Network for Greening the Financial System

Technical Note

NGFS Note on the economic and financial impacts of extreme weather events

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NGFS

Central Banks and Supervisors
Network for Greening the Financial System

Foreword

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The impacts of physical climate risks are not a future issue. They are already materialising across the globe. The increasing frequency and intensity of extreme weather events are becoming a growing source of macroeconomic and financial risk, with global losses now exceeding USD 200 billion annually. However, despite the magnitude of these damages, gaps remain in the understanding of how such shocks propagate through the economy and the financial system.

Against this backdrop, the Network for Greening the Financial System (NGFS) has prepared this technical note at the invitation of the French G7 Presidency, with the aim of contributing to the international policy dialogue on this topic. Drawing on 31 case studies from 28 economies, the note provides new empirical insights into the transmission channels of extreme weather events, showing their impact on output, inflation and financial stability through both real economy and financial sector mechanisms. By bringing together evidence from a wide range of jurisdictions, this work highlights not only common patterns, but also the significant heterogeneity in impacts across countries.

The findings confirm that extreme weather events can generate substantive macro-financial effects, including stagflationary pressures and strains on financial resilience. At the same time, they underline that the magnitude, persistence and distribution of these impacts vary widely. These differences depend on factors such as the nature and severity of the hazard, levels of exposure and vulnerability, as well as resilience capacities – including insurance coverage, fiscal space, adaptive infrastructure and economic diversification.

The note also underscores that crucial data and analytical gaps persist, notably regarding transmission mechanisms, spillovers and second-round effects. Therefore, the NGFS encourages continued efforts by central banks, supervisors, policymakers, regulators, and the research community to further deepen analysis, improve data availability and strengthen international cooperation. Advancing this work will support a more comprehensive assessment of the risks posed by extreme weather events and contribute to more effective policy responses.

The NGFS is grateful to its members and observers for their valuable contributions to this work and for providing the case studies that underpin the analysis. Their strong engagement made it possible to develop a unique cross-country evidence base, reflecting diverse economic structures, exposures and policy frameworks. This collective effort contributes to advancing a shared and empirical understanding of how extreme weather events affect economies and financial systems, and to informing the international policy debate.

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Executive Summary

The frequency and intensity of extreme weather events are rising, with important implications for both macroeconomic and financial risks. For example, annual global direct damages from weather-related events have more than doubled since the early 2000s, reaching over USD 200 billion in 2025.[1] Despite the scale of these damages, there are gaps in our understanding of how these shocks propagate through the economy. Available evidence provides only a partial quantification of the financial and macroeconomic implications.

In order to move forward on these issues, this note aims to support the G7 French Presidency's priority to assess the economic impacts of extreme weather events, their transmission channels and possible international spillover mechanisms. It takes stock of the progress on identifying the economic and financial materiality of these events, to highlight potential cross border knock on effects and disruptions, as well as the connections with price and financial stability.

This work draws on a collection of 31 case studies of extreme weather events from 28 economies between 2015 and 2025, made available for the first time by central banks.[2] These cases provide new insights on the macroeconomic and financial channels. Combined with a literature[3] review, the cases show the impact of events across different economies, illustrating how common transmission channels interact with local factors and how impacts, therefore, differ across hazards and across contexts. The case studies highlight the heterogeneity in the economic impacts of extreme weather across events and economies. Despite this variation, impacts repeatedly emerge on a common set of variables, including output, employment, and prices at both national and regional levels.

The cases illustrate how impacts are propagated through the economy via supply and demand channels. Supply channels are directly hit as productive capital are damaged, climate-sensitive production stalls (e.g., agriculture or hydropower generation), business is interrupted (e.g., transport networks or supply chains) as well as labour supply (e.g., heat-related shocks). These supplyside channels are the ones most commonly highlighted in the cases (such as in Japan, 2018; Tanzania, 2024). The slowing of economic activity that follows can increase unemployment and cause income loss, affecting the economy via demand channels. These effects may spread across borders: when key suppliers are hit, production and trade elsewhere can also be affected. External demand for certain services also weakens in some sectors, particularly tourism (Jamaica, 2025).

These channels affect key macroeconomic variables, like output and inflation. Several cases (Zambia, 2024; Fiji, 2016) illustrate the negative effects on economic growth following an extreme weather event. Initially, inflationary effects are mainly noticeable in food and energy prices (Pakistan, 2022; Ecuador, 2024) but might become persistent as they feed into headline inflation (Zambia, 2024). As such, extreme weather events may generate a short-term stagflationary impulse, combining weaker economic growth with higher prices.

The impact from these events on the financial sector is transmitted through traditional financial channels, such as credit and liquidity risks. In several cases, these events temporarily reduced collateral values (Germany, 2021) and higher non-performing loan ratios (Pakistan, 2022) were observed following an event. While in most cases these effects were transitory, and often highly localized, they can become persistent when unfavourable conditions compound and generate feedback effects to the macroeconomy as lending conditions tighten (Pakistan, 2022).

1 The increase is attributable to a variety of factors, including extreme weather events, but also exposure of assets and increase in insurance coverage. Munich Re (2026) – Climate change presses on: Devastating wildfires and intense thunderstorms exacerbate losses for insurers.

2 The case study on Pakistan, which is prominently featured in the note due to its substantial informative content, was provided by the World Bank.

3 The references are presented in Annex 1.

Resilience channels like insurance schemes[4] may absorb a part of direct losses and limit the macroeconomic impact by supporting liquidity and speeding up recovery. For example, after the flood in Spain (2024), payouts from the statemanaged Insurance Compensation Consortium, operating under a public-private insurance model, absorbed a large share of the losses stemming from damage to housing, vehicles and business facilities in the affected regions. In contrast, after the floods in Pakistan (2022), a circa 1% of total damages was insured, leaving households and small firms largely exposed to wealth and income losses, which translated into rising poverty. Other resilience factors include fiscal space, adaptive infrastructure, and economic diversification, which may correlate with the level of economic development of an economy.

Therefore, the macroeconomic effects of extreme weather events may also pass through the balance sheet of the government and of the insurance sector. Specifically, when insurance coverage is sufficient or government support heavily offsets losses, the effects of such events on firms and households, and consequently on production and GDP, are markedly reduced. However, in these cases the negative effects are felt via a higher cost of insurance coverage in following years, or higher public debt. While these effects may not be easy to identify, they are undoubtedly present.

Given the potential macroeconomic effects – particularly on inflation – and the possible implications for financial system resilience, assessing the impacts of extreme weather and responding in line with price and financial stability objectives falls within the core mandates of central banks and supervisors. The case studies show central banks and supervisors adapting tools within existing frameworks: integrating disaster effects into assessments of growth and inflation; pairing monetary policy with fiscal targeted support where prices are under pressure; including extreme weather as a risk driver in supervisory practices and offering temporary supervisory flexibility to help maintain lending and liquidity in affected regions; and ensuring continuity of cash and payment services.

To improve general understanding and mitigate the potential impact of the effects of extreme weather events, it would be beneficial to improve data and analysis, expand access and availability of insurance coverage, and invest in risk reduction and adaptation. The case study assessment reveals important data gaps on hazards, exposures and losses. Investing in better data quality and availability may enhance risk mitigating strategies from banks, insurers and governments alike. In addition, governments may strengthen resilience by considering their disasterrisk finance (Jamaica, 2025) or public-private insurance programmes (France, 2016), strengthening fiscal buffers, but also by investing in riskreduction and adaptation.

4 This includes private policies, public schemes and public-private programmes.

List of abbreviations

ATM	Automated Teller Machine
BCB	Banco Central do Brasil
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CCS	Spanish Insurance Compensation Consortium
G7	Group of Seven
G20	Group of 20
GDP	Gross Domestic Product
GVA	Gross Value Added
HKMA	Hong Kong Monetary Authority
IMF	International Monetary Fund
IMF WEO	International Monetary Fund World Economic Outlook
MOSE	Modulo Sperimentale Elettromeccanico
MPM	Multidimensional Poverty Measure
NASA	National Aeronautics and Space Administration
NatCat	Natural Catastrophe
NGFS	Network for Greening the Financial System
NPL	Nonperforming Loans
PD	Probabilities of Default
PPIPs	Public-Private Insurance Programmes
SBP	State Bank of Pakistan
SME	Small and Medium Enterprises
USD	US Dollar
WTTC	World Travel and Tourism Council

Introduction

The frequency and intensity of extreme weather events have increased markedly over recent decades. The number of registered extreme weather events rose from approximately 200 in 1980 to around 800 in 2018[5], with an expanding range of geographic locations affected.[6] In addition, NASA data indicate a rise in the intensity of events such as droughts and floods over the past five years.[7] At the same time, the frequency and severity of compound and repeated extreme weather events have increased.[8]

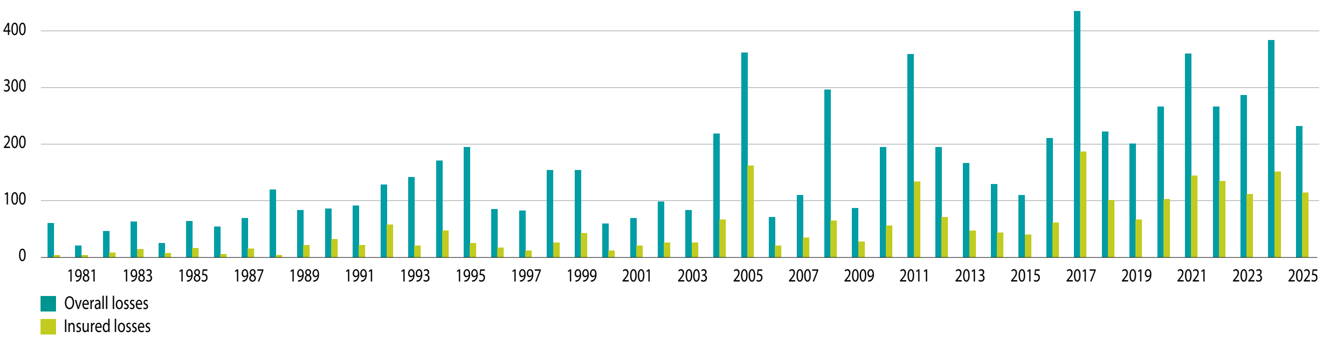
According to the World Meteorological Organization, extreme weather events are defined as rare or unusually intense meteorological phenomena that occur at specific places and times.[9] Thus, the definition relies on the magnitude, duration, and extent of the event and is impact independent. These events mainly include – but are not limited to – heatwaves, cold waves, floods, droughts, tornadoes, and cyclones.[10]

Annual direct losses from extreme weather events are rising. For example, in real terms, annual global direct damages from weather-related events have more than doubled since the early 2000s, reaching around USD 206 billion in 2025. An IMF model estimates that an extreme weather event could cause a cumulative real GDP loss of nearly 6% for the affected country five years after the onset of the shock.[11]

The increasing occurrence of compound and sequential events can further amplify these impacts by triggering cascading effects. Compound events usually generate larger losses than those from isolated events[12] and shorten the recovery time. The implementation of adaptation measures and resilient reconstruction may, conversely, limit the spread and cost of these shocks.

