CDRI
Coalition for Disaster Resilient Infrastructure

Global Infrastructure Resilience Working Paper

Financing

Closing the gap to capture the resilience dividend

GIR FINANCE
2025 WORKING PAPER

This work is a product of the Coalition for Disaster Resilient Infrastructure (CDRI), as part of a working paper series under the ambit of the second Global Infrastructure Resilience Report (GIR 2025). This Working Paper on '*Financing: Closing the Gap to Capture the Resilience Dividend*' identifies key challenges in mobilizing finance for resilient infrastructure, explores the fiscal implications of disaster risks, and highlights actionable frameworks and instruments to strengthen financial resilience across systems and scales. It may be accessed at https://cdri.world/resilience-dividend/global-infrastructure-resilience-report-second-edition/.

This document is a launch edition and may undergo minor changes subject to updates in the analysis.

All papers under the GIR 2025 Working Paper Series are available on the official website of CDRI, accessible on the web link mentioned above. They provide detailed background material, methodologies, analyses, and case studies for each chapter of the report. The papers will be released sequentially starting November 2025 through 2026.

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Acronyms

AAL	Average Annual Loss
ABMN	Asuransi Barang Milik Negara
ADB	Asian Development Bank
ARC	African Risk Capacity
CAT bond	Catastrophe Bond
Cat DDO	Catastrophe Deferred Drawdown Options
CBI	Climate Bonds Initiative
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CDRI	Coalition for Disaster Resilient Infrastructure
CPI	Climate Policy Initiative
CRDC	Climate Resilient Debt Clause
CRRMP	Climate Risk and Resilience Management Plan
DFI	Development Finance Institution
DRFI	Disaster Risk Financing and Insurance
DRM	Disaster Risk Management
EMDEs	Emerging Market and Developing Economies
FEMA	Federal Emergency Management Agency
FRA	Fiscal Risk Assessment
GCA	Global Center on Adaptation
GDP	Gross Domestic Product
GIRI	Global Infrastructure Risk Model and Resilience Index
IDB	Inter-American Development Bank
IFRF	Infrastructure Financial Resilience Framework
IMF	International Monetary Fund
LMICs	Low- and middle-income countries
NAGICO	National General Insurance Corporation N.V.
NDMF	National Disaster Mitigation Fund
NDRF	National Disaster Response Fund
NDRMF	National Disaster Risk Management Fund
NHPC	National Hydroelectric Power Corporation

OECD	Organisation for Economic Co-operation and Development
PML	Probable Maximum Loss
PPP	Public–Private Partnership
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
UNCTAD	UN Conference on Trade and Development
UNDRR	United Nations Office for Disaster Risk Reduction
UTE	Usinas y Transmisiones Eléctricas

Key Messages

The Finance Working Paper focuses on the need to mobilize finance to improve the resilience of existing and new infrastructure while arranging contingent capital to respond to and recover from disasters. The paper begins by highlighting the disproportionate impacts of disasters in low- and middle-income countries (LMICs), which can significantly limit their development and poverty reduction trajectories. Extreme events can affect the economy through multiple avenues, impacting gross domestic product (GDP), public debt, sovereign credit ratings, and borrowing costs. It is therefore imperative to minimize disaster risks by adopting prevention, protection, and mitigation measures.

Disaster risk management (DRM) includes both disaster risk reduction activities, such as retrofitting interventions, and post-disaster response and recovery, and funding should cover both. However, today, most disaster finance flows and insurance instruments are centred on the response and recovery phases rather than risk reduction. Real infrastructure resilience requires investment in risk reduction as well as the development of disaster preparedness and response plans with clear standard operating procedures across the national, subnational, and sectoral levels.

The paper identifies the challenges faced by government and infrastructure agencies in quantifying, sourcing, and disbursing the funds necessary to improve infrastructure resilience. These challenges can be addressed through four sets of policies related to strengthening resilience: i) standards for building and evaluating resilience; ii) risk allocation frameworks to promote effective collaboration between the public and private sectors to manage disaster risks; iii) policies that quantify, allocate, and monetize resilience dividends; and iv) funding strategies that reduce infrastructure vulnerability to disaster risks and mobilize post-disaster finance in view of international public finance constraints.

The implementation of an infrastructure financial resilience framework (IFRF) should help governments and sector agencies monitor their ability to mobilize finance to ensure the resilience of their infrastructure sector. Such an assessment should identify any gaps and lead to a series of recommendations to improve financial resilience. Recommendations can be translated into country-specific financial resilience pathways for infrastructure, comprising the following aspects: resilience objectives for each infrastructure sector, a methodology for quantifying asset vulnerability to disaster risks, and a framework for mobilizing pre- and post-disaster funding.

1. The Consequences of Inaction: An Urgent Call for Resilient Infrastructure Investment

Resilient infrastructure investment is urgently required in low- and middle-income countries (LMICs) and Small Island Developing States (SIDS) to mitigate the increasingly disproportionate economic damage caused by disasters.

As the planet warms due to climate change, the frequency and severity of disasters have also increased. Disasters are defined as damage and disruptions to the functioning of a community or society resulting from hazardous events; they can have human, structural, economic, and environmental impacts (United Nations Office for Disaster Risk Reduction [UNDRR], n.d.). According to the International Disaster Database (EM-DAT), the number of reported disaster events worldwide has substantially increased from 737 in the decade 1965–1974 to 3,634 in 2015–2024 (Delforge et al., 2025). Most of these events took place in LMICs, posing a disproportionate risk to these countries and significantly limiting their development and poverty-reduction trajectories. For example, 70 percent of deaths worldwide caused by climate-related disasters in the past 50 years have occurred in least developed countries (OECD, 2025). Similarly, SIDS are vulnerable to shocks, and given the size of their economies, geographic remoteness, limited resources, and reliance on trade, the long-term economic impacts of these disasters can be extremely costly (United Nations Department of Economic and Social Affairs & UNDRR, 2022). Beyond economic impacts, the loss of infrastructure leads to social displacement and deepens social and economic inequalities. According to the Global Report on Internal Displacement, 7.7 million people have been displaced globally, and more than 26 million instances of movements, were triggered by disasters in 2023 (Internal Displacement Monitoring Centre, 2024), implying repeated and multiple movements. Again, most of these displacements happened in LMICs, particularly countries in sub-Saharan Africa, North Africa, and South Asia.

Box 1

Case study: Calculating the fiscal impacts of disasters using GIRI to estimate infrastructure damage in Bangladesh

Puranasamriddhi et al. (Upcoming) applied the probable maximum loss values from the GIRI model to construct three disaster shock scenarios in Bangladesh (1-in-10-, 1-in-100-, and 1-in-1,000-year return period). The case study calculates the fiscal risks arising from flood damage to built capital. GIRI estimates the total flood damages to buildings and infrastructure sectors in Bangladesh to cost $17.8 billion for a 1-in-10-year, $54.7 billion for a 1-in-100-year, and $65.0 billion for a 1-in-1,000-year flood event coming mainly from housing, roads, and power generation-related infrastructure. These estimates are used as inputs to the International Monetary Fund's (IMF) Debt–Investment–Growth and Natural Disasters macroeconomic model (Marto et al., 2018) to produce simulation results on the impacts on real GDP and public debt.

The shock from all flood scenarios lowers real GDP sharply downward between 1.9 (1-10), 6.0 (1-100), and 7.1 percent (1-1000 return period) due to permanent damages to capital and losses in productivity across sectors. This results further in a steep decline in both private consumption and investment. While public investment from external borrowing can help speed up public capital reconstruction post-disaster, and therefore economic recovery, the 1-in-100- and 1-in-1,000-year scenarios continue to lead to high and persistent GDP losses in future years.

The total public debt-to-GDP ratio increases from initial 36.4 percent of GDP to between 37.1 (1-10), 38.7 (1-100), and 39.2 percent (1-1000 return period) because of the shock. Moreover, the more severe rise in debt for the 1-in-100- and 1-in-1,000-year scenarios means a continued upward trend of public debt accumulation during the reconstruction period. The reconstruction period leads to public debt increasing further to 39.3 (1-100) and 39.9 percent (1-1000). In the post-reconstruction period, all scenarios experience a slow shift from incline-to-steady-to-decline trend as the initial conditions according to Bangladesh's economy in 2022 are assumed for the growth rate to be marginally higher than the debt interest rates.

This disproportionate impact of disasters on socioeconomic development in LMICs calls for urgent investment not just in new infrastructure, but particularly in disaster-resilient infrastructure, to both improve conditions for development and mitigate potential damage from disasters. Despite this, public infrastructure investment in LMICs has been low and has declined over time, dropping to its lowest level since 2010 to about 1 percent of GDP in 2018 (Foster et al., 2022).

The damage and disruption to infrastructure caused by disasters lead to asset destruction, productivity losses due to disrupted supply chains, increased demand for disaster relief crowding out development budgets, and higher public debt and borrowing costs in the long run. The Coalition for Disaster Resilient Infrastructure's (CDRI) Global Infrastructure Risk Model and Resilience Index (GIRI) estimates a total average annual loss (AAL) related to infrastructure of over $732 billion.[1] With the increasing frequency and severity of disasters, these economic impact estimates are projected to rise if no significant disaster-

[1] US dollars

reduction measures are implemented. Looking beyond AAL and at probable losses further highlights their severe impacts. The AAL from the impacts of floods on infrastructure in Bangladesh, for example, is estimated to be $8.4 billion, while damage estimates for a 1-in-10, 1-in-100, and 1-in-1,000-year flood event are $17.8 billion, $54.7 billion, and $65 billion, respectively. Box 1 presents an example of the use of GIRI to translate the probabilistic damage caused by floods to infrastructure in Bangladesh into immediate and long-term macroeconomic consequences for GDP and public debt.

Box 2

Disaster costs on public debt in SIDS

Between 2010 and 2022, public debt in SIDS nearly doubled to a record high of $185 billion (UNCTAD, 2025). The number of countries with public debt amounting to at least 60 percent of GDP has increased to 15; it exceeds 100 percent in five countries: Dominica, Cabo Verde, Barbados, Suriname, and the Maldives (IMF, n.d.-a). SIDS spent about 5 percent of their government revenues on debt interest payments in 2022, and countries such as Palau, the Bahamas, Jamaica, and Fiji allocated more than 15 percent of their resources to interest payments. Moreover, public debt levels vary widely across SIDS regions, with the Pacific SIDS having relatively low public debt (about 30 percent) during this period, while the Atlantic Ocean, Indian Ocean, and South China Seas region SIDS experienced a particularly high increase (more than 80 percent) (Hurley et al., 2024).

This increase in public debt is mainly driven by the region's vulnerabilities to disasters and other large external shocks (e.g., COVID-19) that led to both short- and long-term impacts on public debt. Focusing on disasters, a 2024 ODI Global report on SIDS reviewed the IMF and EM-DAT databases on the economic impacts of disasters and found many extreme events that led to significant public debt increases in the following years. These include the 2017 Hurricane Maria in Dominica (equivalent to 226 percent of GDP), which increased the public debt from 84 to 113 percent three years after the disaster, and 2016 Hurricane Matthew in Haiti (14 percent of GDP), which increased the public debt from 22 to 25 percent (Hurley et al., 2024). The disasters also present acute challenges to SIDS as their economies are small and therefore it can be difficult to mobilize domestic resources swiftly to provide immediate post-disaster responses.

The ODI report also presents several immediate and medium-term recommendations to improve fiscal resilience in SIDS (Hurley et al., 2024). These include i) improving access to affordable climate finance (in terms of grants and low-interest financing) to enhance adaptation resilience and post-shock recovery, ii) optimizing innovative fiscal instruments such as debt-for-climate swaps to scale up resilience investment, and iii) introducing climate-resilient debt clauses (CRDCs) (i.e., debt postponement clauses) to increase fiscal space in times of crisis.

CRDCs are particularly worth highlighting as SIDS, along with members of the Small States Forum, are eligible to benefit from the clauses. The clauses allow for the borrowers to defer principal and interest payments for up to two years when experiencing a disaster. CRDC coverage is limited to hurricanes and earthquakes. It is triggered either when a disaster reaches a certain intensity or when the estimated damage exceeds 10 percent of the country's GDP, as determined by the World Bank (2024a)

Disaster risks have multiple direct impacts on LMICs public finances and make it more difficult to invest in resilient infrastructure.

Disaster risks directly contribute to an already high global public debt. According to a report by the UN Conference on Trade and Development (UNCTAD), the global public debt was approximately $102 trillion in 2024 (UNCTAD, 2025). While public debt in LMICs is $31 trillion, or just less than one third, it has accumulated twice as quickly since 2010. Borrowing costs in LMICs are considerably higher, making the burden of debt more severe for them than for other countries. Many LMIC governments spend more on servicing public debt than on health, education, or other public investments. In 2024, LMICs spent $921 billion in net interest payments on public debt; more than 60 of these countries spent more than 10 percent of government revenues on interest payments, creating a resource outflow and liquidity pressure that could have been channelled towards development and infrastructure resilience (UNCTAD, 2025).

In addition to the consequences of disasters for public debt, disaster risks can lead to the downgrading of sovereign credit ratings and increased borrowing costs, as highlighted in several papers. A 2025 report by the European Central Bank on the impact of physical risks on sovereign credit ratings across 124 countries found that a higher frequency of disasters is associated with lower credit ratings (Ferrucci et al., 2025). Moreover, countries with greater exposure to physical risks have received lower ratings since the Paris Agreement. Research by S&P Global in 2015 quantified the impacts of severe disasters (1-in-250-year event) on sovereign ratings globally; the study indicated that the largest impact on ratings is likely to come from earthquakes and tropical storms, and countries in Latin America and the Caribbean tend to be most at risk (S&P Global, 2015). Focusing on a country-level study, a paper by researchers at the University of Oxford examined the impacts of floods across multiple return periods on sovereign credit ratings in Thailand and found that flooding could lead to sovereign downgrades of up to four notches. The research also quantified the benefits of investing in climate adaptation infrastructure, showing that raising flood protection levels can reduce potential downgrades from four to two notches during the most extreme event (Bernhofen et al., 2024).

