specify)			
17. Total Assets (Sum of Rows 11 to 16)			
18. Unexpired Risk Provision (Section 180)			
19. Claims Provision (Section 181)			
20. Catastrophe Provision (Section 181)			
21. Life Insurance and Annuity Provisions			
22. Deposit Administration Funds			
23. Other insurance liabilities (specify)			
24. Total Insurance Liabilities (Sum of Rows 18 to 23)			
25 Accounts Payable			
26. Bank Loans and Overdrafts			
27. Other Liabilities (Specify)			
28. Total Liabilities (Sum of Rows 24 to 27)			
29. Share Capital			
30, Reserves			
31. Retained Earnings			
32. Head Office Account			
33. Total Capital and Reserves (Sum of Rows 29 and 32)			

APPENDIX II: BARBADOS FINANCIAL SERVICES COMMISSION REPORTING TEMPLATE (Continued)

Income Statement Template:

	Mar-21	Mar-22*	Mar-22^
1. Gross Premiums Written			
2. Reinsurance Assumed			
3. Reinsurance Ceded			
4. Net Premiums Written (Row 1 + Row 2 – Row 3)			
5. Change in unexpired risk provision			
6. Net Premiums Earned (Row 4 - Row 5)			
7. Incurred Claims			
8. Increase (Decrease) in Catastrophe Provision			
9. Claims Expense (Rows 7 + 8)			
10. Commissions paid			
11. Reinsurance commissions received			
12. Net Commission Expense (Rows 10 – 11)			
13. Management Expenses			
14. Total Underwriting Expenses (Rows 9 + 12 + 13)			
15. Underwriting Income (Loss) (Row 6 – Row 14)			
16. Investment Income			
17. Other Revenue			
Other Expenses			
18. Net operating income from general insurance operations (Rows 15 to 17)			
19. Income from life insurance operations (insert amount from Row 21 of Form B.3)			
20. Extraordinary revenue (expenses)			
21. Net Income before Tax (Rows 18 to 20)			
22. Tax			
23. Net Income after tax			