Figure 1 **Global cost of extreme weather events**

(in USD billion, inflation-adjusted)



Source: Munich Re, NatCatSERVICE, April 2026 (exclusing drought and heatwaves).

5 Munich Re (2019) – NatCatSERVICE.

6 While part of this increase is due to improved reporting of events, scientific research confirms that most of this increase is due to climate change. Qi Lui *et al.*, Global warming intensifies extreme day-to-day temperature changes in mid-low latitudes, Nature Climate Change (2026).

7 NASA (2025), NASA data reveals dramatic rise in intensity of weather events.

8 Disaster statistics are subject to well-documented reporting biases. The observed increase in recorded events over time may also partly reflect improvements in reporting systems, data availability, and media coverage, rather than solely a rise in the underlying frequency of disasters.

9 WMO (2023) Guidelines on the Definition and Characterization of Extreme Weather and Climate Events.

10 Extreme weather events are distinct from disasters, defined by their impacts. A disaster occurs when an extreme event causes serious disruption to society, beyond the affected community's ability to cope with its own resources.

11 IMF (2026) Global Economy in the Shadow of War. Chapter 3. Figure 3.4, page 7. The impact onset is estimated using a local projection difference-in-differences (LP DiD) approach (Dube and others 2025). The methodology is explained in the online Annex 3.2. Macroeconomic Dynamics During Wars.

12 NGFS (2023), Compound Risks: Implictions for Physical Climate Scenario Analysis.

Given these impacts on the economy, international fora such as G7 and G20 have made work on extreme weather events and natural hazards a priority. In this context, this note was prepared by the NGFS at the invitation of the French G7 presidency and seeks to complement previous G7 and G20 reports on extreme weather events.[13] In 2024, the G7 Italian presidency produced a High-Level Framework for Public-Private Insurance Programmes (PPIPs) against Natural Hazards to expand affordable insurance coverage while safeguarding financial stability and limiting public sector risk. Under the Brazilian presidency (2024) and South African presidency (2025),[14] the G20 recognised the urgency of scaling up and mainstreaming whole-of-society and whole-of-economy adaptation in the wake of the widespread, significant, and growing impacts of extreme weather events. Despite the scale of these damages, systematic and evidence-based examination of how subsequent effects propagate through the economy, and the financial system remains limited.[15]

This note builds on a cross-economy compilation of 31 covering events between 2015 and 2025, complemented by existing literature.[16] This compilation is unprecedented, insofar as these cases originate for the first time directly from central banks. The sample covers a broad range of economies with diverse characteristics: it includes advanced economies, developing economies, as well as small island states. It also covers a mix of agriculture dependent, manufacturing and services led economies, with differing levels of insurance coverage and fiscal space. They feature five types of extreme weather hazards: droughts, floods, storms, cyclones, and wildfires.

Figure 2 **List of the 31 case studies. High income economies coloured in green and upper-middle to low-income economies coloured in black[1]**

	Type of hazards				
Continent	**Flood**	**Wildfire**	**Drought**	**Cyclone**	**Storm**
Europe	France (2016), Germany (2021), Italy (2023), Netherlands (2021), Poland (2024), Spain (2024)	Greece (2023), Portugal (2017)	France (2022), United Kingdom (2022)	–	Greece (2023), Ireland (2025)
Americas	Brazil (2024)	Canada (2016)	Ecuador (2024)	–	Jamaica (2025)
Asia – Pacific	Australia (2022), Pakistan (2022)	Australia (2019)	–	Fiji (2016), Hong Kong (2024)	Japan (2018), India (2020)
Africa	South Africa (2022), Tanzania (2023)	–	Namibia (2019), Zambia (2023), Morocco (2015)	Eswatini (2021), Mauritius (2024), Mozambique (2019)	–

1 Classification of the economes is based on the World Bank classification (2025).

Source: Authors.

13 G7 (2024) Annex-II-Full-Document-High-Level-Framework-for-PPIPs-against-Natural-Hazards.pdf.

14 G20 Brazil (2024) – G20 Rio de Janeiro Leaders' Declaration ; G20 South Africa (2025) – G20 South Africa Summit: Leaders 2025-G20-Summit-Declaration.pdf.

15 The IAIS has conducted an analysis on the potential financial stability implications of NatCat insurance protection gaps, which, similar to this report, includes a theoretical discussion of the issue and presents case studies to illustrate the impacts on the real economy, financial sector and society. IAIS (2025), GIMAR special topic edition: Potential financial stability implications of NatCat insurance protection gaps.

16 The information was collected through a questionnaire circulated among NGFS members, designed to capture details on the characteristics of the event as well as its macroeconomic and financial impacts.

The note explores how extreme weather events propagate the economy through macroeconomic and financial channels and international spillover mechanisms. It examines factors that contribute to resilience against extreme weather events and the link with the mandates of central banks and supervisors. Section 1 provides a brief economic framework,[17] which is be used to analyse how shocks propagate through the macroeconomy and financial sector. Section 2 analyses the macroeconomic transmission channels, such as supply-side disruptions, demand-side contractions, and international spillovers. Section 3 focuses on how shocks propagate to banks and insurers' balance sheets through financial channels and may spread across borders to, for example, currency markets. Section 4 discusses resilience factors that support an economy to absorb and recover from extreme weather shocks, including insurance, fiscal space and buffers, adaptive infrastructure, level of economic development, and economic diversification. Finally, section 5 explains how the macroeconomic effects of extreme weather events are relevant under the mandates of central banks and supervisors.

17 The note builds on the conceptual framework to analyse the impact of physical climate events as introduced in NGFS (2024) – Acute physical impacts from climate change and monetary policy.

1. Extreme weather events and economic framework

Extreme weather events are the materialization of acute physical risks. Their economic impacts are determined by three interrelated dimensions: hazard, exposure and vulnerability.[18] First, physical hazard refers to the nature and intensity of the extreme event itself, such as a flood, storm, heatwave, or wildfire. Secondly, exposure captures the presence of people, infrastructure, housing, and productive assets in areas where hazards occur. Lastly, vulnerability reflects the susceptibility of exposed assets to damage, which depends on factors such as construction quality, protective measures, institutional capacity, and disaster preparedness.[19]

The variability and interaction of these dimensions explain why the economic impact of extreme weather in the cases reviewed is highly heterogenous. Differences in hazard intensity are observed between the cases. For example, the prolonged drought in Zambia (2023-2024) was a slow but persistent shock that primarily affected agriculture and electricity generation. On the other hand, Hurricane Melissa in Jamaica (2025) was an acute, high-intensity event that caused abrupt economic disruption. Differences in exposure are evident when comparing the floods in the Netherlands (2021) or the typhoon in Japan (2018), where severe damage remained geographically concentrated, with Cyclone Winston in Fiji (2016), which affected a large share of the country simultaneously. Finally, differences in vulnerability are shown by comparing the floods in Germany (2021) and the floods in Pakistan (2022): despite both being extreme flooding events, the macroeconomic implications in Germany remained contained mainly due to the flood's limited geographical scope. However, insurance coverage and public intervention also played a role. By contrast, the extensive regional spread of the floods in Pakistan resulted in persistent macroeconomic stress.

Extreme weather events affect the economy and the financial system over a wide range of time horizons. For example, an extreme weather event can damage productive capital in the short term through the destruction of physical assets or disruptions to economic activity. However, such impacts may also generate longer-term effects, for instance through a loss of employability among affected workers. Also, when public infrastructure such as schools is damaged or destroyed, the resulting loss of services can lead to long-lasting effects on human capital, with permanent repercussions on output and GDP. This note focuses primarily on direct and short-term impacts.

1.1 General framework

To systematically examine the different transmission mechanisms of extreme weather through the economy, this note follows the conceptual framework developed in the NGFS report on acute physical impacts from climate change and monetary policy[20], which has been further enriched for the purpose of this note.[21] Figure 2 shows (i) economic transmission channels through which extreme weather events affect the real economy, (ii) financial transmission channels through which these real economy shocks propagate to and are amplified by the financial system, and (iii) resilience mechanisms that absorb, dampen or redistribute losses and shape recovery. These elements form a sequential but interacting chain from shock to outcome.