Box 3

Case study: Impacts of floods on sovereign credit ratings in Thailand

A modelling exercise conducted by the Smith School of Enterprise and the Environmental Change Institute at the University of Oxford demonstrated both the estimated impacts of extreme flood events on Thailand's economy and sovereign credit ratings, and the potential benefits of investing in resilient infrastructure in mitigating damage (Bernhofen et al., 2024). The research found that a 1-in-100-year flood event could result in GDP losses of 3–4.5 percent and could trigger a sovereign credit downgrade of up to two notches, raising annual interest payments by $1.9 billion. In a more severe scenario, a 1-in-1000-year flood event could downgrade Thailand's credit rating by up to four notches to below investment grade, significantly affecting its borrowing ability.

When invested in flood defence systems, climate adaptation investments could lead to avoided losses of up to $30 billion and $48 billion for 1-in-100-year and 1-in-1000-year flood events, respectively. For a 1-in-1000-year flood, such investments can reduce downgrades by four notches to two, preventing an increase in annual interest payments of approximately $2.3 billion.

Most finance flows currently are centred on response and recovery, with little allocated to the pre-emptive reduction of risk.

Even when capital has been allocated, the amount put aside may be insufficient for LMICs, such that when disasters strike, the financial burden of recovery exceeds the available resources, creating fiscal stress and delaying the restoration of essential services and the country's economic development (see Box 4).

Box 4

Disaster risk financing challenges in LMICs

The World Bank's Disaster Risk Financing and Insurance (DRFI) Program produces disaster risk finance diagnostic reports to assess LMICs' preparedness for risks and their current disaster risk financing strategies, as well as to provide policy recommendations to improve financial resilience against shocks. As of 2025, DRFI has produced reports for 14 countries, with a focus mainly on Southeast Asia and sub-Saharan Africa. The reports highlight common challenges encountered in many countries' main funding mechanisms, including underfunded contingency funds and a heavy reliance on ex-post budgetary reallocations and donor funding support. For example, the contingency fund in Uganda is less than 0.2 percent of its national budget (or approximately $97.5 million), which is underfunded when compared with GIRI's estimates of AAL from direct damage to infrastructure due to multiple hazards (CDRI, n.d.; World Bank, 2022f). Focusing on reallocations, while Somalia has a reallocation mechanism in place to respond to disaster emergencies, the federal government has limited fiscal space because a large share is already dedicated to basic operations, leaving little room for swift reallocation (World Bank, 2025d). Many LMICs, such as Lao People's Democratic Republic (Lao PDR) and Uganda, also rely on donor assistance to cover the gap, but the timing and amount can be highly uncertain and unpredictable (World Bank, 2017a, 2022f).

DRFI suggests a risk-layering approach, a combination of risk retention and transfer instruments for different degrees of disaster severity, a government contingency fund for low-severity disasters, and insurance for high-severity disasters, as a more cost-effective approach for addressing average and severe disaster events. In 2024, the World Bank also approved the expanded Crisis Preparedness and Response Toolkit to provide countries with fast access to cash for emergency response, expanded insurance, and prearranged financing (World Bank, 2024e). This toolkit has helped Morocco, for example, following the 2023 earthquake, to release $300 million to cover both insured and uninsured households (World Bank, 2025b).

2. A Common Analytical Framework

The Global Infrastructure Resilience (GIR) 2025 report uses a common framework to analyse the resilience of infrastructure. This framework examines infrastructure not only as a collection of individual assets but also as networks of connected assets and the services they provide to individuals, communities, businesses, and the economy (CDRI, 2023a).

The resilience of these networks and services depends on their capacity to: i) resist and absorb the shocks caused by disaster impacts; ii) respond to the damage caused by those disasters and maintain basic levels of service continuity during crises; and iii) restore services as quickly as possible in a way that incorporates lessons learned from the disaster and reduces future loss and damage.

It is also essential to look at the resilience of infrastructure service users, which depends on their ability to: i) be better prepared and leverage the information provided by early warning systems to reduce the shock of disasters; ii) find supplementary or alternative means to avail failed infrastructure services (e.g., back-up generators for electricity or alternative modes of transport); and iii) engage in the lesson learning process after disasters so that they are better prepared, together with the infrastructure agencies, for future disasters.

At these three levels (infrastructure assets, services, and users), resilience should be seen not only as the capacity to absorb the next disaster but also as the ability to respond to and recover from it. Building resilience in infrastructure assets and systems requires a comprehensive view of the resilience cycle. **Figure 1** illustrates this cycle and the three capacities for an individual infrastructure asset.

When a disaster occurs, the normal operating performance of an infrastructure asset may drop to a lower state (all the way to zero for a total failure). The magnitude of the drop depends on the capacity of that asset to absorb disaster shocks. Over a period of time, the asset is in a degraded state. During this time, emergency and clean-up actions are undertaken, and design and procurement of repair and reconstruction works are completed. These steps allow the infrastructure agency to start the recovery phase. The lessons learned from the disaster, including

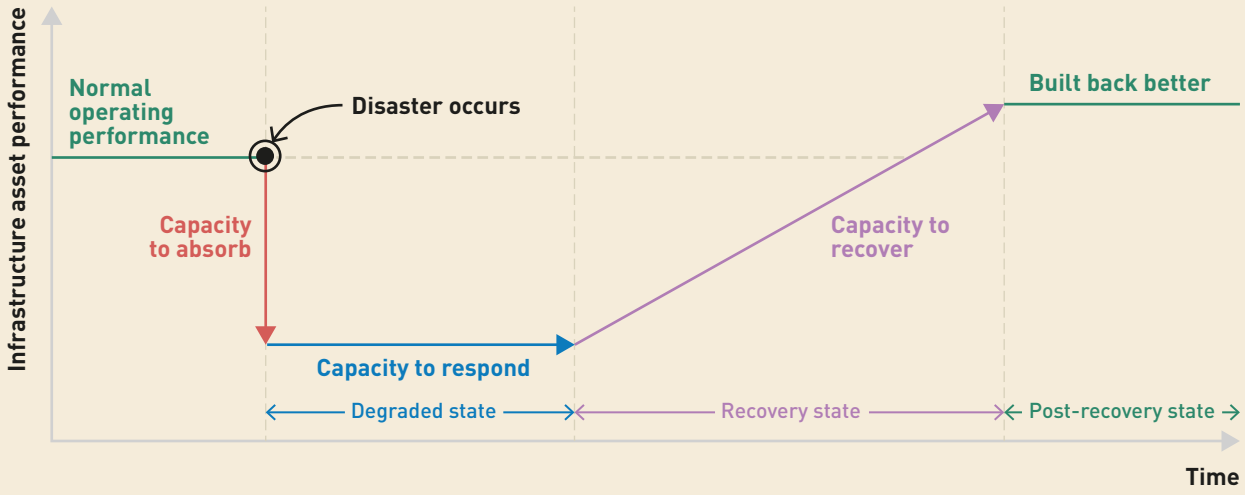


Figure 1

Three capacities for resilient infrastructure

Source: CDRI (2025)

updated risk assessments that incorporate new hazard data and projected climate change impacts, are indispensable for designing the repair and reconstruction efforts of the infrastructure asset affected by the disaster. The recovery phase can then 'build back better' those assets.

Many infrastructure agencies pay particular attention to the capacity to absorb disaster shocks by strengthening standards and regulations, implementing retrofit programmes for existing assets, and enhancing construction supervision for new, more resilient assets. They also expand maintenance and repair programmes to make assets stronger and ready for future disasters (like the cyclone season).

However, focusing only on the capacity to absorb disaster shocks is insufficient. The economic and livelihood impacts linked to interruptions of infrastructure services are directly related to the time it takes for the asset to be back to full or enhanced operation. The longer it takes for the infrastructure asset manager to respond and recover, the larger the impact on households, businesses, and communities.

Figure 1 can also be used to understand the resilience cycle for infrastructure networks and services, where the capacity to recover services depends on the level of redundancy of the network, and 'building back better' requires a network analysis of vulnerabilities.

For users, the capacity of individuals, households, communities, and businesses to respond to infrastructure failures depends on the quality of two-way communications between infrastructure service providers and users, as well as the users' resilience in finding alternative means of service provision.

Building the resilience of infrastructure systems requires agencies and asset managers to strengthen not only the capacity to absorb disaster shocks but also the ability to respond to shocks and recover quickly. **Figure 2** shows the resilience-building process that strengthens the three capacities.

An infrastructure agency or asset owner can implement several measures to strengthen the capacity to absorb disaster shocks (shorter red line on the left-hand side of the graph), such as developing enhanced maintenance, repair, and retrofit programmes or using systems

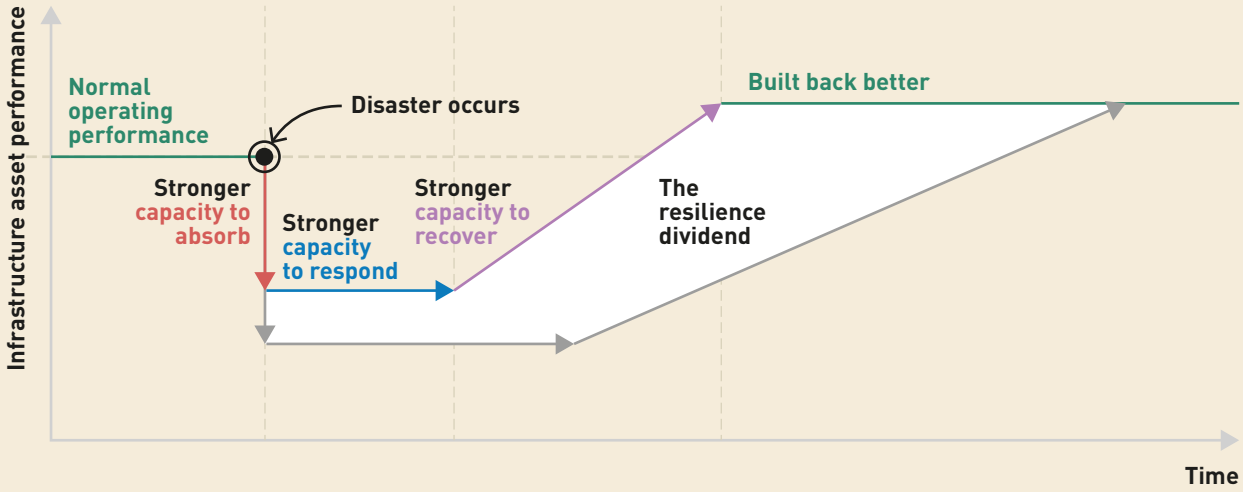


Figure 2

The resilience dividend obtained by strengthening the three capacities for resilient infrastructure

Source: CDRI (2025)

that translate early warning notices sent by hydrometeorological services into preparatory actions to protect assets.

A stronger capacity to respond requires infrastructure agencies to be better prepared for disasters, and to have strong coordination plans with the national disaster risk management agency, emergency services, and other infrastructure agencies or utilities that provide linked services that can fail in a cascade after disasters. Some of these actions to strengthen the capacity to absorb disaster shocks include preparedness plans to remove debris from the asset; early procurement of stand-by repair services, including strategic location of repair materials; or use of new technologies for rapid assessment and evaluation of damage using drones.

Finally, infrastructure agencies or asset owners can strengthen their capacity to recover (represented by the purple line) by implementing post-disaster evaluation and learning activities; defining new tools (such as nature-based solutions or new technologies) to be incorporated in the repaired asset; and enhancing resilience standards in the repair and reconstruction efforts.

All the efforts in strengthening the three capacities will lead to less damage and degradation of performance, less time to respond, and more effective repair and reconstruction processes in case of a future disaster or similar magnitude. The strengthening of the three capacities will also lead to a faster restoration of services and a lesser impact on livelihoods and the economy. The white area in the graph visually represents the 'resilience dividend' of those efforts. It is defined as the value of reduced future asset loss and damage, avoided service disruption, wider social, economic, and environmental co-benefits, and reduced systemic risk that accrue over the lifecycle of an infrastructure system.

This framework is consistently applied across various chapters of this report, including surveys of businesses and resilience professionals, as well as analyses of technologies, finance, nature-based solutions, and institutions for resilient infrastructure.

3. Current Landscape of DRM Finance for the Infrastructure Sector

DRM finance covers both the funding of disaster risk reduction activities—such as retrofitting interventions—and the mobilization of more traditional disaster risk finance and insurance instruments to fund post-disaster response and recovery.

The typical approach to disaster financing is reactive, representing a fundamental challenge in building resilient infrastructure systems. Traditional disaster risk financing focuses on the allocation of risks, losses and post-disaster funding requirements across asset managers, lenders, insurers, governments, and international donors. However, when it comes to infrastructure, this approach leaves a significant element out, the reduction of an asset vulnerability to proactively mitigate negative outcomes rather than manage them when they occur. Infrastructure agencies should have a financial resilience framework in place to determine how much funding to allocate to risk reduction and how to mobilize such funding from public and private sources, as well as to ensure that sufficient contingent capital is available in case of a disaster.

Strengthening infrastructure resilience should cover three types of interventions: (1) pre-disaster risk reduction, (2) post-disaster emergency response, and (3) reconstruction finance. Before a disaster, funding can be allocated to increase the infrastructure's **capacity to absorb** shocks by investing in resilience efforts such as preparedness measures and asset upgrades and maintenance. During a disaster, funding is used to increase the asset's **capacity to respond** where speed of mobilizing access to financial resources is crucial, especially with critical infrastructure at a local level. In post-disaster scenarios, funding is used to increase the **capacity to recover** by repairing and reconstructing infrastructure, not only by restoring assets to their previous state but by also making them more resilient to future shocks.

Figure 3 from the Financial Protection Forum below summarizes the main sources of contingent capital that countries can target, ranging from having a dedicated budget line, arranging for contingent loans, increasing taxes, involving international aid partners, and buying insurance. Each of these can be used at

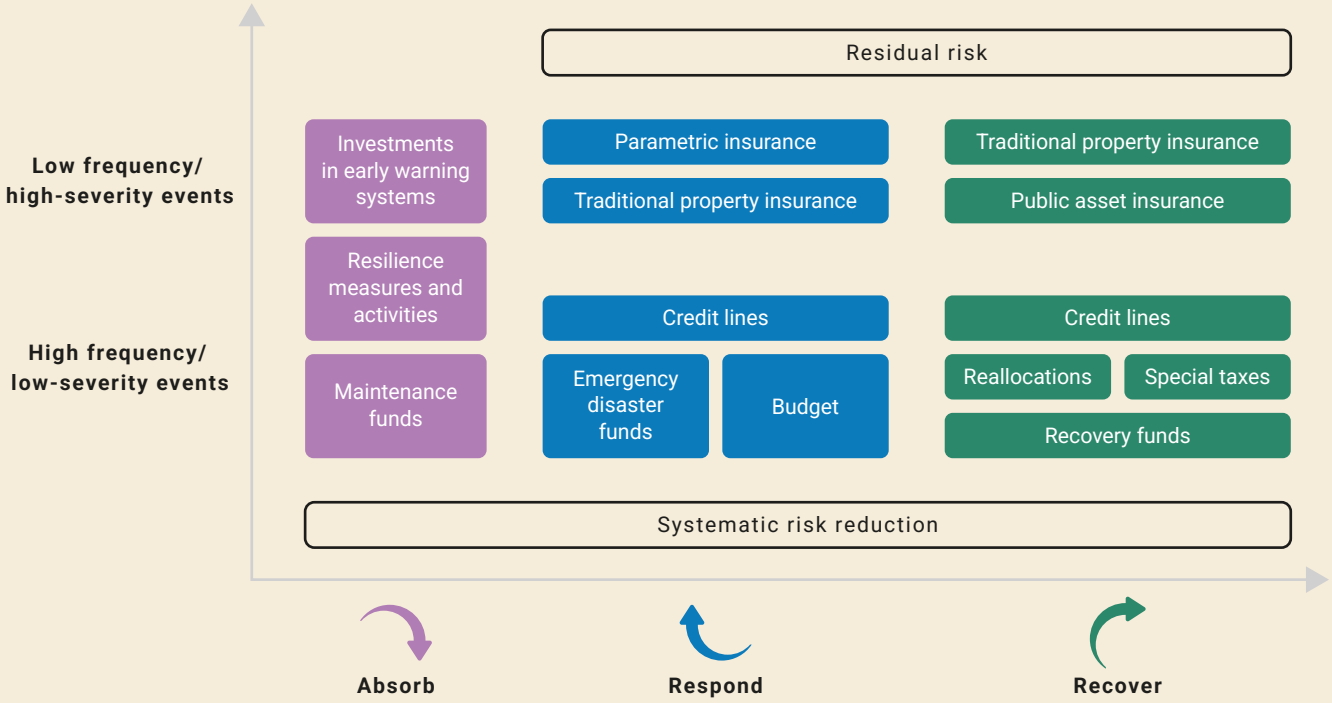


Figure 3

Expanded landscape of infrastructure disaster risk reduction, management, and financing

Source: Modified from the figure in Financial Protection Forum, 2023, figure 1

different times through a risk-layering approach, depending on a country's financial strength and capacity, the types of disaster risk it is exposed to, and the frequency and severity of those risks. While these measures are all complementary, no single instrument can fully cover all disaster-related risks.

This risk-layering approach should ideally be replicated at the sector level by relevant infrastructure agencies to ensure that entities responsible for delivering infrastructure services and managing infrastructure systems are empowered to manage disaster risks and mobilize funding for resilience.

This expansion of the disaster risk financing landscape to include risk-reduction measures is critical for infrastructure, given its far-reaching influence on the broader economy. Infrastructure serves as an enabler for all other sectors, providing essential access to transport, power, and water to drive economic activity and deliver development services. For example, Mühlhofer et al. (2024) analysed 700 floods and tropical cyclones in 30 countries and found that infrastructure damage accounted for between 64 and 89 percent of service disruptions, which spread beyond the hazard footprint in nearly three out of four events, impacting up to 10 times the directly affected population. Failure of infrastructure causes compounding losses, breaks supply chains, and leads to economic stagnation, as the consequences extend far beyond the directly affected infrastructure assets.

Infrastructure assets require large upfront investments for assets that are meant to last decades. Compared with the agriculture and health sectors, which can shift resources seasonally or annually, investments in infrastructure are essentially 'locked in'. Furthermore, infrastructure systems, especially in emerging market and developing economies (EMDEs), often have limited redundancy and take longer to repair and restore. This makes it imperative to upgrade and retrofit infrastructure to keep up with an ever-evolving disaster landscape and to safeguard the wider economic and social benefits associated with these assets.

Box 5

Disaster risk financing and layering in Indonesia

Indonesia is a sprawling archipelagic nation, exposed geographically to frequent earthquakes, tsunamis, and volcanic eruptions and seasonally to floods, landslides, droughts, and forest fires. Over the past 30 years, Indonesia has experienced an average of 289 natural disasters per year, which claim, on average, more than 8,000 lives annually (World Bank, 2024c). In 2017, the Ministry of Finance estimated that the average annual direct economic cost of disasters was $1.46 billion, while the disaster reserve fund available in the State Revenue and Expenditure Budget (Anggaran Pendapatan dan Belanja Negara) was only $198 million, underlining the significant financial protection gap before insurance.

In 2018, a national DRFI strategy was created, which had several components including the below:

- A public state insurance programme (Asuransi Barang Milik Negara [ABMN]) to protect government infrastructure through a consortium of 75 companies: Prior to its implementation, the use of insurance was ad hoc and subject to individual ministries' needs. The Ministry of Finance started with a pilot covering its own office buildings, education and training facilities, and health care facilities, with a total of 1,337 assets insured for $688 million at an annual insurance premium of $1.5 million. By 2023, the programme covered 76 ministries and agencies, insuring 10,920 units
- Pooling fund for disasters, which pools post-disaster financing from different sources, ensures reliable pre-arranged financing, streamlines disbursement channels, and leverages financial markets. The pooling fund acts as a central vehicle to facilitate coordination and flow based on the government's decision to retain or transfer risk. The funds can be raised through direct budget contributions, international partners, or insurance payouts, rather than through ad hoc planning after a disaster (World Bank, 2020).

3.1 Capacity to Absorb

Infrastructure resilience finance must begin with risk reduction through investment in early warning systems, retrofits, upgrades, and maintenance by sectoral agencies and asset managers.

Investing in early warning systems is often the first de-risking step.

International financial organizations and public and private sectors all have a crucial role to play in increasing a country's capacity to absorb shocks from disasters. The UNDRR and the World Meteorological Organization (WMO) launched the Global Observatory for Early Warning System Investments in 2024 to track finance flows into these vital systems (UNDRR & WMO, n.d.). A large portion of investments so far has come from the World Bank ($1.7 billion), Green Climate Fund ($1.6 billion), and Asian Development Bank (ADB) ($1.4 billion), with the main beneficiaries concentrated in Asia. Investment in such systems and processes is crucial as they can quickly warn authorities and citizens of impending storms, floods, or droughts,

Box 6

India's National Hydroelectric Power Corporation's investment in early-warning systems

While national-level programmes are important, they need to be supplemented with sector agency–led efforts and funding for their assets. For example, India's National Hydroelectric Power Corporation (NHPC) has invested in its own early-warning system (at a cost typically less than 0.1 percent of plant capital expenditures) and disaster management planning. According to its latest Sustainability Report 2023–2024, each power station has developed its own disaster management plans under the guidance of a nodal disaster management committee at the headquarters corporate office (NHPC Limited, 2025). These plans are communicated to the subnational government authorities and integrated into the State's Master Disaster Management Plan. A cloud-based technology enables real-time monitoring of water levels and river discharge, ensuring all power stations receive early warnings from upstream river data and enabling quick response to potential flooding.

giving them enough time to organize a response that can save lives and reduce economic losses.

These types of investments can help agencies in sectors such as power and water utilities, roads, railways, and airports plan better, minimize damage, and protect the initial investment in their assets. While these actions are critical, finance flows at the sector agency level are rarely tracked. This is a key area where more research and focus are needed.

Managing resilience through data, best operational practices, and ongoing investments in maintenance and retrofit measures is critical.

While integrating resilient features into infrastructure design is important, the assets themselves must also be properly maintained and upgraded to fit the changing climate. In 2019, a World Bank paper on infrastructure in Organisation for Economic Co-operation and Development (OECD) countries estimated that every $1 spent on infrastructure maintenance is as effective as $1.5 of new investment (Hallegatte et al., 2019). The lack of upkeep of infrastructure assets exacerbates the risk of damage, especially in many LMICs where fiscal constraints limit the resources available for maintenance and incremental resilience measures. A study by Rozenberg and Fay (2019) found that good maintenance reduces the total life cycle cost of transport and water and sanitation infrastructure by more than 50 percent. The study also detailed how the benefits of operations and maintenance (O&M) costs vary across sectors; The failures to perform routine maintenance for the water and sanitation sector would reduce the useful life of installed capital and increase overall capital replacement costs by at least 60 percent, while failures to perform routine maintenance for the transport sector would increase overall capital and rehabilitation costs by 50 percent.

One way to address this is to dedicate extrabudgetary funds related to maintenance and retrofitting programmes that allow a country and its sector agencies to make timely resilience investments to better absorb future shocks. For example, several LMICs have used such funds for road maintenance. Fondo de Conservación Vial de El Salvador, created by the Ministry of Public Works in El Salvador, is a road conservation fund responsible for the maintenance of over 7,269 kilometres of roads, with a $150 million line of credit from the Central American Bank for Economic Integration. While this may

not traditionally be seen as a disaster resilience programme, continuing to replenish the fund and investing to maintain a functioning road infrastructure network can yield high benefits in terms of delivering key social benefits and minimizing economic disruptions during disasters.

Given the different needs of each sector and the different types of infrastructure assets, a more targeted approach is required for maintenance. As Hallegatte et al. (2019) noted, an important tool for sector agencies would be a comprehensive inventory of all assets and their condition, to support the strategic, financial, and technical aspects of managing infrastructure assets across their life cycle.

Debt instruments such as green bonds and resilience bonds may be issued to invest in climate-resilient critical infrastructure.

As infrastructure agencies evaluate the level of resilience needed for new infrastructure assets, it is important for them to use a cost–benefit framework to assess the financial benefits of investing in resilience and the expected improvements in insurance metrics (e.g., a reduction in AAL). The quantification of direct resilience benefits at the asset level can follow the Physical Climate Risk Appraisal Methodology recommended by the Institutional Investors Group on Climate Change (2024) or the Resilience Cost Benefit Analysis tool presented in the CDRI study on India's national infrastructure pipeline (CDRI, 2025b).

Box 7

India's national infrastructure pipeline

A recently published study on India's national infrastructure pipeline (CDRI, 2025b) provides a comprehensive set of recommendations to enhance infrastructure resilience in the Indian context. This model could be replicated in many CDRI member countries.

The study incorporates the Resilience Cost–Benefit Analysis tool; a toolkit for implementing infrastructure resilience that combines policy, governance, project delivery, and financing components; and an overview of the main contractual aspects relating to infrastructure resilience, which should be reflected in standard-form concessions or public–private partnership (PPP) agreements in the power, road, and railway sectors (see Annexure C for a summary of the report's recommendations).

Debt issuance is often used to raise funds for upgrades, and in LMICs, this is typically done by sovereign or government-backed entities in collaboration with development banks. Green bonds provide a way for countries to tap into the international institutional market to access new investors and/or obtain better borrowing terms. The proceeds from these bond issuances can finance essential upgrades to infrastructure assets. In 2020, Egypt was the first country in the Middle East and North Africa region to issue a sovereign green bond with technical assistance from the World Bank. The five-year green bond was competitively priced and over-subscribed, attracting a number of new investors to the country (World Bank, 2022e). The World Bank aided in defining governance, communications strategy and impact measurements but not financially. Proceeds were used for both new build and upgrades to transportation, energy, water and waste management systems. Similarly, in 2021, the Colombian government issued green bonds to fund specific adaptation measures, such as sustainable transportation, water management, and biodiversity (World Bank, 2022g).

These types of bonds are not limited to the public sector. In 2015, the ADB and India Infrastructure Finance Company Ltd. jointly guaranteed a $68 million project bond for ReNew Power Ventures Private Ltd., a New Delhi–based independent power producer. Together, the two institutions guaranteed 28 percent of the bond, boosting the credit rating to AA+ (Lambert & Shah, 2015). A sector agency may be able to similarly issue a green bond with technical assistance or guarantees from international organizations, assuming it is responsible for its own funding.

Box 8

Brazilian government's sustainable bonds

In November 2023, the Brazilian government carried out its first sovereign issuance of sustainable bonds, raising $2 billion in the international market to accelerate the country's transition to a low-carbon economy. One of the main destinations of these funds was the National Fund on Climate Change (Fundo Clima)—an instrument of the National Policy on Climate Change managed by the National Bank for Economic and Social Development (BNDES).

In 2023, about $2 billion (or R$10.4 billion) was made available, and in 2025, $2.1 billion (or R$11.2 billion) in investments was approved, including for the following projects (Ministério da Fazenda, n.d.):

Urban macro drainage and flood control in the city of Campinas (state of São Paulo)

- The project received about $15 million (or R$80 million) from the Climate Fund, within a total financing of $94.8 million (R$503.7 million) from BNDES. It combines traditional infrastructure (three rainwater reservoirs and a derivation gallery) with nature-based solutions (three linear parks to recover vegetation), mitigating historic flooding and directly benefiting about 200,000 residents.

Water infrastructure and coastal resilience (states of Ceará and Espírito Santo)

- State of Ceará: Financing of $47 million (R$250 million) from the Climate Fund for the state's water resources investment plan, which aims to increase water security and the resilience of the population in the face of increasing climate irregularity.
- State of Espírito Santo: Financing of $28 million (R$150 million) from the Climate Fund for investment in resilience, increased adaptive capacity, and disaster risk reduction, through the recovery of urban rivers and infrastructure actions in coastal cities.

The indicators for these programmes are linked to the federal government's Multi-Year Plan; they are also connected to the Sustainable Development Goals (SDGs). For example, the indicators for the urban macro drainage project are related to SDG 6 Clean Water and Sanitation and SDG 11 Sustainable Cities and Communities, including i) the percentage of urban and rural households supplied with water, ii) the number of municipalities that benefited from the expansion of water supply, iii) the number of indigenous villages that benefited from the drinking water supply, and iv) reduction in the number of rural families without access to water (Brazil Sovereign Sustainable Finance Committee, 2024).