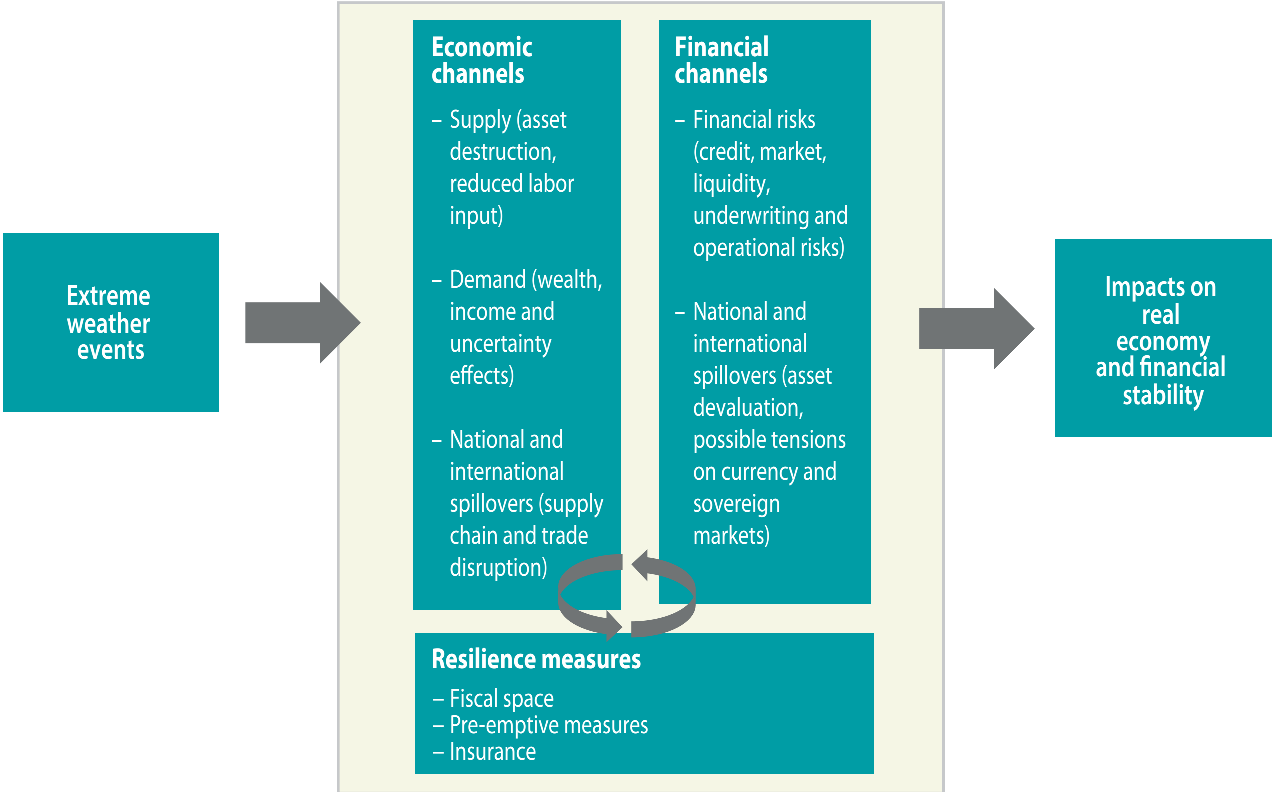
18 NGFS (2024) – Acute physical impacts from climate change and monetary policy.

19 NGFS (2024) – Conceptual Note on Adaptation. Vulnerability often correlates with a country's level of economic development.

20 NGFS (2024) – Acute physical impacts from climate change and monetary policy.

21 This framework was enhanced based on a literature review as well as the most frequently observed transmission mechanisms identified in case studies.

Figure 3 **Economic and financial transmission channels of extreme weather events**



Source: Authors, inspired by the NGFS (2024), Acute physical impacts from climate change and monetary policy.

1.2 Economic channels

The direct impact of extreme weather events is often felt on the supply side, where the production factors capital, labour supply and total factor productivity may be impacted. First, the destruction or impairment of capital – including critical infrastructure – disrupts current production and future productive capacity. The scale and persistence of output losses depend on whether capital is permanently destroyed or temporarily constrained, for example through downtime, repair needs, or reduced utilisation. Secondly, damage to capital is frequently accompanied by reduced labour supply as destroyed housing and transport networks limit access to workplaces or force workers to relocate. These effects are particularly pronounced in developing economies, where extreme weather events may trigger large-scale and sometimes persistent labour reallocation across sectors and regions. Interruptions to power, water and transport networks can also have a large effect on productivity, as will interruption to supply chains. Lastly, total factor productivity can be depressed through a reduction in the efficiency with which remaining inputs are combined. Supply-chain disruptions, power outages, damaged transport infrastructure, and organisational frictions increase transaction costs and lower operational efficiency, even when capital and labour are only partially affected.

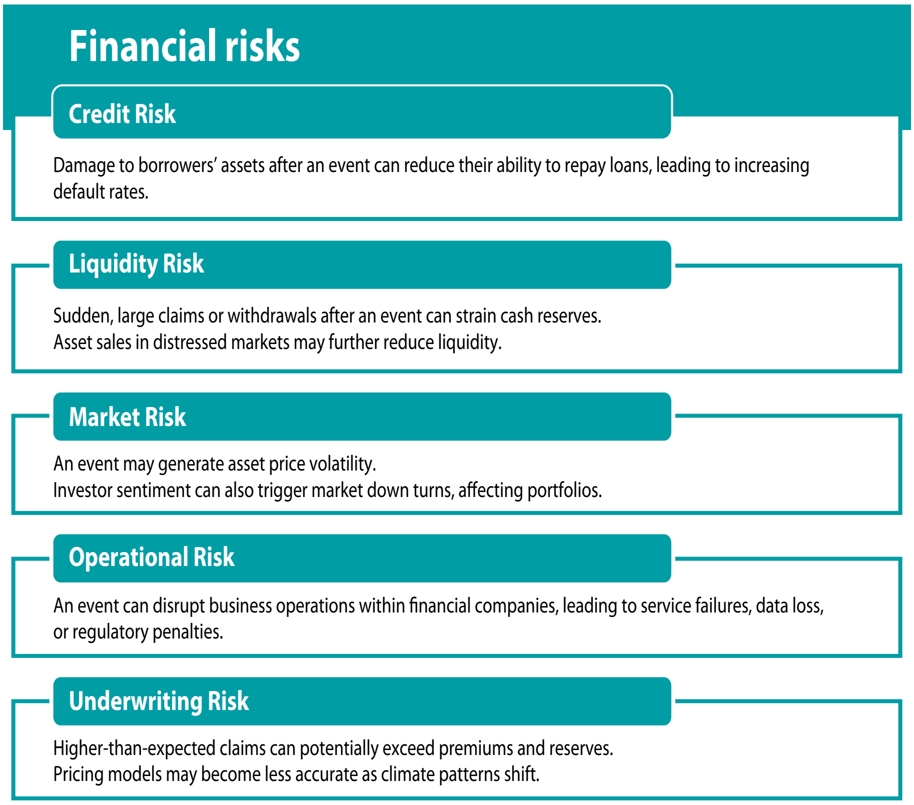
On the demand side, extreme weather events affect economic activity primarily through income, wealth, and confidence channels. The destruction or devaluation of assets reduces household and firm income directly, for example through lost wage earnings, business interruptions, and lower rental or agricultural income. Asset losses – most notably damage to residential property or declines in house prices – also erode household wealth, further depressing consumption and investment. These income and wealth shocks exert immediate downward pressure on aggregate demand, particularly in regions with limited insurance coverage or high exposure to climate-sensitive sectors. Extreme weather events might also increase uncertainty about future income and economic conditions. As a result, households tend to raise precautionary savings, while firms postpone or scale back investment. Empirical evidence shows that declines in consumer and business confidence following disasters often lead to sustained reductions in spending, with limited catch-up over time.[22] Consequently, demand-side effects may persist even after physical reconstruction has begun, slowing the overall recovery. Nevertheless, effects on demand can be ambiguous[23] as rebound in demand can also be observed after the shock, linked to reconstruction efforts and to public support measures.

The effects of extreme weather can disrupt national and international supply chains and trade, leading to spillover effects. For example, shocks to upstream producers propagate downstream and can affect output across multiple stages of the production process. Additionally, extreme weather can damage or destroy bridges, roads, waterways.[24] As a result, even localized weather-related shocks can propagate through supply-chain and trade linkages, amplifying their impact across the broader economy.

1.3 Financial channels

Economic impacts of extreme weather events can increase financial risks, bearing on banks and insurers' balance sheets, and affect cash flows and credit supply. For example, banks and insurers can be affected through increasing non-performing loans, devaluation in collateral or a large volume of withdrawals following extreme weather events. These shocks are transmitted through traditional risks monitored by financial supervisors, as shown below.

Figure 4 **Types of risks within the financial channels**



Source: Authors.

22 Baker *et al.* (2023), Using Disaster to Estimate the Impact of Uncertainty.

23 Ashizawa *et al.* (2022), Physical risks from climate change faced by Japan's financial institutions: Impacts of flood on real economy, land prices, and FIs' financial conditions.

24 Disrupted internal waterways, in particular, can have disproportionate effects on output as they are critical for transporting intermediate goods, which are essential to international production network. NGFS (2024), Acute physical impacts from climate change and monetary policy.

When physical assets lose value or are destroyed, borrowers can offer less collateral, which limits access to credit and increases borrowing costs as lenders raise risk premiums. At the same time, lower cash flows further reduce repayment capacity, reinforcing these effects, and creating a financial accelerator mechanism that amplifies the impact of physical shocks. When financial conditions tighten and access to finance is reduced, it becomes more difficult to rebuild the economy after an extreme event, prolonging and amplifying the shock effects. These changes also weaken broader economic activity, while potentially undermining the financial sector's resilience and its ability to intermediate.

1.4 Resilience measures

The macroeconomic and financial impacts of extreme weather events are not determined solely by the size of and exposure to the physical shock, but also by the capacity of economies to absorb, redistribute, and recover from losses. The resilience threshold[25] of an economy is determined by several factors such as fiscal space, adaptive infrastructure, level of economic development, size and capacity of the insurance market, economic diversification. In addition, literature shows that environmental degradation may also further weaken economic resilience.[26] Looking at these factors, developed and emerging economies may respond differently to extreme weather events.

25 NGFS (2024), Acute physical impacts from climate change and monetary policy. The report explains the concept of threshold. This threshold is country specific and is dependent on a country's wealth, fiscal capacity, and insurance mechanisms, among other factors. The resilience threshold is likely to be lower in lower-income countries than in higher-income ones, and as a result, lower-income countries already experience relatively larger damages and economic repercussions from physical hazards.

26 Zhai *et al.* (2024), Investigating Vulnerability, Adaptation, and Resilience: A Comprehensive Review with the Context of Climate Change.

2. Extreme weather events can propagate to the economy via supply and demand channels

Extreme weather events can propagate through the economy via supply (i.e., destruction of productive capital, reduced labour input and declines in total productivity factor), and demand channels (i.e., wealth, income and confidence factors) and may even disrupt supply chains and trade, leading to (inter)national spillovers. These channels may lead to macroeconomic impacts in terms of output and inflation.