Similarly, resilience bonds—which are a more recent subset of green and sustainability bonds, specifically for climate-resilient investment—may be used to finance upgrades to key infrastructure assets. In 2019, the European Bank for Reconstruction and Development launched the first-ever dedicated resilience bond with a AAA rating. It raised $700 million from commercial banks, central banks, and insurance companies to increase the resilience of assets such as Tajikistan's Qairokkum Hydropower Plant. A $196 million financing package organized by the European Bank supports the climate-resilient rehabilitation and modernization of the plant, thereby improving the country's electricity supply by enabling the plant to cope with the expected impacts of climate change (Global Center on Adaptation [GCA], 2020). This bond was provided at market rates and was not concessional in nature.

Research by Climate Bonds Initiative (CBI) found that only 19 percent of labelled green bonds had any resilience-related use of the proceeds (CBI, 2024). The study highlighted a key limitation—a lack of clarity about what constitutes a climate-resilient investment. CBI has since issued its first resilience taxonomy, which clarifies the measures and activities that constitute resilient interventions across socioeconomic sectors, making it easier for investors to deploy capital accordingly. Governments can play an important role in embedding such taxonomies into financial regulations, thereby helping channel institutional investor capital into resilience through public-sector financing vehicles, including international and national development banks.

3.2 Capacity to Respond

In the face of a disaster, the speed of financial mobilization is key to the capacity to respond. This can be achieved by implementing systematic budgeting processes at the federal, subnational, sectoral, and private-sector levels to improve responsiveness.

During a disaster, affected entities need access to capital and means to disburse them quickly. While there is sufficient time to arrange funds for recovery and reconstruction, rapid mobilization of funds is critical in the relief phase, especially to restore critical infrastructure.

At a national and subnational level, a part of the budget is usually set aside as a disaster fund so that capital can be mobilized quickly. For example, in the US, the Federal Emergency Management Agency (FEMA) works in partnership with the Small Business Administration to cover immediate disaster-related expenses incurred by businesses, such as the construction of temporary shelters, debris removal, or urgent repairs. However, there may still be a delay between when capital is paid out and when it reaches the affected areas. This is where preparedness at the subnational and local levels becomes critically important. During a disaster, subnational governments often depend on fund transfers from national governments, which can delay response measures. This 'vertical fiscal imbalance' does not incentivize local governments to be fiscally responsible, as they expect to be bailed out by the state. Federal governments should have a decentralization policy to ensure that subnational governments have the funds and authority to act in a way best suited for their jurisdictions.

Similarly, sectoral agencies need to set aside a budget and pre-arrange funds for immediate disbursement during an emergency; typically, they need to use the same set of financing instruments. Furthermore, they can strengthen their supply chains by embedding resilience-focused clauses in procurement contracts. Policies that encourage business continuity planning can ensure that businesses, especially small and medium-sized enterprises, are better

Box 9

Decentralized budget management to address disaster risks in Vietnam

The 2013 Law on Natural Disaster Prevention and Control in Vietnam, which was amended in 2020, defines the principles of disaster prevention and control; the rights and obligations of agencies, organizations, households, and individuals; and policies for state management and assurance of resources. In particular, the law details the decentralization of prevention and control activities and authorizes subnational governments to perform such activities, including implementing information and communication activities to improve community awareness, response plans for different disaster risks, and training for disaster prevention and control. The law also highlights different types of decentralised financial resources for disaster prevention and control, mainly i) state budget funds and ii) natural disaster prevention and control funds. The state budget fund for disaster prevention and control comes from the state annual budget and is decentralized across subnational levels, from provinces, municipalities, and districts to communities and townships, to for disaster responses and reliefs due to the consequences of disasters. The natural disaster prevention and control funds are decentralized at the provincial level and operate outside the state budget. These can be used to finance a range of response measures, including household and social infrastructure repairs and environmental sanitation. Local contingency budgets of 2–4 percent of the total annual planned budget have to be set aside for emergencies and depleted first before federal contingency budgets are used (World Bank, 2022a).

equipped for shocks. When working with procurement agencies, clauses that link payment terms to resilience measures can incentivize supply chains to restore service as quickly as possible.

Pre-arranged financing is key to preparedness but rarely reaches low-income countries.

The Centre for Disaster Protection's 2024 report on the state of pre-arranged financing for disasters states that pre-arranged financing for disasters amounts to only 1.1 percent of total crisis financing and remains heavily concentrated in upper-middle-income countries (42.4 percent), with only $183.8 million (3.1 percent) available for low-income countries between 2018 and 2022 (Plichta & Poole, 2025). Fiscal constraints and high debt in low-income countries make it difficult for them to organize pre-arranged financing.

Insurance policies can complement public-sector contingent capital and international aid during the response phase. Insurance can be largely split into two categories: general and parametric. General insurance provides compensation for losses or damages sustained by a policyholder, wherein damage and payouts are determined after the disaster has taken place. Parametric insurance is triggered when a metric surpasses a predetermined threshold, thereby providing a pre-specified payout regardless of the amount of damage. Parametric insurance tends to be better suited for immediate disaster response, while general insurance and catastrophe bonds (CAT bonds) are better suited for the reconstruction phase.

Analysis by the Centre for Disaster Protection also found that catastrophe deferred drawdown options (Cat DDOs) account for half of all pre-arranged financing globally (Plichta, 2025). Cat DDO is a sophisticated form of a contingent credit line offered by development banks that provides immediate liquidity to governments in the aftermath of a natural disaster or a public health emergency. Funds are

Box 10

Catastrophe Deferred Drawdown Options

A Cat DDO is different from both a traditional loan raised after a disaster and catastrophe bonds and insurance products. The prerequisites and policies required for a Cat DDO reduce overall risk, making it more affordable while ensuring speedy disbursement and enhancing a country's long-term financial resilience. Cat DDOs also provide more flexibility as they are not tied to specific parametric criteria—such as a certain amount of flooding—and can be triggered by a government's own assessment of an emergency. For example, the World Bank and the Government of Colombia have integrated Cat DDOs in Colombia's fiscal risk management strategy since 2008. Cat DDO I was disbursed in 2011 during the La Niña phenomenon, Cat DDO II was disbursed in 2020 at the onset of the COVID-19 pandemic and a third Cat DDO of $300 million was approved in 2021, which set the issuance of a sovereign green bond as a prior action, achieved by the government in September 2021 (World Bank, 2022c)

Despite these advantages, Cat DDOs are not without their disadvantages. They are sophisticated and difficult to comprehend, and if triggered, can add to the debt burden. They are increasingly being made available to low-income countries in the form of grants rather than loans, which also makes them more accessible. They engage countries at the national level, with policies not always trickling down to subnational governments and sector agencies. For example, only one of nine provinces in Sri Lanka adopted a standard by-law issued to regulate and supervise a national policy and plan for disaster management as required by the Cat DDO (World Bank, 2022c).

pre-approved and become available typically after a country declares a state of emergency—the 'drawdown tigger'. Approval is contingent on the eligible country administering robust macroeconomic and DRM policies (World Bank, 2024b), which the lending entity monitors periodically. For example, St. Vincent and the Grenadines were required to set up a national disaster management policy. In Malawi, the Cat DDO was tied to purchasing parametric drought insurance, enabling emergency cash transfers when rainfall thresholds were reached (Plichta, 2025).

3.3 Capacity to Recover

Recovery can take many forms and ideally should be geared towards improving resilience through a 'build back better' approach.

Recovery from a disaster goes beyond the initial response of minimizing damage and restoring service to reconstructing and ensuring that assets are made more resilient to future disasters. A key consideration is achieving a balance between the speed and quality of recovery. While it is important to repair and restore infrastructure as quickly as possible, it is also essential to ensure that when rebuilding an asset, its vulnerability is reduced. Disasters can be seen as an opportunity to build back better, though planning a resilience-informed recovery with longevity in mind may require more time, as depicted in **Figure 4**.

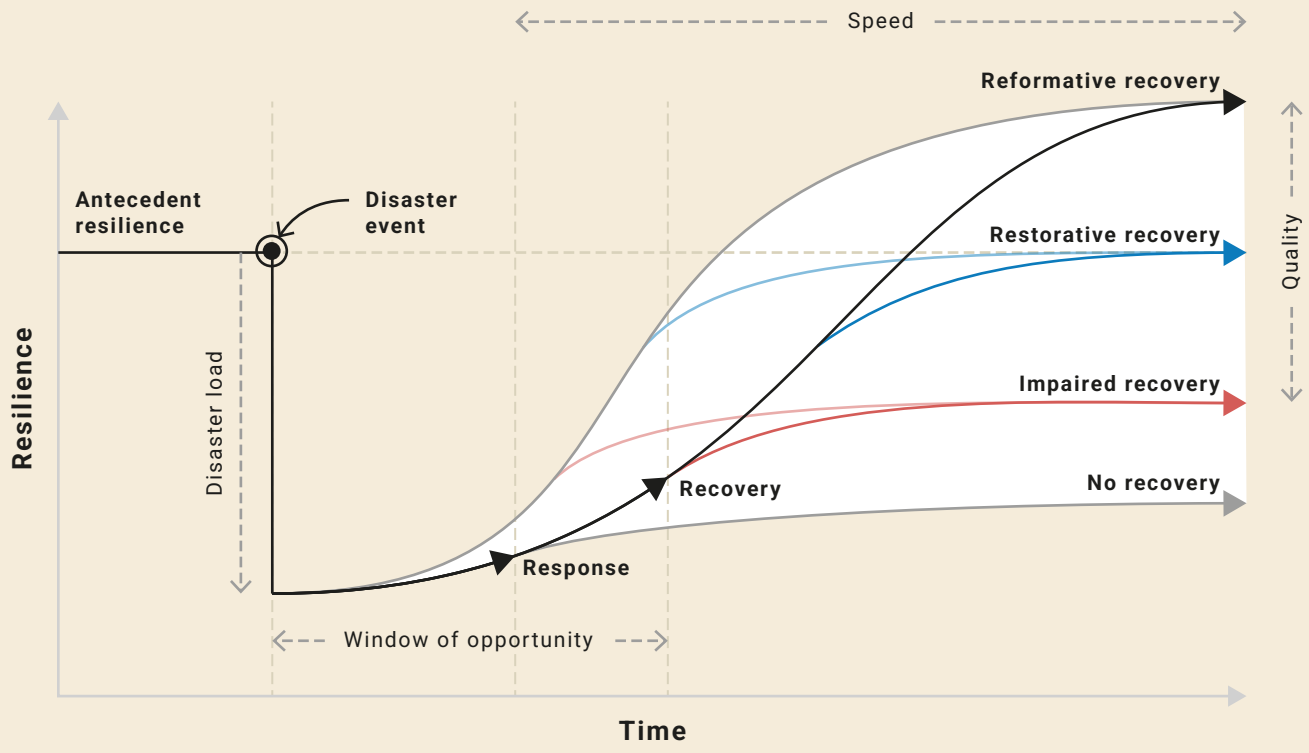


Figure 4

Conceptual framework of recovery for building resilience

Source: Cambridge Centre for Risk Studies and AXA XL (2020)

The dynamic nature of climate change requires countries to go beyond simple insurance to pooling risks and financial resources (both public and private) across jurisdictions to try and cover the 'protection gap'.

Evidence from several studies shows that there exists a 'protection gap', the difference between insured losses and actual damage—which makes it difficult for infrastructure to fully recover and be ready for the next shock. This is the case in both developed and developing markets. For example, Hurricane Beryl had a significant impact on the Caribbean in 2024. In response, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) paid out $85 million through 12 individual parametric insurance policies across five countries. Initial damage assessments estimated the total economic loss in St. Vincent and the Grenadines and Grenada alone to be around $230 million (or 22 percent of GDP) and $219 million (16.5 percent of GDP), respectively (Meenan, 2024). The payouts were quick, arriving within eight days of Beryl making landfall, but insurance alone was not enough to cover the damage and cost of recovery.

This remains the case in developed and developing markets. For instance, in 2013, the Rim Fire in California caused damage estimated at $31.5 million, but only $3.5 million was recovered through insurance claims and $5.1 million from eligible disaster assistance (Sasson et al., 2021). Swiss Re Institute estimated the protection gap to be $1.8 trillion in 2022—up by 20 percent since 2018—across all sectors globally (Swiss Re Institute, 2023).

In disaster-prone areas, where premiums are higher, countries can benefit from establishing large-scale agreements at the national level. For example, in Colombia, regulations mandate insurance for public assets at the national and subnational levels, under an umbrella framework agreement that pools risk and lowers insurance premiums. Similarly, the Indonesian government has expanded its state asset insurance programme, transferring the risk from the national government to a consortium of domestic insurance market companies. Governments may also set up their own captive or mutual insurer, as Australia did with the Australian Capital Territory Insurance Authority mentioned in **Box 5**.

Box 11

Indonesia's public asset insurance programme

In 2018, a national DRFI strategy was developed, and in 2019, a public state insurance programme, ABMN, was launched in Indonesia specifically to protect government infrastructure (World Bank, 2024c). Prior to the implementation of ABMN, the use of insurance was ad hoc and subject to individual ministries' requirements. The Ministry of Finance started with a pilot covering its own office buildings, education and training facilities, and health care facilities; a total of 1,337 assets were insured for $688 million, with an annual insurance premium of $1.5 million. By 2023, the programme covered 76 ministries and agencies insuring 10,920 units.

Insurance is provided by a consortium of 75 general and Sharia insurance/re-insurance companies, and the transactions take place directly between the client ministries and the consortium without the need for a broker. Selection criteria include a minimum capital requirement of $9.6 million, a risk-based capital ratio of at least 120 percent, a minimum liquidity ratio of 100 percent, and a track record in catastrophe insurance. This allowed for ABMN policies to be affordable, enabling them to offer a single rate significantly lower than that of standard products, with comprehensive coverage for a wide range of risks.

The 2021 Mamuju earthquake in West Sulawesi was the first disaster to test the system. The earthquake hit on 15 January 2021; by 21 July 2021, the evaluation and approval process was completed, and the claim payment of $3.95 million was settled in April 2022. One limitation was that values attached to public assets in the database reflected either depreciated book value, acquisition value, or fair value and not new replacement cost that would help rebuild, leaving the cost of truly rebuilding to be covered by other sources of funds.

Risk pooling does not have to stop at the national level. Pooling disaster risk at the regional level has become essential for countries seeking greater financial resilience against shocks. The four regional pools, African Risk Capacity (ARC), CCRIF, Pacific Catastrophe Risk Insurance Company, and Southeast Asia Disaster Risk Insurance Facility, had a global insurance coverage of $1.4 billion as of 2022, with CCRIF representing more than 70 percent of the coverage (Adam et al., 2025). Collaborative risk pools not only diversify risk portfolios across member states, thus lowering insurance costs, but also offer quicker access to funds, technical expertise, and the global re-insurance market.

Specific agencies may also choose to invest in targeted insurance suited to their sectoral needs. For example, the Uruguayan electric power company, Administración Nacional de Usinas y Transmisiones Eléctricas (UTE), found itself vulnerable to fluctuations in commodity prices, in particular, oil price volatility, in times of drought. More than 80 percent of the country's electric power is hydraulic, so when the volume of water in reservoirs decreases due to the lack of rain, UTE must rely on thermal power generation, which requires purchasing oil at a high cost. To address this, in 2013, a partnership between UTE, the World Bank, the catastrophe insurance–linked securities manager Nephila, the insurance company Allianz, and the reinsurer Swiss Re was forged to provide $450 million in insurance coverage for the next 18 months against high oil prices caused by drought. While the insurance was not ultimately triggered, this set a precedent

Box 12

Regional risk pools: ARC and CCRIF

Several regional pools have been set up to cover multiple countries and provide access to international insurance markets, including the following:

African Risk Capacity (ARC, 2023)

- Membership: Founded in 2012 by the African Union, ARC includes 39 African Union member states.
- Funding: Initial capital was paid by Germany through KfW, and the United Kingdom through the Department for International Development, but now donors also include the United States Agency for International Development, International Fund for Agricultural Development, Rockefeller Foundation, Office of the United Nations High Commissioner for Refugees, European Union, and Dutch, Swedish, French, and Canadian governments.
- Product evolution: Initially, parametric insurance policies covered only drought, but coverage has now been expanded to include floods and tropical cyclones.
- Payouts: ARC currently offers maximum coverage of $30 million per country per season for drought events that occur with a frequency of one in five years or less. Since 2014, ARC has collected over $100 million in premiums, provided $720 million in insurance coverage, and paid out a total of $65 million, mainly to the agriculture sector. (Climate Policy Initiative, 2020a)

Caribbean Catastrophe Risk Insurance Facility (CCRIF, 2024)

- Membership: CCRIF, a first- of-a-kind regional risk pool, was set up in 2007. It initially served Caribbean governments, but in 2015, it was extended to Central American countries. Today, it includes 19 Caribbean governments, four Central American governments, three Caribbean electric utility companies, three Caribbean water utilities, and one tourist attraction—the Cayman Turtle Conservation and Education Centre.
- Funding: CCRIF was developed under the technical leadership of the World Bank and with a grant from the Government of Japan. It was capitalized through contributions to a Multi-Donor Trust Fund by the Government of Canada, the European Union, the World Bank, the governments of the United Kingdom and France, the Caribbean Development Bank, and the governments of Ireland and Bermuda, as well as through membership fees paid by the participating governments.
- Product evolution: Initially focused on hurricanes and earthquakes, CCRIF today offers parametric insurance products for tropical cyclones and excessive rainfall and has specialized products for electric and water utilities and fisheries. A product for fluvial flooding is offered to selected countries only.
- Pay-out: Since inception, it has made 78 pay-outs totalling approximately $390 million (Climate Policy Initiative, 2020).

Box 13

Leveraging insurance to promote cross-country collaboration

Insurance can be leveraged to promote collaboration across various countries and sectors to improve system-wide risk management. To this end, there are multiple international initiatives supporting developing countries in their efforts to leverage insurance solutions for resilience:

- **Global Shield against Climate Risks** is a joint initiative of the Vulnerable Twenty (V20) Group and the Group of Seven (G7). It aims to provide and facilitate more and better pre-arranged protection against climate- and disaster-related risks for vulnerable people and countries. This initiative is implemented through a set of vehicles, including the World Bank's Global Shield Financing Facility.
- **The ASEAN+3 Disaster Risk Finance Initiative is a regional initiative** that aims to strengthen the capacity of ASEAN+3 members to manage disaster and climate risks. The objectives of the initiative are to i) support the implementation of DRFI solutions; ii) lay the foundation for DRFI solutions through technical cooperation and investment in data and risk modelling, risk advisory toolkits, and the development of enabling legal and regulatory infrastructure; and (3) increase access to affordable financial instruments, including insurance, to secure adequate and appropriate financing for pre- and post-disaster efforts. The World Bank acts as the technical lead of this initiative.
- **The Insurance Development Forum** is a public–private partnership led by the insurance industry and supported by the World Bank, the United Nations, and other international organizations. It aims to enhance the use of insurance to build greater resilience against disasters by facilitating resource mobilization and forging strategic partnerships (Adam et al., 2025).

for using such tools to improve resilience in the power sector (World Bank, 2018b).

Insurance alone is not enough. Funds, grants, and debt instruments are required for effective reconstruction.

In many cases, reconstruction often takes years and requires significant up-front investments, making it more difficult to manage with pre-arranged financing. Additional funding pools are often used to cover the gap. For example, a mix of emergency government funding, international aid grants, and insurance payouts was used to fund a multi-year repair and reconstruction of Sint Maarten's Princess Juliana International Airport following damage caused by hurricanes.

Another method is to set aside capital in a reconstruction fund. Established mostly at the national level, these funds accumulate capital over time, which is used for disaster response and recovery.

As with all national funds, accessing them in an emergency can take time and may involve navigating red tape. In the Philippines, for example, requests for funding from the National Disaster Risk Reduction and Management Fund require complex documentation and evaluation by several agencies before they are approved by the Office of the President. This process can take from five weeks to one year or more (World Bank, 2023). Such delays and administrative burden are not limited to developing countries. In the US, after the 2012 Hurricane Sandy, over $50 billion was allocated, but after two years,

Box 14

Reconstruction of Sint Maarten's Airport after Hurricane Irma (Ranger et al., 2021)

Princess Juliana International Airport (PIJAE) on the island of Sint Maarten/ Saint Martin was devastated in 2017 by Hurricanes Irma, Jose, and Maria. The roof and jetways were damaged, and sand and flooding made the runway inaccessible, severely affecting tourism, a key driver of Sint Maarten's economy. Services were completely suspended for a month, and temporary facilities were used for operations for over a year. When basic services resumed in 2018, reconstruction funds were raised through several sources:

- **Government of Sint Maarten Emergency Funding:** This provided emergency cash transfers of $5 million and an additional $15 million for a fully committed facility to cover operating expenditures during reconstruction of the airport.
- **Dutch Government Grant:** The Dutch government in April 2018 established the Sint Maarten Recovery, Reconstruction, and Resilience Trust Fund as a tripartite undertaking of the Government of the Netherlands, Government of Sint Maarten, and World Bank. In December 2019, the Trust Fund gave the Government of Sint Maarten a $72 million grant for the Sint Maarten Airport Terminal Reconstruction Project. The project is a tripartite initiative that includes the $72 million grant managed by the World Bank, $50 million from the European Investment Bank, and $7 million from the PIJAE.
- **Insurance:** The airport is insured by National General Insurance Corporation N.V. (NAGICO), a major, privately owned general and life insurance carrier in the Caribbean, which in turn is backed by major global re-insurers, including Swiss Re, Hannover Re, Munich Re, Partner Re, and Peak Re. The airport's initial claim of more than $100 million was disputed by NAGICO, which estimated the damages at $37 million, including profit loss. NAGICO initially paid out only $25 million, but a July 2018 judgement by the Sint Maarten Court of First Instance ordered NAGICO to pay an additional $33 million to continue restoring the airport. A separate arbitration panel ruled in favour of an additional $14 million in August 2019.

only $11 billion had been disbursed to various agencies under the Disaster Relief Appropriations Act of 2013 (Cambridge Centre for Risk Studies & XL Catlin, 2018). Processing delays often compel sector agencies to rely on their own disaster management resources rather than on national funds. During Hurricane Sandy, the New York Metropolitan Transit Authority suffered damages of over $5 billion, but it had only $1.7 billion in insurance coverage. Although FEMA reimbursed approximately 75 percent of the uninsured loss, this still left the Metropolitan Transit Authority with a loss of nearly $1 billion, despite taking several actions, such as shutting down service and moving stock outside the flood zones (Cambridge Centre for Risk Studies & XL Catlin, 2018).

Another way is for governments to issue a CAT bond. CAT bonds are high-yield bonds sponsored by governments and generally issued by re-insurers. Bonds pay out in the event of a catastrophe and are triggered when specific parametric triggers are met. CAT bonds are attractive to insurers

Box 15

India's National Disaster Response Fund

The Government of India allocates national budget resources to its National Disaster Risk Management Fund (NDRMF), 80 percent of which goes to the National Disaster Response Fund (NDRF) and the remaining 20 percent to the National Disaster Mitigation Fund (NDMF) (International Recovery Platform, 2023). NDRF dedicates 10 percent of the amount to disaster preparedness and capacity building, 40 percent to response and relief, and 30 percent to recovery and reconstruction. According to its website, approximately $7.80 billion has been allocated to NDRMF for the period 2021–2022 to 2025–2026, out of which around $6.23 billion is for the NDRF, to be used for expansion and modernization of fire services and resettlement of displaced people affected by erosion; about $1.56 billion is for NDMF to be used for providing catalytic assistance to most drought-prone states, managing seismic and landslide risks, reducing the risk of urban flooding, and implementing mitigation measures to prevent erosion, among others (Ministry of Home Affairs, n.d.).

as they offer the possibility of multi-year commitments, whereas most re-insurance deals are for a one-year term and lower costs by attracting alternative sources of capital (e.g., hedge funds, sovereign wealth funds, pension funds, and mutual funds) to compete with traditional reinsurance. CAT bonds are also appealing to investors as they are largely uncorrelated with the returns of other financial market instruments. Mexico was the first government to use the bond market for CAT bonds in 2006, and as of 2024, it has issued 20 such instruments (World Bank, 2024f). However, insuring against catastrophes can be expensive for LMICs (Inter-American Development Bank [IDB], 2017).

Strengthening financial resilience for infrastructure requires moving beyond reactive disaster funding, and towards a comprehensive framework that prioritizes risk reduction, improves rapid response capacity, and enables sustainable recovery.

This paper shows that there are several dimensions to increasing an asset's capacity to absorb, respond to, and recover from a climate-related disaster, each with its own set of trade-offs. Nonetheless, the persistence of protection gaps and the complex interplay of national, subnational, and sector-level responsibilities mean that no single instrument can suffice. A country can truly deliver resilience at scale only by adopting a layered approach to disaster risk financing, using a diversified set of complementary tools adapted to local contexts.

4. Financing Resilient Infrastructure at Scale: Addressing Challenges

A paradigm shift is required to ensure that both new investments are designed, financed, and built according to resilience standards and existing infrastructure is made more resilient.

The estimates on infrastructure investment needs and gaps vary across literature and sources depending on the underlying methodologies, definitions, assumptions, types of expected transformation, and time-horizon (Atlantic Council, 2025; CDRI, 2023; OECD, 2017). The investment projections differ due to the lack of comprehensive data on investments across countries, the reliance on global models instead of country-specific infrastructure and development trajectories, and the limited integration of incremental investment needs for climate change adaptation and mitigation (OECD, 2017). Nevertheless, the main message across the literature is clear: There is currently a significant funding gap in the range of trillions of dollars annually for infrastructure investments, and mobilizing financing from both private and public sectors is urgently required to meet this gap.

The OECD, World Bank, and UN Environment Programme estimated that an annual investment of $6.9 trillion by 2030 for infrastructure is needed to meet the objectives of the SDGs and the Paris Agreement, with investments required mainly in the transport (43 percent of the total investment needs) and energy (34 percent) infrastructure sectors (OECD, 2024). Similarly, UNCTAD estimated a total annual gap of $3.8 trillion in LMICs across infrastructure sectors in achieving the SDGs by 2030, with energy infrastructure accounting for more than half of the gap (UNCTAD, 2023). Focusing on new infrastructure only, a 2018 analysis by the Global Infrastructure Hub estimated a total infrastructure investment gap of $15 trillion between 2016 and 2040 (or $1 trillion annually) across 56 countries concentrated in the Asia-Pacific and North and South America regions (Global Infrastructure Hub, 2018). Rozenberg and Fay (2019) also estimated that between $620 billion and $2.7 trillion per year is required by 2030 to build new infrastructure in LMICs.