2.1 Supply factors: losses of capital and labour input, as well as decline in productivity

Several cases demonstrate that extreme weather events led to damage to productive capital, particularly in agriculture and other sectors reliant on land, biological assets and infrastructure. For example, during the floods in Pakistan (2022), farming activity remained constrained even after floodwaters receded, as degraded land quality and destroyed complementary capital limited production. In Tanzania (2024), the cyclone damaged four major bridges along the southern road corridor, isolating two regions from the rest of the country for an extended period. Similar dynamics were observed following the cyclone in Fiji (2016) and the wildfires in Portugal (2017). The destruction of agricultural plantations, forestry land, processing facilities and storage assets can lead to multiyear output losses, with agricultural production declining significantly.[27]

Droughts and heatwaves can reduce output even without destroying capital, by impairing its effective use. For example, in Ecuador (2024) and Zambia (2023), severe droughts sharply reduced hydropower generation, leading to lowered electricity output and subsequent widespread power rationing. In Ecuador, electricity generation declined to 20-25% of total capacity, causing blackouts of up to 14 hours per day. Although power plants remained physically intact, the reduced capacity constrained industrial production and increased operating costs of firms due to reliance on inefficient backup generation. In India (2020), extreme heat similarly impaired electricity generation by forcing thermal power plant shutdowns, reducing manufacturing output during peak periods. Other types of extreme weather events can have similar impact. In Japan (2018), a typhoon had a significant impact on the electrical infrastructure, causing power outages that affected 1.7 million households in the Kansai region and took two weeks to fully resolve.[28]

As a second supply-side channel, extreme weather events can disrupt labour supply on a substantial scale. In South Africa (2022) and Brazil (2024), flood damage to transport infrastructure impaired commuting and access to workplace, contributing to short-term employment declines in affected regions. Heat-related events are also relevant, as demonstrated by extreme heat episodes in France (2022) and the United Kingdom (2022), where millions of working hours were lost in a single summer due to physiological heat stress.[29] In Pakistan (2022), the floods disrupted employment for an estimated 4.3 million workers – around 20% of the pre-flood workforce – as inundated land and destroyed productive capital prevented labour from being deployed even after waters receded, particularly in agriculture and SMEs where employment fell by over 50% in heavily affected areas.

Lastly, supply-side impacts may be amplified via damage to logistics embedded productive capital, affecting the efficiency with which inputs are combined. In these cases, output losses do not arise from the unavailability of capital or labour, but from coordination failures across production stages. In South Africa (2022), floods in the Durban region damaged key infrastructure and port access, interrupting export logistics and input deliveries for manufacturing firms despite continued availability of labour and machinery. The Durban food basket increased by 13.6% year on year in the month following the event. Similarly, in Brazil (2024), flooding in Rio Grande do Sul disrupted regional transport

27 OECD (2025) – Global Drought Outlook. The report shows that the economic impact of drought is already visible in agriculture, where observed dry years have led to crop yield losses of up to 22%, directly reducing farm incomes and increasing price and food security pressures.

28 98% of the households recovered in three days after the event.

29 Costa *et al.* (2024) – The heat is on: Heat stress, productivity and adaptation among firms shows that both a rising number of high-temperature days and the incidence of heatwaves are associated with losses in labour productivity, with stronger effects among smaller and less productive firms.

networks and led to prolonged airport closures, impairing the movement of intermediate goods and workers. In Greece (2023) and Northern Italy (2023), flood damage to road and rail networks constrained agricultural processing and industrial production by delaying the delivery of inputs and isolating production sites. In France (2016), flooding of the Seine disrupted fluvial transport to and from the port of Le Havre, constraining transport of bulk and intermediate inputs despite intact port infrastructure. In Spain (2024), flash floods negatively impacted logistics in Valencia, with commuting disruptions and damaged roads and railways, which led to transportation disruptions. Beyond transport infrastructure, in Ireland (2023), severe storms and flooding damaged electricity and broadband infrastructure, causing prolonged outages of fixed and mobile communication services in affected regions, which interfered with business operations, remote working, logistics coordination and digital service delivery.

2.2 Demand channels: wealth and income effects

A prominent demand side channel operates through household income and consumption effects, as disrupted wage and business income might influence households' consumption and investment demand for goods and services.[30] While a reduction in consumption was not directly documented, evidence from Greece (2023) and Italy (2023) shows that floods damaged land and processing facilities, leading to a 30-50% reduction in seasonal hiring during peak period and, consequently, to a lower wage income. In addition, following the droughts in Zambia (2023), severe crop failures and blackouts of up to 21 hours a day reduced labour demand in agriculture, manufacturing and services. This, combined with a significant increase in inflation (11% to 15,5% in August 2024), severely eroded purchasing power. The droughts in Namibia (2019) show similar effects, where unemployment and (food) inflation reduced household income. The impact of extreme weather events can lead to repair or rehousing costs for households. This affects household's consumption choices and reduces their capacity to consume goods and services other than those related to repair.[31]

Demand-side impacts are also visible through lowered tourism and services consumption, especially in small open economies that depend on visitor inflows. For example, following the cyclone in Fiji (2017), tourist arrivals and related service exports fell sharply. More recently, hurricane damage in Jamaica (2025) led to disruption of tourism infrastructure, including damage to a large share of hotel capacity, resulting in a near 40% year-on-year decline in visitor arrivals in the subsequent quarter. These demand impacts directly affect employment and income in hospitality, retail and transport services, potentially prolonging the macroeconomic impact beyond immediate physical disruption.

A further demand channel operates via wealth and balance sheet effects. The floodings in France (2016), Italy (2023) and Spain (2024) caused extensive damage to residential property and local infrastructure, reducing household net worth. When physical hazards reduce housing prices and thus household wealth, consumption demand is typically expected to fall.[32]

Private investment and confidence effects are a third demand-side transmission channel, especially in sectors with long planning horizons such as tourism, forestry and agriculture. Following Cyclone Winston in Fiji (2016), private investment slowed markedly as firms focused on short-term repair rather than expansion, while repeated hurricane exposure in Jamaica has been associated with weaker investment sentiment outside externally financed reconstruction. These confidence effects reduce demand independently of immediate physical damage.

30 Campbell *et al.* (2005) – How do house prices affect consumption? Evidence from micro data. Using UK micro data, this paper shows that higher house prices lead to increased consumption. Accordingly, when physical hazards reduce housing prices and thus household wealth, consumption demand is expected to fall.

31 Banque de France (2023), Climate change and residential real estate: what are the risks for the banking sector?.

32 Campbell *et al.* (2005) – How do house prices affect consumption? Evidence from micro data. Using UK micro data, this paper shows that higher house prices lead to increased consumption. Accordingly, when physical hazards reduce housing prices and thus household wealth, consumption demand is expected to fall.

Nevertheless, effects on demand can be ambiguous in some cases.[33] For example, Ashizawa *et al.* (2022) have shown that while flood-related shocks initially have a negative impact on demand and GDP, these effects may be mitigated by a rebound in demand linked to reconstruction efforts and to public support measures following the extreme weather event.

2.3 National and international spillovers

Physical climate risks can spill over across sectors, regions, and national borders, thereby extending their macroeconomic impact beyond areas directly affected by extreme weather events. These spillovers may operate through cross-border supply chains and trade, reflecting the integration of global production networks. Localized climate shocks can therefore cause both supply- and demand-side disturbances elsewhere, as disruptions in production, logistics or trade propagate across regions and economies.[34]

Various cases illustrate how extreme weather can translate into macroeconomic spillovers via imports and exports. Recurrent droughts in Zambia (2024) severely constrained electricity generation and maize production, resulting in more than 30% and 140% increases in imports of fuel/energy and maize respectively. Similarly, the floods in Pakistan (2022) not only reduced domestic agricultural production but it also led to a sharp decline of agricultural and textile exports by around 13%. At the same time, imports – particularly of food and energy – rose by over 60%. This resulted in a widening trade deficit and reinforced pressure on domestic prices and demand.

Spillovers also arise through logistics disruptions and internal trade linkages, magnifying economic impacts at both regional and international levels. Floods in South Africa (2022) hindered port operations in Durban, leading to severe export delays – grape shipments, for example, reportedly took up to 50 days to leave the country. Similarly, floods in Brazil (2024) blocked roads, closed an international airport and reduced port capacity, causing a sharp contraction in foreign trade, particularly imports, which fell to their lowest level since mid-2020. Taken together, the evidence from case studies underscores that extreme weather events can propagate through production networks and trade volumes, generating spillover effects well beyond the initially impacted regions.

Beyond the negative impact on the volume of goods traded internationally, price increases linked to extreme events represent another channel of international transmission. This applies particularly to agricultural products. The destruction of part of the production or lower yields may lead to a reduction in available supply, creating upward pressure on prices. For example, in Zambia (2023), drought conditions adversely affected crop production and resulted in a year-on-year increase of 39.9% in maize grain prices. Beyond national supply, it is the global supply of agricultural products that may be affected, potentially leading to a generalized increase in prices for these goods.

Extreme weather events can also disrupt international supply chains and production networks. Although this was not directly observed in the NGFS case studies sample, the much-analyzed floods in Thailand (2011) offer a striking example. The flooding of industrial zones hosting automotive and electronics firms disrupted global value chains, causing imports of transport equipment from the Philippines to Thailand to fall by over 20% compared with the previous year. In the hard disk drive industry, output from major Thai producers declined by roughly 30% nearly one-third of global production capacity, triggering a worldwide shortage and price increases of 24-33%, with effects persisting well beyond the initial shock.

33 Ashizawa *et al.* (2022), Physical risks from climate change faced by Japan's financial institutions: Impacts of flood on real economy, land prices, and FIs' financial conditions.

34 Physical climate risks can spill over across regions, sectors and national borders, thereby extending their macroeconomic impact well beyond the areas directly affected by extreme weather events. Within the NGFS framework, such spillovers operate predominantly through cross-border supply chains and international trade, reflecting the growing integration of global production networks. Localized climate shocks can therefore amplify both supply- and demand-side disturbances elsewhere, as disruptions in production, logistics or trade propagate across countries and regions.

2.4 Macroeconomic impacts on growth and inflation

Physical risks affect economic growth and inflation through the interaction of supply and demand-side and financial channels. In the short run, extreme weather events may lower output growth (most frequently on a regional level)[35] by simultaneously constraining production and weakening aggregate demand, while exerting upward pressure on prices through shortages of goods and services with relatively inelastic demands. When this shock persists, this may lead to headline inflation. As such, extreme weather events may have a (short-term) stagflationary impulse as it combines weaker growth with higher prices. The relative strength and persistence of these effects depend on factors such as economic diversification, import capacity, energy dependence, and policy buffers. Empirical evidence shows that extreme weather events can also be followed by a temporary boost to GDP, due to an increase in investment and spending in reconstruction.[36]

Several cases illustrate the significant negative growth effects following an extreme weather event. For example, the droughts in Zambia (2023-2024) led to a revision of projected 2024 growth from 4,7% to 2,3% due to the disruption of economic activities. In Fiji (2016), Cyclone Winston caused GDP growth to slow down from 3.8% in 2015 to 0.4%[37] in 2016, driven by disruptions in agriculture, tourism and consumption. In Pakistan (2022), the effects were particularly pronounced, with real economic growth dropping to -0,6% in 2023 (from 6,1% in 2022). By contrast, in larger and more diversified economies such as Canada (2016) and Brazil (2024), extreme weather events reduced output regionally but had only modest and short-lived effects on national GDP. In South Africa (2022), the floods contributed to a reduction of 1.8% in Durban's annual GDP, while the country's GDP fell by 0.7% in Q2 2022. In Spain (2024), estimates indicate that the regional wealth loss in Valencia amounted to more than €17 billion, that would exceed 20% of the regional GDP. By contrast, the impact on Spain's aggregate national GDP growth in Q4 was between 0.1 pp and 0.2 pp.