In terms of the needed incremental costs of making infrastructure resilient, CDRI estimated in its first Global Infrastructure Resilience report in 2023 that the total annual investment required for adapting existing and retrofitting aging

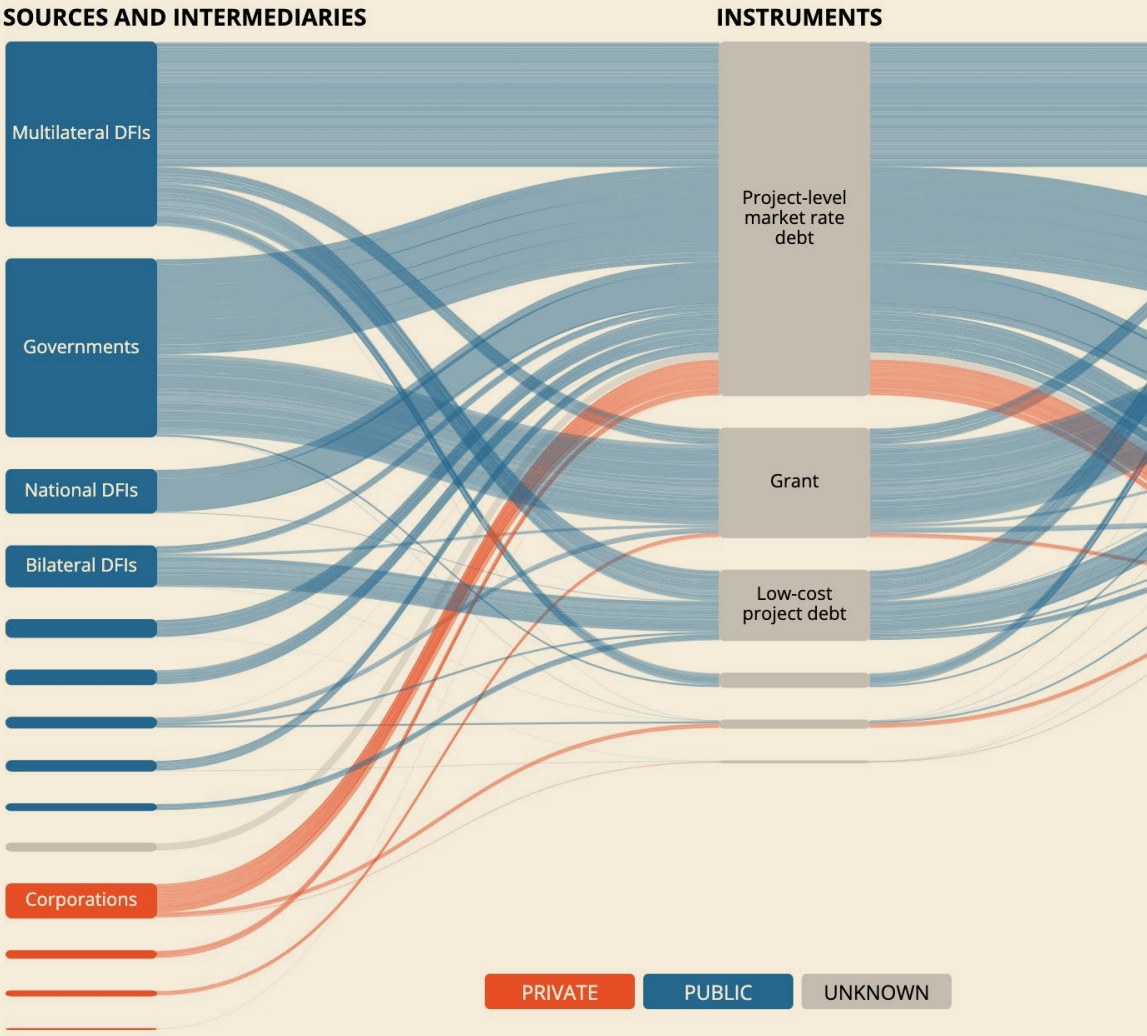


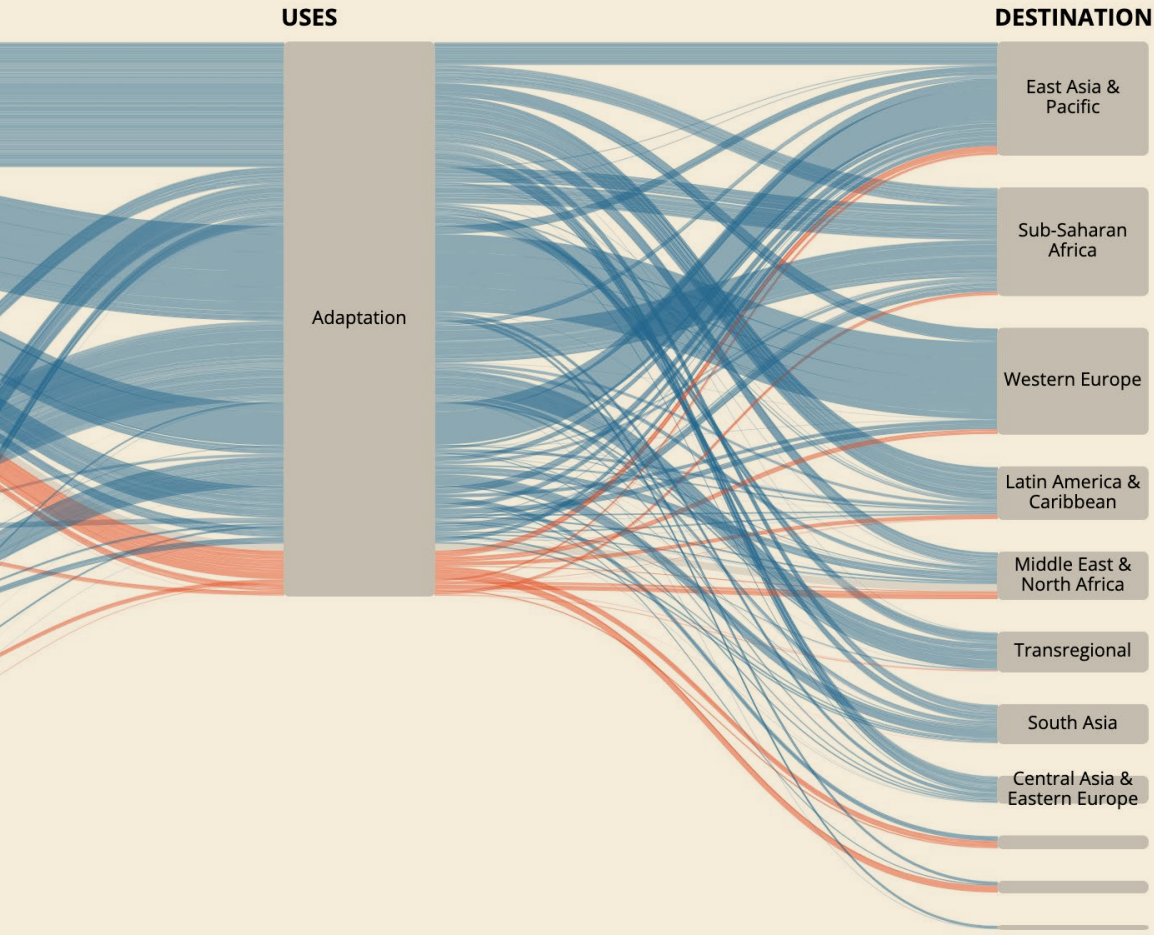
Figure 5

Sectoral breakdown of investment for adaptation in 2023

Source: CPI (2025a)

infrastructure in LMICs (not counting the cost of new infrastructure) to be both net zero and the investment needed to make infrastructure resilient to climate impacts to be up to $2.9 trillion between 2021 and 2050 (CDRI, 2023). For new infrastructure, Hallegatte et al. (2019) found that an additional 3 percent above the overall investment needs is required for building resilience into infrastructure systems, with a potential net benefit of $4.2 trillion over the lifetime of new infrastructure in LMICs (or $4 benefit per $1 invested in resilience).

These amounts are of a different order of magnitude from current adaptation finance flows: about $66.6 billion was mobilized across sectors for climate adaptation and resilience in 2023, according to the Climate Policy Initiative (CPI, 2025a). However, only $6.3 billion was directly allocated to DRM (CPI, 2025b), which is substantially less than the $170 billion annually suggested by the GCA (Global Commission on Adaptation, 2019). Two other aspects of these adaptation finance flows also require urgent attention. First, in geographic terms, the $46 billion mobilized for LMICs is a fraction of the estimated funding needed for adaptation in LMICs: $222 billion annually by 2030 and $248 billion by 2050 (CPI, 2025b). Second, the majority of the funds, came from the public and non-state sectors—mainly from multilateral development finance institutions (DFIs) ($22.4 billion), national governments ($21.1 billion), and national and bilateral DFIs ($5.1 and $5.0 billion, respectively)—while the private sector provided only about $4.0 billion (**Figure 5**) (CPI, 2025a)



The funding of incremental resilience interventions should be an integral part of infrastructure planning and financing, complementing the current primary focus on mobilizing finance for 'early-action' post-disaster events. Development finance should embed disaster risk reduction in mainstream financing activities by assessing asset exposure and vulnerability to disaster risks when considering the funding of infrastructure.

Importantly, funding for the resilience of new infrastructure assets should be fully integrated into the finance plans of new projects. In this context, governments face a triple challenge: i) determining how much to invest in disaster risk reduction versus mobilizing contingent capital; ii) establishing clear guidelines and standards to define resilience targets, measure resilience performance, and monetize resilience benefits; and iii) implementing regulatory and contractual frameworks to mobilize private capital alongside public sources of funding.

The allocation of funds between pre- and post-disaster actions is a fundamental component of disaster risk management finance for governments and infrastructure agencies. The previous section highlighted the different types of disaster risk reduction activities, including enhanced maintenance of existing assets, retrofitting of existing assets, and incorporation of resilience measures into new assets. It also described various forms of contingent funding that can be mobilized for response and recovery measures. Quantifying both sets of funding requires an analytical framework, which we present later in this paper.

The establishment of clear guidelines and standards to define resilience targets has direct financial implications. The higher the resilience standard selected, the more the financial resources required to build new assets and retrofit existing ones; however, the need for contingent funding for repair and reconstruction of those assets post-disaster will be reduced. In addition, it is critical to mobilize private capital to address funding shortfalls that have been mentioned earlier to ensure the resilience of both existing and new infrastructure.
These challenges can be addressed through four parallel activities relating to strengthening infrastructure **resilience**:

1. Define and implement resilience standards.
2. Implement risk allocation frameworks, including Public Private Partnerships (PPPs), that include DRM and promote effective collaboration between the public and private sectors in the development, operation, and financing of infrastructure.
3. Implement frameworks and policies that quantify, allocate, and monetize the benefits of resilience.
4. Fund relevant interventions to reduce infrastructure vulnerability to disaster risks, and mobilize post-disaster finance in the light of international public finance constraints.

4.1 Resilience Standards

Resilience standards are important as they establish both baseline engineering standards and process-based targets.

Standards can be divided into technical standards, best practices, and labels. Various studies and examples underline the need to mainstream disaster-resilience-related terminology in standard documents and ensure that losses from disasters are appropriately covered by the insurance sector throughout the infrastructure project's lifespan. The incremental costs associated with improving standards should be weighed against the expected reduction in AAL.

Box 16

Japan's building safety standards

The building safety standards in Japan are a good example of a policy and legal framework that is tailored to a country's disaster risk profile. In Japan, a country that is particularly prone to earthquakes, disasters are a significant area of research (World Bank, 2018a). The Building Standard Law of 1950 has been revised several times in response to severe earthquakes. For example, the 1981 revision is based on the response to the 1968 Tokachi-Oki Earthquake, which caused major damages to reinforced concrete buildings (World Bank, 2018a). The disaster resulted in a research project between government, universities, and industries to improve anti-seismic technology and a seismic design method which then became the new building standard law. This pattern of responding to gaps in building standards underpins Japan's ever-improving building safety standards and has been proven effective. The 1995 Great Hanshin Earthquake destroyed approximately 100,000 homes in the Hyogo prefecture; however, only 3 percent of those collapsed homes were built after 1981, when the updated seismic standard was introduced (World Bank, 2018a). This translated into significant avoided losses.

Box 17

The Philippines' climate resilient schools (World Bank, 2024d).

The Philippines lies in a highly seismically active region known as the 'Pacific Ring of Fire' and is extremely prone to destructive earthquakes and typhoons. The government partnered with the World Bank to finance resilient recovery of disaster-affected school infrastructure and to support building back better. A multi-hazard vulnerability assessment informed the selection and prioritization of schools into four types of intervention: repair, rehabilitation, retrofitting, and reconstruction. Vulnerability reduction measures were incorporated into the engineering designs of the affected schools to ensure resilience to future climate risk. A contingent emergency response component was built into the contract to reallocate uncommitted project funds to response and recovery needs in the event of a disaster or crisis.

Infrastructure standards should be embedded in recovery actions to build back better and improve the long-term resilience of infrastructure at a limited incremental cost

In another example, CDRI reviewed the clauses in the standard agreements for projects in India under the National Infrastructure Pipeline (NIP) to mainstream disaster resilience in the land transport and power infrastructure sectors (CDRI, 2025b). The study revealed many gaps related to disaster resilience, particularly the limited considerations of risks and disaster resilience in the standard agreement framework, as well as the lack of clear allocation of financial and operational responsibility between stakeholders.

In addition, there should be a link between infrastructure resilience standards and taxonomies of resilient investments to facilitate the mobilization of capital for resilience. Funding measures and activities that help achieve specific resilience standards will naturally be classified as a resilient investment under these taxonomies. The European Union (EU) taxonomy is a classification system that defines economic activities aligned with a net-zero-by-2050 trajectory and broader sustainability objectives linked to climate adaptation and resilience. The Climate Bonds Initiative Resilience Taxonomy, launched in 2024, addresses the perceived lack of clarity on what constitutes a climate-resilient investment. It lists more than 1,400 different adapted and enabling resilience measures and activities across seven climate resilience themes (CBI, 2024).

4.2 Risk Allocation

Risk allocation between the public and private sectors is key to involving private-sector stakeholders in the development, management, and financing of infrastructure assets and ensuring effective collaboration with the public sector in addressing inter-alia DRM issues.

This covers various elements such as contractual frameworks, the role of regulators, and the mobilization of private finance.

An example of a PPP framework for climate resilient infrastructure is provided in the GCA handbook (GCA, 2021). It outlines a four-step project cycle comprising i) project identification, ii) appraisal, iii) tender and award, and iv) contract management, with key intervention points for climate resilience

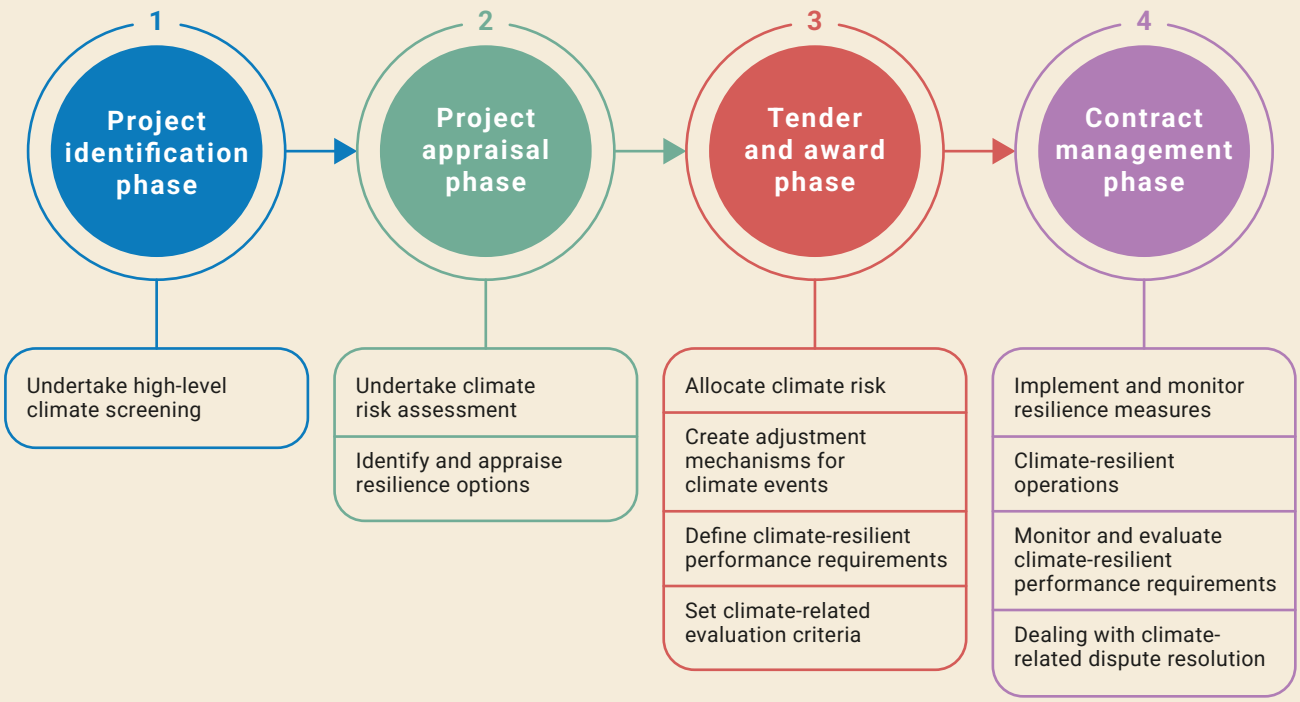


Figure 6

GCA PPP framework for climate resilient infrastructure

Source: GCA (2021)

in each step so that both public and private partners consider adaptation and its co-benefits where possible (**Figure 6**).

GCA also highlights several country case studies and delineates specific roles for private and public sectors throughout the project cycle. For example, the public sector plays a crucial role in the project identification phase by leading the high-level climate assessment and prioritizing projects in terms of need and co-benefits. In Ghana, the Ministry of Environment, Science, Technology and Innovation led the assessment and applied advanced methodologies to identify 35 prioritized adaptation options, focusing on safeguarding critical infrastructure and locating various funding sources (GCA, 2021).

During the contract management phase, it is critical to involve the private sector to ensure rapid restoration of services in the immediate aftermath of a disaster, which then enables the public sector to allocate funds towards overall recovery. For example, in the Dar Es Salaam Bus Rapid Transit System PPP in Tanzania, revenue losses and damage to buses and other assets are the operator's responsibility, while the public sector focuses on keeping the busway operational during events (GCA, 2021).

It is important to have specific clauses in the contract that reflect the agreed risk allocation. Some key considerations are listed below, but more detailed sector-specific guidance can be found in the World Bank's Climate Toolkits for Infrastructure PPPs (World Bank, 2022b):

Construction standards: These help ensure that resilience is embedded in designs to better protect against shocks. For example, Melbourne's Metro Tunnel and Station PPP Project agreement specified that the design "must include measures for all high and extreme climate change risks to ensure the infrastructure, Stations and precincts are resilient to the projected impacts of a changing climate over the relevant asset's Design Life. This should be in accordance with the adopted climate-change projections and scenarios within the Climate Change Risk Assessment and Climate Change Adaptation Plan" (World Bank, 2025c, p. 10).

This can be extended to retrofitting standards, as seen in the Strengthen Alabama

Box 18

São Paulo intercity train line

The São Paulo government introduced the 101-kilometre intercity train line to connect the cities of São Paulo and Campinas, aiming to create up to 10,000 jobs and improve services for users across 11 municipalities. This is one of the largest PPP projects in Brazil, attracting an estimated $2.5 billion from the private sector, the IDB, and the Global Infrastructure Facility (IDB, 2023). In addition to providing economic and environmental benefits, the PPP contract sets strict standards for impact assessment and biodiversity conservation It also allows for consideration of different climate scenarios (as envisaged by the Intergovernmental Panel on Climate Change) to strengthen climate resilience, particularly against the impacts of floods on the drainage system.

Homes Program in the US, which provides grants of up to $10,000 for upgrades that adhere to the FORTIFIED standard (FORTIFIED, 2025). Most insurance companies in Alabama offer discounts of up to 55 percent of the premium associated with storm risk for those who are part of the programme, and residents can get a tax deduction of up to $3,000 when they upgrade to mitigate the risk of storm damage. The programme is open to all homeowners, with no income limits or additional tests required.

Insurance requirements: Insurance can help cover potential risks from natural hazards. The Government of Kenya mandates disaster risk insurance coverage under its power purchase agreement template. The seller (the project company) shall "at its sole cost and expense, obtain and maintain, in full force and effect, for the periods specified in Schedule 8, the insurance policies set forth in Schedule 8, in the amounts stipulated (provided that, having regard to the level of cover generally taken out by international independent geothermal power producers acting in accordance with Prudent Operating Practice, such insurances are available on commercially reasonable terms), with reputable insurance companies" (World Bank, 2019, p. 26).

Reliability standards: These set a threshold to establish the quality of the asset. For example, Texas's Department of Transportation specified in its design criteria that "all drainage structures, storm systems and outfalls shall be evaluated for the 100-year storm event" (World Bank, 2025c).

Contingency plan requirements: A contingency plan can ensure emergency response and business continuity. For example, "a system should be established where information can be continuously displayed by installing equipment that can supply electricity for a certain period, even during emergencies such as disaster," and "a manual should be prepared in advance for responding to emergencies such as earthquakes, fire and accidents, and approval should be obtained from the municipality" (World Bank, 2017b). This may also include providing for financial contingencies—such as sufficient insurance coverage against potential climate and related risks or a climate contingency account that reserves a portion of a project's cash flows to deal with extreme events (World Bank, 2025e).

Box 19

Brazil's Contrato de Reabilitacao e Manutancao (CREMA) guidelines (World Bank, 2025e)

In Brazil, road contract projects must follow CREMA guidelines, which integrate climate risk management with road maintenance and development projects through the Basic Climate Risk and Resilience Management Plan (Basic CRRMP).

The plan is used in the procurement stage to guide initial investment and embed resilience in the contracts. Once the contract is awarded, the contractor must develop a detailed CRRMP, which includes the following:

1. The current state of conservation and maintenance of road infrastructure elements critical to resilience
2. A comprehensive catalogue of required actions with prioritization and investment schedules
3. Proactive, resilience-focused maintenance obligations
4. Emergency response protocols (emergency action plan)

Flexibility provisions: Sufficient flexibility is embedded especially in long-term contracts to better manage uncertainties, such as any unexpected effects of climate change. For example, "the Parties agree that should any significant changes in climate conditions materially affect the project costs or timeline, both parties will negotiate in good faith to adjust the contract terms to reflect the new reality, ensuring economic balance and project viability" (World Bank, 2025e). The contractual arrangements should also consider including resilience costs in tariffs as maintenance charges, with a mechanism for adjustment throughout the operating period, subject to frequent review by a regulator. In projects that depend on resources from climate-vulnerable regions, more specific clauses could be added, such as the following: "In the event of an increase of more than [5 percent] in the costs of (including the cost of transportation of) raw material, equipment or labour resulting from unforeseeable climatic events affecting the geographic location where materials are sourced, equipment are manufactured, the labour force is located (or the transportation route therefore), prices set forth in this Agreement may be adjusted according to a predefined formula reflecting the proportionate increase in costs" (World Bank, 2025e).

Clarity around the definition of force majeure can be crucial in disasters. Japan's Aichi Toll Road Concession Project PPP agreement clearly stipulates the force majeure events for which additional costs are borne by the public sector: "Force majeure includes a storm, torrential rain, flood, high tide, landslide, fall of ground, strike of lightning, earthquake, fire, other natural disaster, or uprising, riot, disturbance, act of war, epidemic, or other human-made disaster, of which the cause is not attributable to either the government or the concessionaire" (World Bank, 2017b). It goes further by specifying the indicators for each type of event, for example, for heavy rain, which is defined as "maximum rainfall of 80 mm or

Box 20

Setting up a resilience regulatory framework

All public infrastructure is bound to policy, regulations, and codes with the purpose of maximising its benefits for the public. However, as the resilience regulatory framework is currently in its nascent stage, it requires a series of tests to build credibility and confidence. Seethapathy (2025) has identified four main tests to improve the regulatory process:

1. Frequency tests to understand a range of impact probability and uncover the potential large impacts from smaller probability
2. Adequacy tests to identify potential failures against high impact scenarios.
3. Means tests to assess customers' ability to pay over the asset's long lifespan
4. Judicial tests for regulatory rulings to ensure reasonable fairness and durability

The current regulatory mechanisms can also be greatly strengthened by creating and improving the following four blocks of knowledge areas and datasets:

1. Subnational (district-level) climate map: Collecting detailed district-level climate data (e.g., minimum/maximum temperature, rainfall, wind speed, coastal tides, and disaster occurrence) is critical to understand how the local climate has changed over time.
2. Vulnerability map: Vulnerable assets and systems should be identified based on the climate map and each type of vulnerability categorized by season, geographic location, and operational capability. Moreover, these vulnerabilities should be ranked according to disruption, restoration, and operating impacts.
3. Remediation estimates: The costs of remediation (including new builds and infrastructure upgrades) are estimated based on the climate and vulnerability maps, along with timelines and priorities.
4. Regulatory review: Datasets and knowledge are shared with regulators for reviews and insights to build a long-term business case for resilience.

more in 24 hours. Even if rainfall is below the above standard, it is considered heavy rain if hourly rainfall is significant (20 mm or more), provided that the hourly rainfall is observed at the nearest weather observation station (managed by the public corporation) from the damaged place, or a storm which is defined by "Maximum wind speed of 15 meters per second or more (average in 10 minutes)" (World Bank, 2017b). (Refer to Annexure B for more guidance on contractual clauses from the World Bank.)

The contractual arrangements should also include resilience costs in tariffs and maintenance charges, with a mechanism for adjustment throughout the operating period, which can be frequently reviewed by a regulator.

The most comprehensive PPP frameworks often combine different sources of public and private funding with risk layering. Private-sector stakeholders may be exposed to an initial layer of risk vulnerability (quantified as a damage threshold expressed as a percentage of capital expenditure or revenue), while a second layer is transferred to the insurance market, and a third layer is borne by governments.

Sustainability labels such as FAST Infra and the Blue Dot Network help incorporate vulnerability to disaster risks into lenders' due diligence and Investor appraisal. They provide a tool to monitor the factors that affect an infrastructure's sustainability throughout its life.

Various public–private initiatives have emerged in recent years to deal with some of the issues highlighted in this paper.

The EMDE Investor Taskforce was recently convened by the UK government with the aim of bringing together public- and private-sector stakeholders to address persisting challenges in mobilizing capital to support a climate-resilient transition in EMDEs. The main hurdles identified were a lack of situational awareness among regulators of the costs of inaction; a lack of deep understanding of real risks and opportunities (risk perception and data gaps); a lack of investable products (with sufficient scale and liquidity); and regulatory barriers (EMDE Investor Taskforce, 2025).

The Insurance Development Forum is launching a blended finance resilient fund to provide loans for infrastructure assets in EMDEs. The fund aims to facilitate insurance sector investments in infrastructure to improve the resilience of vulnerable communities to climate and disaster risks (Insurance Development Forum, 2024).

4.3 Policies for Infrastructure Resilience

Governments should have policies in place that quantify, allocate, and monetize the direct and indirect benefits of infrastructure resilience.

This can be achieved by empowering national infrastructure agencies and sector ministries to quantify infrastructure exposure and vulnerability to disaster risks and to implement resilience cost–benefit analytical frameworks. The Government of India, for example, has created a publicly available national portal to provide district-level data on climate hazards, and vulnerability and temperature series maps. This information has led to analytical works on risk assessments for utilities to meet load requirements under various climate conditions.

Direct benefits include incremental cash flows resulting from a resilient intervention—as compared to a counterfactual case that incorporates the impact of climate risks—and the reduction in an asset's vulnerability, which may lead to improved insurance terms. Indirect benefits may include improved reliability of critical infrastructure, reduced post-disaster cleanup costs, increased land value, and, more broadly, enhanced access to infrastructure for users and reduced environmental degradation. Quantifying these incremental cash flows is a task that governments are best equipped to perform, often with assistance from international experts in the field.

There are different mechanisms for allocating and monetizing resilience benefits across stakeholders, including adaptation certification to assign values to resilience, fiscal incentives such as tax exemptions or tax increment financing, and direct payments such as user fees, tourist taxes, or ecosystem payments. For example, the African Development Bank's Adaptation Benefits Mechanism aims

to mobilize new and additional finance to enhance climate change adaptation action by certifying quantified adaptation benefits using rigorous methodologies and independent verification (African Development Bank, 2025). This helps projects demonstrate resilience improvements and co-benefits and makes adaptation costs transparent.

4.4 Funding for Resilience Interventions

Governments are expected to both allocate budget funding to pay for resilience interventions that reduce infrastructure vulnerability to disaster risks and mobilize post-disaster finance.

The funds required to make existing and future infrastructure resilient cannot be raised through additional sovereign debt, given the international public finance constraints that most LMICs face today. This has several implications for development finance: the need to embed resilience features in all multilateral development bank and DFI funding for new infrastructure, thus making resilience finance a mainstream component of international public sector finance flows; the importance of sovereign loans for resilience, such as the IMF Resilience and Sustainability Facility, which has been successfully implemented in Jamaica (IMF, 2024) and the benefits of inserting adaptation and resilience debt relief clauses in sovereign debt capital market issuances and other international loan agreements, whereby borrowers typically have the right to defer principal repayments for a specific period of time following the occurrence of a disaster.

Disaster risk reduction funding should come from a combination of public and private sources of capital. The recent World Bank report Financing Climate Adaptation and Nature-Based Infrastructure presents a series of case studies that demonstrate ways to increase private-sector participation (World Bank, 2025a).