While inflationary effects are primarily noticeable in food prices, they can become more broad-based, driven primarily by supply constraints and real income effects. Disruptions to agricultural production and logistics repeatedly triggered sharp increases in food prices. Similar, though more localised pressures were observed in middle- and high-income economies. Following floods in South Africa's (2022) KwaZulu-Natal region, the cost of the food basket increased by more than 13%. In Southern Europe, floods and droughts in Italy (2023) and France (2016) contributed to temporary food price spikes despite limited national GDP effects, highlighting how extreme weather events can generate inflationary pressures even when aggregate output losses are contained. In Pakistan (2022), flood-related damage to crops and transport infrastructure pushed food inflation to 37% (up from 13.4%), while in Zambia (2023-2024) drought-related crop failures and energy shortages lifted headline inflation, with food prices contributing disproportionately. Some of the key evidence for the weather induced inflation is also demonstrated in Box 2 in Annex.

Extreme weather events also generate long run impacts through human health, creating additional losses through higher healthcare costs, reduced labour productivity, and long-term human capital damage. For example, studies both in developed and developing economies show that heatwaves amplify air pollution risks.[38] During the drought in Zambia (2023-2024), some households adopted crisis livelihood coping strategies such as reducing expenditure on health (27 percent), selling household goods (20 percent) and selling productive assets (16 percent), directly reducing future productivity.

Under specific macroeconomic conditions, extreme weather events can also affect exchange rates. Currency pressures tend to arise in economies with high import dependency and limited fiscal buffers (see also Section 4). The floods in Pakistan (2022) provide a clear example: the total economic impact ultimately caused a pronounced depreciation of the Pakistani rupee. Similar dynamics were observed following the drought in Zambia

35 Usman *et al.* (2024) – Going NUTS: The regional impact of extreme climate events over the medium term. A subnational examining GDP impacts across EU regions at the NUTS3 level find that extreme weather events significantly reduce regional output growth, with an estimated impact of – 2.4%. Extending the analysis to 1,600 regions in 31 countries, Costa *et al.* (2025), The macroeconomic implications of extreme weather events, find that severe events reduce regional output by 2.2% relative to trend, with a 1.7% loss persisting after five years.

36 This rebound reflect the limitations of GDP as a measure of welfare, as post-disaster growth may mask significant distributional losses.

37 3,5% projected before the event.

38 Kalisa *et al.* (2025) – Heatwaves amplify air pollution risks in Sub-Saharan Africa.

(2023-2024), where higher food and electricity imports combined with reduced export earnings put pressure on loans denominated in foreign currency, leading to exchange rate risks. By contrast, in advanced economies and in cases with effective risk-transfer mechanisms – such as Jamaica's Hurricane Melissa, where catastrophe bond payouts and external financing provided rapid foreign-currency liquidity – exchange rate effects were limited or absent despite very large headline damages.[39]

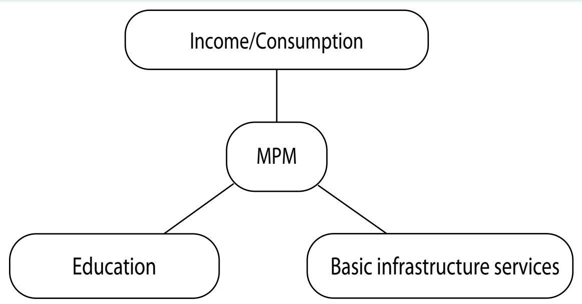
As a result of a complex interplay of supply and demand factors along with spillovers, extreme weather events can seriously impact income, consumption, livelihood, basic infrastructure services and access to education particularly in developing economies. Box 1 illustrates some of the examples of multidimensional deprivations caused by weather events, using the World Bank's measure of multidimensional poverty.

39 Empirical evidence using monthly data for 177 countries shows that exchange rates in emerging markets and developing economies are particularly sensitive to such shocks: in countries with flexible exchange rate regimes, nominal effective exchange rates can depreciate by up to around 6 percent within two years after an extreme weather event, and even more following large events (Ngoc Nguyen and Minh Nguyen 2024, IMF).

Box 1

Extreme weather events and multidimensional poverty

The World Bank[1] estimates that the impact of extreme weather events accounts for an annual consumption loss of USD 520 billion globally, pushing 26 million people into poverty every year. The World Bank's Multidimensional Poverty Measure (MPM) tries to capture poverty beyond monetary deprivations by including access to education and basic infrastructure (figure below).[2] The MPM is used in the NGFS case studies to analyse signals of increased poverty following an extreme weather event.



Income, consumption and food insecurity

The Pakistan flood (2022) led to USD 30 billion in damages (9.7% of Pakistan's GDP). This resulted in an increase in the national poverty rate by 3.7-4 percentage points, pushing over 9 million additional people into poverty.[3] Similarly, the Eloise cyclone in Eswatini (2021) raised food security concerns, leading to a temporary surge in emergency food imports. In Zambia (2023-24), the agriculture loss during the drought caused severe food insecurity for over 5.8 million people. The drought in Namibia (2019) resulted in a widespread food shortage for one-third of the population, making them depended on drought reliefs.

Basic infrastructure services: drinking water, sanitation and electricity

As a second pillar of poverty, people may be deprived of access to critical infrastructure, as observed following the droughts in Zambia (2023-2024) that resulted in severe electricity shortages. Electricity supply GVA decreased by 28.9% in 2024, which is the single largest negative sectoral contribution. As a result, Zambia recorded loadshedding through 2024, with 8-12 hours/day from March to May and up to 21 hours/day by late 2024 in some areas. In Ecuador (2024), the drought seriously strained the hydroelectric energy production which led to electricity rationing. During the flood in Pakistan (2022), while an estimated 5.4 million people were reported to be consuming unsafe drinking water, 6.3 million people were estimated to have lost access to proper sanitation facilities. In the affected regions in Zambia (2023-2024), 2.4 million school aged children lacked safe drinking water and school meals amid the drought.

Education: educational attainment and educational enrolment

In Pakistan, millions of children went without access to learning during the flood as it severely disrupted education systems by damaging or destroying 25,187 schools. A study conducted by UNESCO in 2023 also confirmed that extreme weather events can negatively impact access, quality and inclusiveness of education[4].

1 World Bank (2017) – Unbreakable, Building the Resilience of the Poor in the Face of Natural Disasters.

2 The MPM is composed of six indicators: consumption or income, educational attainment, educational enrolment, drinking water, sanitation, and electricity. These are mapped into three dimensions of well-being: monetary, education, and basic infrastructure services.

3 Quantifying the poverty impact of the 2022 floods in Pakistan.

4 Learning at risk: the impact of climate displacement on the right to education; global report – UNESCO Bibliothèque Numérique.

3. Extreme weather events can also be transmitted to the financial system

This section outlines how extreme weather events are transmitted through financial channels, potentially giving rise to traditional financial risks such as credit, market and liquidity risks. It describes the impact on banks and insurers, as well as the international spillover mechanisms that may arise from portfolio interconnectedness and stress in currency markets.

3.1 Financial transmission channels

Financial institutions, which finance and provide insurance to businesses in the real economy, may see their balance sheets affected by an extreme weather event, due to higher financial risks (credit, liquidity, market, operational, underwriting risks). These events may impact the asset side through a decrease in the value of loan, bond, and equity portfolios, but can also affect the liability side. Insurers, for example, may incur higher claims, in both life and non-life insurance following an extreme weather event.

As a first transmission channel, extreme weather events can increase credit risk on a financial institution's balance sheets, primarily through higher probabilities of default (PDs) and rising non-performing loan (NPL) ratios. Disruptions to production, employment and income weaken borrowers' cash flows and repayment capacity, particularly in sectors and regions directly affected by the event. The cases covered in this note show that in advanced economies, these effects have generally been moderate and temporary, as observed after the floods in Germany (2021) and the wildfires in Portugal (2017). In developing economies, however, credit risk effects tend to be larger and more persistent. Following the floods in Pakistan (2022), for example, substantial increases in non-performing loans were recorded in the banking and microfinance sectors. This is consistent with broader empirical literature showing that extreme weather events can increase PDs and NPLs and, in more fragile systems, may raise the likelihood of bank distress or failure.[40]

A second transmission channel operates through declines in collateral values, although this mechanism is less frequently observed directly in the case studies. The German flood case (2021) provides the clearest evidence: banks experienced a contraction in collateral values in flood affected regions, while collateral values in non-affected regions remained stable or improved. Other cases point to this mechanism more indirectly. Following the DANA floods in Valencia (2024), large-scale destruction of residential and commercial property resulted in estimated wealth losses of around €17 billion, implying a significant deterioration in real estate collateral values. Likewise, the case of the flood in France (2016) documents substantial damage to machinery, equipment, and business premises – asset classes commonly pledged as collateral – particularly in manufacturing and retail sectors.

As a third channel, extreme weather events may cause temporary liquidity pressures for financial institutions due to emergency cash withdrawals, payment deferrals, or cashflow disruptions among borrowers. For instance, following the floods in Brazil (2024), banks reported increases in loan renegotiations, payment moratoria, and drawdowns of existing credit lines by firms and households. While no persistent funding stress emerged, the episode shows how physical shocks create short-term liquidity needs. In Pakistan (2022), widespread payment deferrals at microfinance institutions after the floods led to liquidity strains and declining capital buffers. Similarly, in Canada (2016), mortgage delinquencies in the affected area rose from 0.59% before the event to over 0.90% within a year, before gradually reverting to pre-flood values within 12-18 months. These cases indicate that liquidity channels are typically transitory, but can be material for smaller, less diversified, or weakly capitalised institutions or branches.

40 Nie, Regelink & Wang (2023) – Banking Sector Risk in the Aftermath of Climate Change and Environmental-Related Natural Disasters.

3.2 Feedback effects from the financial sector to the real economy

Financial sector stress may feed back into the real economy when banks tighten credit conditions in response to higher risks. Overall, the case studies suggest that banks generally remained well capitalised and liquid following extreme weather events. However, some episodes point to more pronounced impacts on local credit supply. In Pakistan (2022), following the floods, the sharp rise in non-performing loans led to an increase of more than 50% in loan-loss provisioning, compressing capital adequacy ratios below regulatory thresholds in specific parts of the banking and microfinance sector. This constrained lending, particularly in flood-affected areas, reinforcing the economic downturn. These findings highlight that while systemic risks are often contained, local credit tightening can materially amplify the economic impact of physical hazards, especially in financially constrained environments.

Loan moratoria, payment deferrals and debt restructurings may dampen the financial impact. For example, following the Canadian wildfires (2016), targeted relief measures offered by banks such as payment deferrals, fee relief and flexible credit arrangements, helped to contain the persistence of arrears. Similarly, following the floods in South Africa (2022), several banks waived certain fees to help customers manage financial losses and claims following the floods. The same was observed for some French banks which, following the floods in 2016, deferred annual loan repayments and spread out loans that were used for the purchase of agricultural machinery and equipment. Also, in Spain (2024), loan moratoria were introduced for affected consumers, self-employed individuals and SMEs, suspending loan repayments and interest accrual to help ease their debt burden. Additionally, after the storm in Greece (2023), financial institutions implemented temporary suspensions of debt collection and payment obligations for affected households and businesses, in line with guidance and coordination from public and prudential authorities.

3.3 National and international financial spillovers

As banks and insurance companies are interconnected through interbank loans, security holdings and payment systems, extreme weather events might trigger financial spillovers to other regions. While not directly observed in the cases[41], Rehbein and Ongena (2022) demonstrated that during the 2013 floods in Germany, local banks exposed to flood-related losses in affected areas subsequently reduced lending in unaffected regions in which they also operated. This credit contraction occurred because banks, facing depleted capital buffers due to disaster losses, reduced their lending more broadly, thereby transferring the negative economic effects of localized disasters to unaffected areas.[42]

While not directly observed in the cases, the damage and subsequent devaluation of real estate assets could also generate financial spillover effects. This stress could spread to the financial system through the reassessment of these asset prices, an increase in default risk probability, and rising insurance premiums. To date, historical evidence of such a shock leading to international spillover effects remains limited, but may grow over time as extreme weather becomes more severe.[43]

The reinsurance market constitutes another channel through which localized climate shocks can generate international financial spillovers. While extreme weather events initially translate into claims at the domestic level, a significant share of the associated financial losses may be transferred abroad through reinsurance arrangements. By design, reinsurers – often large and international – allow national insurance markets to pass on part of disaster-related losses to global balance sheets. This is illustrated, for example, by the case of Pakistan (2022), where the floods generated insurance claims of USD 95.9 million across life and non-life sectors. Most of the exposure was reinsured abroad, leaving only USD 25.3 million in domestic claims uninsured or not reinsured. Post-shock,

41 Due to the design of the survey, members were not specifically asked about spillover effects outside of their jurisdictions.

42 While not yet observed in the case studies, the potential for cross-national spillovers from extreme weather events is substantial, especially given the global reach of major banks and insurers. The interconnected nature of the global financial system means that the economic shock of a localized disaster can quickly spread, affecting businesses, households, and economies worldwide (FSB (2025) – Assessment of Climate-related Vulnerabilities: Analytical framework and toolkit).

43 Financial Stability Board (2023), Assessment of Climate-related Vulnerabilities – To demonstrate how the framework can be applied in practice, the report examines the potential financial stability consequences of the crystallisation of climate physical risks via real estate markets. The analysis involves a severe yet plausible conceptual scenario of how a climate physical shock to the real estate sector may affect financial stability if insurance becomes less available, which causes risks to shift to households and businesses or to governments. It also identifies the different channels through which risks could spread across the financial system and relevant metrics to monitor such channels.

the large insurers remained largely insulated due to high reinsurance coverage (up to 95%), keeping the overall liquidity impact minimal. A similar mechanism was observed in Jamaica (2025), where extensive reliance on international reinsurance – complemented by the Caribbean Catastrophe Risk Insurance Facility (CCRIF) – implied that a large share of climate-related financial losses was absorbed outside the domestic financial system. Beyond traditional reinsurance, insurers can rely on alternative risk transfer instruments, such as catastrophe bonds, to further diversify climate risk.

4. Resilience of the economy

The macroeconomic and financial impacts of extreme weather events are not determined solely by the magnitude and exposure to the physical shock, but also by the capacity of economies to absorb, redistribute and recover from losses. This section examines the factors that shape the capacity of economies to absorb and recover from extreme weather shocks, such as fiscal space, adaptive infrastructure, level of economic development, depth and efficiency of the insurance market, and economic diversification.

4.1 Adaptive infrastructure and policies

From an ex-ante perspective, integrating adequate infrastructure and other pre-emptive measures can help mitigate the effects of extreme weather events. As Hallegatte and co-authors[44] have documented, wealthier regions tend to benefit from stronger institutions, better protective infrastructure and more extensive social safety nets which reduce economic damages of extreme weather events. Examples of protective infrastructure are the Thames Barrier in London, the Netherlands' system of storm surge barriers, and the Venice MOSE Barrier system. Because such systems involve high upfront costs and create large positive externalities, governments are often best placed to ensure they are built and maintained. However, due to these high costs and funding needs, adaptation investments are sometimes deferred or insufficient, especially in developing countries. Beyond infrastructure, risk-sensitive urban planning could further mitigate losses, for instance by restricting construction in high-hazard areas or improving the availability and quality of hazard data to inform land-use decisions.

Another type of pre-emptive measure was introduced by some small island states, which aimed to develop innovative financial instruments to protect their economies against extreme weather consequences[45]. For instance, Grenada and Barbados were pioneer countries in incorporating natural disaster clauses into their (state-contingent) debt instruments, allowing for the automatic deferral of debt service payments in the event of such shocks. Box 3 in the appendix focusses on how extreme weather events affect particularly island economies.

4.2 Insurance absorbs part of the losses within the private sector[46]

Broad and efficient insurance coverage plays a key role in post-disaster recovery, by pooling risks and ensuring rapid payouts. Giuzio and co-authors[47] show that economies with higher insurance coverage experience significantly smaller output losses following extreme weather events. Many cases show large volumes of insured losses, and subsequent insurance payouts. The wildfires in Portugal (2017) triggered the largest insured loss in Portugal, with claims (paid or provisioned) amounting to €230 million (approximately €150 million was linked to commercial and industrial activities). The typhoon in Japan (2018) caused record-high insurance payout for an extreme weather event excluding earthquakes, amounting to 1.07 trillion yen (equivalent to USD 9.7 billion). Similarly, in France, the public private Cat-Nat regime[48] ensured predictable compensation of around €1.2 billion after the floods (2016), and approximately €3.6 billion for the drought (2022), which alone accounted for more than 95% of total Cat-Nat claims that year. In both French cases, banks remained well capitalized despite exposures to affected firms, illustrating how insurance payouts and public reinsurance arrangements dampen financial amplification.

44 Hallegatte *et al.* (2016) – Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters.

45 Clearly Gottlieb (2021), Sovereign Debt Evolution: The Natural Disaster Clause – Cleary Gottlieb (2021).

46 For a more detailed discussion on the role of insurance, see IAIS (2025).

47 Guizio *et al.* (2025) – Climate change, catastrophes, insurance and the macroeconomy.

48 The French CatNat regime (Catastrophes Naturelles) is a mandatory public-private insurance system that guarantees compensation for direct damage caused by natural disasters, such as floods, droughts, and earthquakes.

In another public-private example, DANA in Valencia (2024) generated around 250,000 insurance claims. By late 2025, the Spanish Insurance Compensation Consortium (CCS)[49] had paid over €4 billion in compensation and estimated the total insured cost at approximately €4.8 billion, making it the costliest extreme weather event ever managed by the Consortium. Nevertheless, given that such schemes usually benefit from government guarantees, fiscal risks are not entirely removed but rather partially transferred to the sovereign.

Despite its stabilizing role, insurance coverage gaps remain across economies and hazards.[50] Even in advanced economies, such coverage gaps persist. After the Limburg floods in the Netherlands (2021), insurers paid out a total of €224 million in compensation, while an additional €104 million in uninsured losses was channelled through the public Act on Compensation for Damage in the Event of Disasters. Even so, a residual share of losses remained uncovered (estimated at approximately €60 million).[51] Following the floods in Germany (2021), one-third of total losses (€8.7-9 billion out of approximately €33 billion) were insured, and with no NatCat scheme in place, a large government relief fund (€30 billion) also came into play, providing compensation for at least part of the uninsured losses. As well as public infrastructure, affected individuals, companies and institutions could apply to receive compensation for documented uninsured losses of up to 80%, or even 100% in cases of hardship. In developing economies, the insurance protection gap is considerably wider. The dominance of bank credit over insurance as a recovery mechanism can slow the post-disaster recovery. This pattern was observed after the Amphan storm in India (2020), where households increased borrowing to finance reconstruction. As a result, many households reduced food consumption to service debt, and rural employment declined as financial resources were redirected toward rebuilding efforts.

Operational challenges can affect the stabilizing role of insurance, when extreme weather events generate a large volume of claims within a short period. In South Africa (2022), delays in insurance payout and litigation disturbed infrastructure rebuilding and economic activity resetting, further amplifying the economic effect of the disaster. During the 2023/24 drought in Zambia, farmers – many of whom had paid premiums into a safety net system – faced prolonged waits, unclear communication, and eroded trust as insurers struggled with operational bottlenecks and high payout volumes. Such operational shortcomings may also point to gaps in regulatory and supervisory frameworks. More broadly, cost and benefits associated with insurance mechanisms may be distributed unevenly across countries and socioeconomic groups (e.g. across households, SMEs, and regions), and their implementation can be affected by political and institutional constraints, including fiscal space, acceptability, and affordability.

4.3 Fiscal space limits the spread of economic and financial shocks

The capacity to absorb shocks and the scale of public spending directed toward support measures are critical determinants of recovery.[52] Reflecting this, advanced economies typically ramp up public expenditure rapidly after extreme weather events, whereas developing economies – constrained by limited fiscal space – tend to exhibit weaker and slower fiscal responses.[53]

These differences in fiscal capacity are clearly reflected in the nature and scale of public responses implemented following cases. Across all GDP levels, jurisdictions responded publicly to the extreme weather events in the case studies, with differences primarily in scale and self-sufficiency. Following severe flooding, both Spain (2024) and Germany (2021) adopted large-scale public support measures: Spain introduced urgent support for households

49 The Spanish Insurance Compensation Consortium (Consorcio de Compensación de Seguros or CCS) is a public, state-run entity that provides mandatory insurance coverage for extraordinary natural disasters (floods, earthquakes) and political risks (terrorism, riots) in Spain. It operates as a safety net funded by surcharges on private insurance policies, covering damages not typically covered by standard policies.

50 In 2024, global insured losses from natural catastrophes (climate-related or otherwise) amounted to 137 billion, relative to 318 billion USD in total reported economic losses, according to Swiss Re – Natural catastrophes: insured losses on trend to USD 145 billion in 2025.

51 This affected in particular businesses with exchange policies and firms that did not claim turnover losses under the applicable scheme – HKV (2023) – Actualisatie inschatting schade Limburg 2021.

52 Del Valle *et al.* (2020), Rules for recovery: impact of indexed disaster funds on shock coping in Mexico.

53 Minh Nguyen *et al.* (2025) – Understanding the Macroeconomic Effects of Natural Disasters.

and businesses after flash floods in Valencia, including a €5 billion (around 5.4 billion USD) public guarantee facility and a temporary loan moratorium, while Germany established a €30 billion (around 35.5 billion USD) federal and state fund to finance urgent reconstruction after the 2021 floods. While developing economies also deployed such responses, they sometimes also (partly) relied on international aid and support. South Africa (2022), for example, issued around USD 55 million in disaster relief funding through the National Treasury, while also relying on international Red Cross contributions.

However, increasing government expenditures may in itself weaken the fiscal position of an economy, while lower economic activity may simultaneously reduce tax revenues. For example, after the flooding in Pakistan (2022), there was lower economic activity, which resulted in tax bases (income, production and trade) declining, precisely at a time when government expenditure was increasing. In advanced economies, fiscal policy tends to respond countercyclically, with increased public spending and transfers helping cushion economic downturns. By contrast, responses in developing economies are often procyclical, reflecting limited borrowing capacity and tighter financing constraints.[54]

Although not observed in the cases reviewed, larger deficits and higher debt levels may increase sovereign credit risk and, consequently, borrowing costs, which then feed back into fiscal dynamics.[55] Moreover, acute climate related disasters themselves trigger repricing in sovereign bonds, especially, for highly indebted and lower income economies.[56] In severe cases, these dynamics can culminate in sovereign credit rating downgrades. Such was also the case for Pakistan after the 2022 floods.[57]

The repricing of sovereign debt has the potential to send shock waves throughout the financial system.[58] Sovereign bonds typically constitute a large share of domestic banks', insurance companies' and other institutional investors' asset portfolios. A rise in sovereign yields reduces the market value of these holdings, weakening capital positions of banks and other market participants, and potentially tightening credit supply to the private sector. The weakening of banks' balance sheets increases the probability that banks would have to be bailed out by the government, which increases sovereign distress even further.[59] This dynamic is known as the "sovereign-bank nexus," where deteriorating sovereign risk transmits to the banking system and feeds back into macro-financial instability. The increased risk and repricing of sovereign bonds undermine their role as safe assets in the economy and disturbs the functioning of financial markets. As sovereign bonds become riskier, their value as collateral in the funding markets weakens, impairing traders' balance sheet capacity and reducing market-making activity, which in turn can diminish secondary market liquidity to a dysfunctional level.[60]

4.4 Economic diversification and other resilience factors

Lastly, more fundamental economic characteristics such as a lack of diversification, low labour mobility, and weaker social safety nets make it more difficult for economies to reallocate resources and support recovery, amplifying the long-term macroeconomic consequences of extreme weather.[61] For example, in Pakistan, agriculture is a large sector of the economy, contributing 24% of total GDP and 37.4% of employment in 2023. Large areas of land, particularly growing the nation's stable crops such as rice

54 See for example Ilzetzki and Vegh (2008).

55 Baldacci and Kumar (2010) – Fiscal deficits, public debt, and sovereign bond yieds.

56 Anyfantaki *et al.* (2025) – Decoding climate-related risks in sovereign bond pricing: a global perspective.

57 See Fitch (2022), via link.

58 Sovereign bonds typically constitute a large share of domestic banks', insurance companies' and other institutional investors' asset portfolios. A rise in sovereign yields reduces the market value of these holdings, weakening capital positions of banks and other market participants, and potentially tightening credit supply to the private sector. The weakening of banks' balance sheets increases the probability that banks would have to be bailed out by the government, which increases sovereign distress even further (Brunnermeier *et al.*, 2016; Acharya, Drechsler & Schnabl, 2014). This dynamic is known as the "sovereign-bank nexus," where deteriorating sovereign risk transmits to the banking system and feeds back into macro-financial instability. The increased risk and repricing of sovereign bonds undermine their role as safe assets in the economy and disturbs the functioning of financial markets.

59 Brunnermeier *et al.* (2016); Acharya, Drechsler & Schnabl (2014).

60 Brunnermeier and Pedersen (2008) – Market liquidity and funding liquidity.

61 Costa and Hooley (2025) – The macroeconomic implications of extreme weather events.

and cotton were destroyed by floodwaters, reducing the country's food availability and driving more people into poverty. In Eswatini (2021), the concentration of activity in agriculture and forestry resulted in a disproportionate output loss. These losses also propagated to manufacturing and transport service subsectors, thus amplifying total economic losses beyond the directly affected sector.

In this light, the economic impact of extreme weather events on small island economies is unique due to their remoteness, smaller and less diversified economy, and relatively weak fiscal cushion. Box 3 in the Annex illustrates the economic impact of extreme weather events on island economies based on three cases: Hurricane Melissa in Jamaica (2025), Belal Cyclone of Mauritius (2024) and Winston Cyclone in Fiji (2016).

5. Extreme weather events can impact price stability and resilience of the financial system

This section explains how extreme weather events can impact price stability and the resilience of the financial system. It discusses the tools for risk mitigation available to central banks and supervisors, as well as other relevant stakeholders.

The case studies show that extreme weather events generate complex and heterogeneous economic financial effects, across hazards and economies. In each instance, different transmission channels shaped the economic and financial impacts, often amplifying pre-existing vulnerabilities in the real economy or the financial system.[62] Central banks typically operate under a dual mandate to maintain price and financial stability.[63]

If extreme weather events affect economic outcomes, then they are a relevant consideration for monetary policy makers just like any other economic shock. If the shock is temporary, policymakers may look through it; but if it becomes persistent or recurrent, or if second-round effects on inflation or inflation expectations are anticipated, a monetary policy response may be required.

The review included cases where extreme weather shocks directly impact growth and inflation assessments that inform policy decisions. In the aftermath of the 2022 floods, the State Bank of Pakistan (SBP) tightened the monetary policy stance to contain the severe inflationary pressures exacerbated by the disaster. As such, the SBP raised its policy rate by a cumulative 825 basis points from July 2022, bringing it to 22.0% by the end of FY23, contributing to bringing inflation back down.

Financial stability is generally understood as the ability of the financial system to absorb shocks while continuing to provide essential services. Where extreme weather events threaten this resilience – whether through for example loan losses, volatility in financial markets, or disruptions to payment and credit systems – central banks can act within their mandates to mitigate these risks.[64] Integrating extreme weather event effects into financial stability monitoring is therefore a natural step to allow central banks to discharge their capabilities. Specific tools developed in this context vary according to factors such as each institution's particular mandate and the jurisdiction's legal and regulatory framework. In recent years, many central banks included stress testing methodologies and scenario analysis in their toolkits to better assess the impact of weather shocks.

As an example of responses focused on ensuring financial stability, in Brazil (2024), after the floods in Rio Grande do Sul, the BCB implemented a set of targeted measures to preserve financial stability and ensure continuity of financial services in the affected regions. The BCB intensified its supervisory communication with financial institutions operating in the affected areas and introduced temporary regulatory flexibilities, like exceptional conditions for borrowers, relaxed loss provisioning rules for credit operations under federal programmes, and a temporary allowance for banks to deduct reserve requirements on savings deposits. The BCB monitored loan modifications closely, as they increased sharply in the second quarter of 2024, although these did not translate into higher credit losses by year end. This helped to maintain the smooth functioning of the National Financial System. Partial credit guarantees have also been used in some to maintain lending post disaster (Thailand, 2011; Morocco, 2015[65]). In another example, after the 2024 floods in Valencia, the Banco de España monitored the availability of cash, ensured the functioning of ATMs and payment services, and implemented special procedures for exchanging damaged banknotes, safeguarding basic financial operations during the recovery phase.

62 FSB (2025) – Assessment of climate-related vulnerabilities.

63 Tamez, M., Weenink, H., & Yoshinaga, A. (2024) – Central Banks and Climate Change: Key Legal Issues. In some jurisdictions, central banks additionally have a role as advisor to the government.

64 IMF (2024) – Central Banks and Climate Change: Key Legal Issues.

65 The case in Thailand is not included in the NGFS sample. Information is based on the report World Bank (2011), Thai flood. Information on the drought in Morocco also comes from the International Monetary Fund (2016) Morocco, Financial system stability assessment.

In parallel, the core objective of financial supervision – to promote the safety and soundness of individual financial institutions and the financial system – provides a clear basis for regulatory and supervisory measures addressing risks from extreme weather events, insofar as these risks affect financial resilience. Both banking and insurance supervision have a role to play here, ensuring institutions are resilient enough to withstand the aftermath of an extreme weather event. From a banking perspective, some cases show that financial institutions can be directly affected by extreme weather events via operational channels and through credit and market risks, for example through an increase in NPLs.[66] From an ex ante perspective, important tools available to central banks and supervisors are stress testing and scenario analysis.[67] An example of how central banks and supervisors support their financial institutions is the Hong Kong Monetary Authority's cloud-based platform for banks to assess the impact of physical risks on residential and commercial buildings. These types of data can feed back into regulatory dialogue and as such raise sectoral awareness of the risks associated with extreme weather events. From an ex-post perspective, supervisors might offer temporary regulatory flexibility to help maintain lending and liquidity in affected regions.

The frequency and intensity of extreme weather events are rising, with important implications for both macroeconomic and financial risks, so that central banks and supervisors should take these events into account. However, as mitigating the effects of extreme weather events is multifaceted, it is important that there is close collaboration between all stakeholders, both before and after extreme weather risks materialise. Close collaboration between governments, the sector, central banks and supervisors is vital for effective and efficient risk mitigation. The case study assessment reveals important data gaps on hazards, exposures and losses. Investing in better data quality and availability may enhance risk mitigating strategies from banks, insurers and governments alike, presenting as a viable way forward for future work.

66 ECB – Managing climate-related risks.

67 See for example Ranger *et al.* (2022).

Conclusion

The note highlights that extreme weather events affect the economy and the financial system through multiple transmission channels. These impacts are highly diversified and complex, reflecting differences in the type of hazard, exposure and vulnerability. Similar events can generate markedly different macroeconomic and financial outcomes across economies and regions.

While the case studies provide valuable insights, significant gaps in the measurement and assessment of such impacts remain, notably with respect to cross-border spillovers and second-round effects. Strengthening analytical frameworks and improving data to better capture these spillover effects would therefore be a key priority for future work. This work is based on past physical events and therefore does not provide a forward-looking assessment of risks. Prospective analyses would be welcome in the future to complement the current assessment and to identify the largest financial exposures and vulnerabilities.

In this respect, further work by the NGFS could help advance a better evaluation of the macroeconomic and financial implications of extreme weather events, building on the evidence gathered in this note.

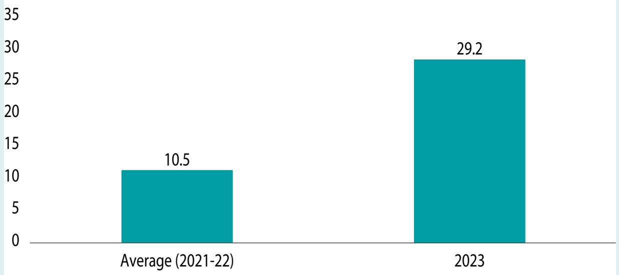
Annex

Annex 1 – Box 2: Weatherflation: evidence from case studies[68]

The inflation effects of a specific severe weather event depend on whether the demand or the supply effects of the event dominate. Severe weather events generate negative shocks to both supply and demand, and these effects usually push inflation in opposite directions. The interplay of demand and supply factors depend on the type of events, the sectors exposed, the structure and maturity of the economy, location, seasonality, and time horizon. While the weather induced inflationary effects concern all economies, the effects are found to be more pronounced in the case of developing economies.[1]

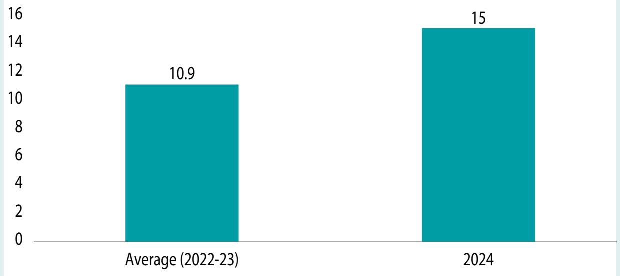
Several cases show significant contagion[2] and inflationary pressures for a short period[3], which subdued as the economy recovered from the shock, namely Belal Cyclone of Mauritius (2024), Hurricane Melissa in Jamaica (2025) Winston Cyclone in Fiji (2016). For instance, post the cyclone, inflation in Fiji remained above the 5.0 percent mark for five consecutive months before started decelerating. For Mauritius, food inflation accelerated from 3.6 per cent to 15.8 per cent immediately after the cyclone. The lingering impacts on inflation were evident in the case of the flood in Pakistan (2022) and drought in Zambia (2023-24), see figure below.[4]

Pakistan



Source: IMF WEO.

Zambia



Source: IMF WEO.

After the flood in Pakistan, food inflation shot up from 13.4 per cent to 37.3 percent in urban areas and from 13.0 per cent to 40.8 per cent in rural areas, largely due to flood damage to crops, livestock, and farming infrastructure such as wheat storage. The inflationary pressure was further exacerbated by the higher energy prices and depreciation of domestic currency which collectively led CPI inflation to move to 29.2 per cent in 2023 from an average of 10.5 per cent during 2021-22.

In case of Zambia, food inflation was in double-digits and rose throughout 2024, reaching a peak of 17.4 per cent in July amid drought related supply shortages. Inflation was also driven by higher import demand, currency depreciation, and energy prices. Combined, these factors pushed inflation to 15 per cent in 2024 from an average of 10.9 per cent during 2022-23.

The central banks, particularly central banks of Pakistan and Zambia, raised their policy rates to arrest the build-up of inflationary pressures in their economy. Pakistan raised policy rates by 825 basis points to stabilize the macroeconomic situation post the extreme climate disaster.[5]

1 Cevik *et al.* (2023) – Eye of the Storm: The Impact of Climate Shocks on Inflation and Growth.

2 Through demand and supply channels.

3 In addition to the cases mentioned in section 2.4.

4 17 consecutive months of rising inflation in case of Zambia.

5 It may be noted that while weather events have played a dominant causative role for inflation, this is not the sole reason for the higher inflation in these economies. Various global and domestic factors have also contributed to the build-up of inflation.

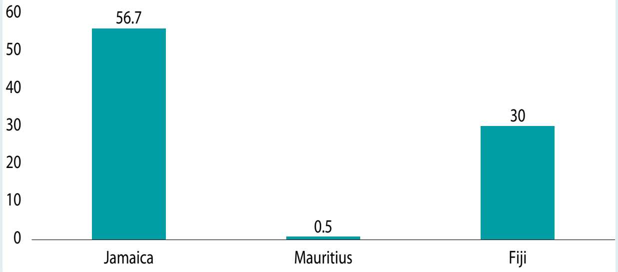
68 Weatherflation refers to the weather induced inflation.

Annex 2 – Box 3: How extreme weather events affect island nation economies

Small island economies are more vulnerable to extreme weather events.[1] The economic cost of extreme weather for small island economies is approximately 18 per cent of their GDP on average, which is significantly higher than the world average of around 3 per cent.[2] The weather events also disrupt the long-term growth and investments as significant resources are diverted for reconstruction post the event. The disasters usually take a heavy toll on the fiscal capacity and trade balance of these economies.

Economic Loss

(per cent of GDP)

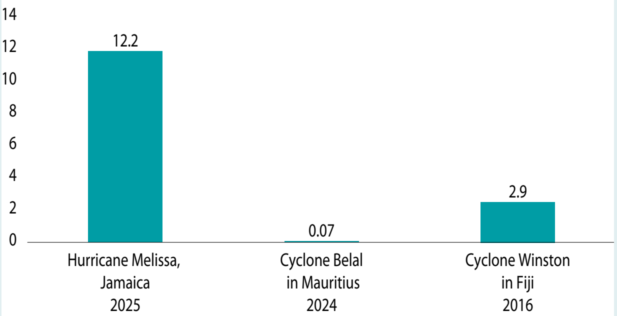


Significant economic loss *vis-à-vis* lower size of the economy

In Jamaica, Hurricane Melissa resulted into an economic loss of ~ 57% of Jamaica's GDP and in Fiji, Cyclone Winston led to a loss of around 30 per cent of GDP. However, economic loss is found to be lower for Mauritius from Cyclone Belal[3] compared to the total size of its economy. To compare with advanced economies, floods in France in 2016 and Germany in 2021 caused economic loss which is less than 1 per cent of their GDP. It demonstrates the higher vulnerability of island economies to weather shocks.

Economic Loss

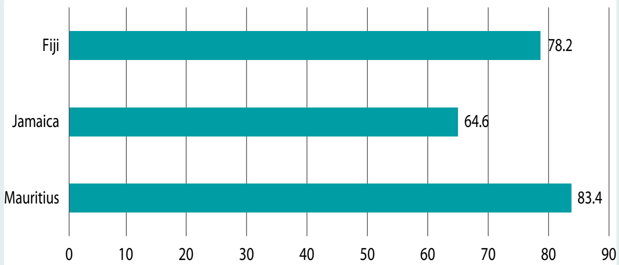
(USD Billion)



Fiscal and debt sustainability concerns

Fiji's public debt-to-GDP ratio considerably increased post the Winston cyclone.[4] For Jamaica, post Hurricane Melissa, public debt was projected to be higher by 5.2 per cent at end-FY 2025/26 relative to the earlier estimate of 64-65 per cent. These island economies are already in the indebted category as their debt GDP ratio stands above their threshold target.[5] This would make these island nations vulnerable to extreme weather events.

Gross Debt-GDP Ratio



Source: IMF WEO.

…/…

1 UNDP (2018) – After the Rain: The Lasting Effects of Storms in the Caribbean.

2 The Payne Institute for Public Policy (2025) – Small costs for large gains: climate resilience in small island developing states.

3 Not inclusive of infrastructure damages.

4 Major factor behind the increase in government's debt to GDP percentage was the expenditure of around $500 million from 2016 to 2018 to address the damages from cyclones.

5 For Jamaica the target is 60 per cent and for Mauritius, it is 80 per cent (References: National Budget 2025-2026 | Public Finance and Debt Reduction Lessons from Jamaica.

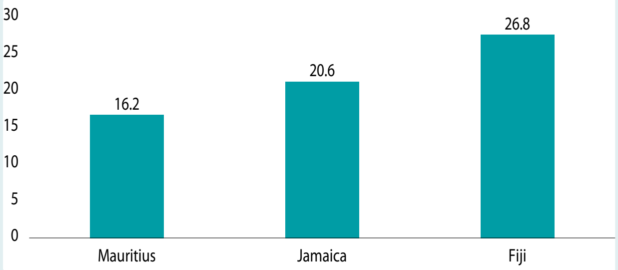
Inflation

While Belal Cyclone in Mauritius (2024), Hurricane Melissa in Jamaica (2025) Winston Cyclone in Fiji (2016) produced significant contagion and inflationary pressures for a short period, the effects subdued with the recovery from the disaster (refer Box 2 also).

Impact on current account balance

The weather events impacted the current account balance mainly through higher imports and decline in exports. Since tourism is a major contributor to GDP (figure below), weather shocks could put pressure on the balance of payment position including forex reserves of these economies through impact on the tourism sector. For instance, Fiji's current account deficit in 2016 expanded by 1.4 percent mainly driven by the decline in exports, increase in imports stemming from reconstruction demand and around 30-40 per cent decline in tourism.

Travel and Tourism Contribution to GDP



Source: World Travel and Tourism Council (WTTC).

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