The infrastructure financial resilience framework presented in the following section should help governments allocate limited public finance between disaster risk reduction and post-disaster action

Box 21

IMF Resilience and Sustainability Facility: Increasing Jamaica's economic resilience to climate change

The IMF, since 2022, has been supporting LMICs with the Resilience and Sustainability Facility (RSF), which provides both policy support and affordable, longer maturity financing to extend financial headroom, improve macroeconomic stability, and help build resilience for governments and various infrastructure (IMF, 2025b). Many LMICs have benefited from this, including Bangladesh, DR Congo, Cote d'Ivoire, and Jamaica (CPI, 2025c). For example, the RSF has supported Jamaica by providing $258 million in special drawing rights (SDR) to strengthen the country's fiscal and financial policy frameworks to make the economy more resilient to climate change (IMF, 2024). This includes supporting reforms to accelerate resilience, improve climate risk management, and create a more enabling environment for driving green financial instruments. These efforts are expected to help Jamaica better manage its public debt trajectory and reduce its debt to below 60 percent of GDP by 2028.

5. A Financial Resilience Pathway: Implementing an Infrastructure Resilience Framework

We define 'infrastructure financial resilience' as the degree to which a country has adequate financial instruments, institutions, governance arrangements, capacities, partnerships, and funding to support the actions of—infrastructure agencies, related stakeholders, and the public—to prepare for, respond to, and recover from disasters.

Table 1 describes the different components, quantitative and qualitative, of infrastructure financial resilience.

The analysis of quantitative components is based on a dataset to be obtained from the relevant ministries and infrastructure agencies, as summarized in **Table 2**.

The analysis of this quantitative data should help address the following issues:

- **Is the country's level of funding for disaster risk reduction commensurate with the vulnerability of its infrastructure sector(s), given its income bracket? Answers can be provided for specific infrastructure sectors and in relation to the aggregate stock of infrastructure assets**.

This question establishes a link between the relative level of vulnerability of infrastructure assets, as quantified by the AAL, and the amount of funding available to reduce such vulnerability. Comparisons should be made across countries in the same income bracket (or with similar macroeconomic characteristics and/or on a regional basis) to determine whether i) vulnerabilities should be reduced through investment in disaster risk reduction measures and ii) the level of funding for such measures is adequate. In other words, a country with a low infrastructure AAL relative to its GDP should allocate less funding to disaster risk reduction than a country with a much higher level of infrastructure vulnerability.

- **Is the level of risk transfer appropriate (e.g., does the contingent capital in place meet a sufficient level of PML, in aggregate and for each infrastructure sector)?**

This question looks at the relationship between funding that could be mobilized post-disaster and the possible damage that each infrastructure sector or the asset class

Table 1

Components of infrastructure financial resilience
Source: Author's analysis

Quantitative components	Considerations
Funding	• Amount of funding mobilized for disaster risk reduction and disaster risk finance (including contingency funds) • Comparison of vulnerability levels of different infrastructure sectors • Fiscal headroom • National to subnational government transfers
Financial instruments	• Ratio of national and international capital sources for disaster risk reduction and disaster risk finance • Extent to which a panoply of available instruments is used • Public and private sources of capital
Qualitative components	**Considerations**
Institutions	• Infrastructure division in Ministry of Finance (and relation to planning agencies) • National development bank (or financial institution(s) that channel resilience finance) • Infrastructure agencies • Regulators • Infrastructure operators • DRM agencies • Local governments • Civil society organizations
Governance	• Transparency and public engagement • Rules of the game for allocation, disbursement, and use of funds • Inter-agency arrangements • Standards and value for money
Capacities	• Human resources • Skills • Technologies and tools
Partnerships	• International financial institutions and donors • Banking and insurance sectors • Rating agencies

(as a whole) could be exposed to. The funding available includes all public- and private-sector sources and all financial mechanisms and instruments, from budget reallocation to lines of credit, insurance coverage, and potential additional borrowings. The ratio of such an aggregate quantum of funding to the PML corresponds to a post-disaster funding gap (including the insurance gap), which should be assessed across countries in the same income bracket.

• Is the level of residual risk borne by the country's public finances sustainable, given its macroeconomic characteristics? Is the country's financial position able to cope with repeated disasters in a short period of time?

The funding gap identified in the previous question translates into a level of residual risk for the country's public finances (and/or that of specific infrastructure

Table 2

The quantitative financial information to be obtained at the national or subnational level and for each infrastructure sector
Source: Author's analysis

Funding disaster risk reduction	
National or subnational level	**For each Infrastructure sector**
• Ratio of aggregated AAL for all infrastructure sectors to the value of the total infrastructure asset stock (using GIRI) • Comparison of the above ratio among countries in the same income bracket	• Ratio of AAL to the value of the infrastructure sector asset stock (using GIRI) • Ratio of the probable maximum loss (PML) (up to the 1-in-100-year return period) to the value of the infrastructure asset stock (using GIRI)
• Ratio of aggregate preventative maintenance expenditures for all infrastructure sectors to the country's infrastructure AAL	• Ratio of preventative maintenance expenditures in each infrastructure sector to the AAL of that sector
• Ratio of domestic funding sources to total funding (including international sources) allocated to disaster risk reduction for all infrastructure sectors • Comparison of the above ratio among countries in the same income bracket	• Ratio of domestic funding sources to total funding (including access to international funding sources) allocated to disaster risk reduction for each infrastructure sector
• Share of public sources of funding (both domestic and international) as a proportion of total funding available for disaster risk reduction for all infrastructure sectors	• Share of public sources of funding (both domestic and international) as a proportion of total funding available for disaster risk reduction for each infrastructure sector
Disaster risk finance (post-disaster)	
National or subnational level	**Infrastructure sector**
• Amount of contingent capital available to fund emergency response to disaster risks and recovery in aggregate for all infrastructure sectors • As part of these amounts, what is the split between public and private sector sources of finance for emergency response and recovery funding?	• Amount of contingent capital available to fund emergency response to disaster risks and recovery for each infrastructure sector • What is the split between public and private sector sources of finance for emergency response and recovery funding for each infrastructure sector?
• Ratio of the amount of contingent capital available to the AAL and PML of the country's infrastructure sector (using GIRI) • Comparison of the above ratio among countries in the same income bracket	• Ratio of the amount of contingent capital available to the AAL and PML for each infrastructure sector (using GIRI)
• What is the weighted average tenor/duration of private sector instruments available to fund post-disaster infrastructure recovery in aggregate? • What is the annual cost of private sector contingent capital? • How does this cost compare as a percentage of AAL with other countries in the same income bracket?	• What is the weighted average tenor/duration of private sector instruments available to fund post-disaster recovery for specific infrastructure sectors? What is the annual cost of private sector contingent capital for specific infrastructure sectors?
• What fiscal headroom and international borrowing capacity does the country have to mobilize additional funding for post-disaster recovery? Please define the bands within which impact would be sustainable (using macro parameters such as projected GDP, debt/GDP, inflation, and sovereign rating)	

agencies) in that a share of reconstruction costs would have to be funded from additional borrowing that is not currently planned for. The answers will draw on an analysis of funding bands within which any incremental borrowing would be sustainable in the long run, using macroeconomic parameters such as the debt-to-GDP ratio and the potential impact on sovereign rating.

The answers to these questions should be compared with those from countries in the same income bracket, preferably using a CDRI database. They determine the level and type of adjustments that each country (and its various infrastructure agencies) may consider improving the quantitative aspects of the infrastructure sector's financial resilience.

This quantitative assessment should be complemented by a review of qualitative aspects, using a checklist to generate a structured diagnostic to identify a financial resilience pathway. It can be applied at both the national and the subnational level and by infrastructure agencies.

Table 3 presents the qualitative questions for the infrastructure financial resilience checklist.

Table 3

Infrastructure financial resilience checklist
Source: Author's analysis

The role of national or subnational level entities in enabling the policy, regulatory, and budgetary environments to mobilize funding for infrastructure resilience	The role of Infrastructure sector agencies responsible for raising and deploying capital to achieve financial resilience of infrastructure sectors
Understanding disaster risks Goal: To determine whether a country's infrastructure ecosystem (e.g., ministries, agencies, regulators, lenders, operators) has adequate frameworks to assess the sector's exposure and vulnerability to disaster risks	
• Is there a national agency or ministry responsible for monitoring the vulnerability of the infrastructure sector to disaster risks?	• What is the degree of coordination between such a national agency and sector agencies? • Are infrastructure agencies responsible for the quantification of disaster risk vulnerability in their sector?
• Are there procedures to prepare vulnerability assessments at the national and subnational levels?	• Are there procedures to prepare vulnerability assessments at the sector level?
• Has the banking sector undertaken a climate risk assessment of its loan portfolio? • Are any actions being undertaken to reduce the vulnerability of the banking sector?	• Which infrastructure agencies have commissioned a climate risk assessment for their sector?
• Is there a process for monitoring the availability of insurance cover for the infrastructure sector as a whole?	• Do any infrastructure sectors face difficulty in obtaining insurance for property damage or business interruption? If so, is this limited to specific geographies?

Institutions and governance Goal: To demonstrate that a country has a coordinated approach between national, subnational, and sector agencies to assess funding requirements and mobilize and allocate financial resources for disaster risk reduction and post-disaster response and recovery	
• To what extent does a national agency or ministry influence the amount of funding allocated for disaster risk reduction? For post-disaster response and recovery? • Is a national development bank involved in assessing funding requirements for disaster risk reduction? For post-disaster response and recovery?	• Are infrastructure agencies responsible for assessing funding requirements for disaster risk reduction? For post-disaster response and recovery?
• Are there procedures to determine funding requirements and identify funding sources at the national and subnational levels?	• Are there procedures to determine funding requirements and identify funding sources at the sector level?
• Are there mechanisms in place to allocate funding responsibilities between national and subnational actors? • Are local governments involved in the decision-making process relating to the funding of infrastructure? • Are civil society organizations involved in the decision-making process relating to the funding of infrastructure?	• Do infrastructure agencies have the autonomy to mobilize funding for disaster risk reduction? For emergency response and recovery? • Are sector agencies able to access post-disaster funding within a predetermined time frame?
• Are there national and subnational financial recovery plans for the infrastructure sector as a whole? Do national and subnational recovery plans include performance indicators?	• Are there financial recovery plans for each infrastructure sector?
Capacity and partnerships Goal: To establish whether the national and sector agencies responsible for the infrastructure sector have the necessary human and technical resources to properly fulfil their financial roles, with access to relevant partnerships	
• Do national and subnational agencies responsible for managing disaster risks have adequate human resources? • Do they have appropriate training programmes in place?	• Do sector agencies have adequate human resources? • Do they have appropriate training programmes in place?
• Do they have access to relevant data and technology to monitor and quantify risks?	• Do sector agencies have access to relevant data and technology to monitor and quantify risks?
• Does the country engage with a diverse group of international finance institutions? • Does the country have multi-annual programmes with international financial institutions (e.g., CAT DDO, IMF resilience finance loan)? With philanthropic institutions? • Is the country involved in one or several international climate finance initiatives?	• Do sector agencies have access to international finance institutions?

The diagnostic process is structured around a few questions for each of the qualitative elements, with responses scored on a 0–3 scale and averaged to generate overall scores. The scoring scale can be defined as follows:

- 0: Not in place—no evidence of activity in this area; major gaps exist.
- 1: Emerging—early-stage efforts or partial actions exist, but they are not yet systematic or effective.
- 2: Developing—significant progress has been made, though with some gaps in coverage or consistency.
- 3: Established—the process is fully developed, institutionalized, and functioning effectively.

Both quantitative and qualitative assessments follow a four-stage process that consists of understanding strengths and weaknesses ('diagnose'), prioritizing areas for improvement ('prioritize'), setting a road map to improve financial resilience ('act'), and tracking progress ('track').

This approach corresponds to an IFRF. The framework should help identify gaps in relation to global best practices.

While the Fiscal Risk Assessments (FRAs) conducted by CDRI focus on quantifying the fiscal impacts of disasters, including revenue shocks, public debt trajectories, and contingent liabilities arising from critical infrastructure damage, the IFRF offers a complementary approach by operationalizing these insights into forward-looking planning and investment strategies (see Annexure D for an overview of the Fiji study).

Box 22

Integrating FRAs into resilient infrastructure planning

CDRI (2025a) has conducted comprehensive disaster risk assessments at both national (Fiji, Mauritius, India, and Nepal) and subnational (the Indian states of Himachal Pradesh, Odisha, Gujarat, and Tamil Nadu) levels, analysing direct and indirect economic losses. The study introduces an FRA framework that highlights infrastructure-related disaster risks and the associated contingent liabilities. This analysis relies on the quantification of infrastructure systems' vulnerability to specific risks, using GIRI and other risk assessment tools. It also outlines integrated disaster risk financing strategies for governments to incorporate into broader DRM and public finance planning.

Fiji's experience highlights the importance of:

- Catastrophe risk modelling to inform risk-based budgeting
- Risk layering of disaster risk financing mechanisms tailored to sectoral vulnerabilities
- Embedding resilience in infrastructure planning to avoid future liabilities

The IFRF provides the means to mitigate the losses from disasters through risk-layered financing mechanisms, resilience-building investments, and adaptive budgetary planning. Together, these approaches can enable governments to move from reactive, post-disaster fiscal responses to proactive, risk-informed public investment management. By incorporating the IFRF into national and sectoral development strategies, countries can better align infrastructure planning with financial preparedness, thereby strengthening both physical and fiscal resilience.

This framework can inform a series of recommendations laid out in an infrastructure financial resilience pathway, to be followed by the relevant infrastructure stakeholders in a country.

Governments and national infrastructure agencies have an important role to play in the implementation of an infrastructure resilience pathway. Such a pathway should be based on the proposed IFRF and incorporate the following:

- Quantifying infrastructure exposure and vulnerability to disasters (using GIRI, for example)
- Defining resilience objectives
- Implementing resilience cost–benefit analysis frameworks
- Mobilizing adequate pre- and post-disaster finance

The IFRF complements the five-step-approach promoted by the UNDRR to "enable a shift from reactive disaster response to proactive risk reduction" (UNDRR, 2025):

1. Understand the financial consequences of a disaster.
2. Analyse the existing disaster risk reduction financial landscape in the country.
3. Identify and prioritize financing needs.
4. Match needs with financing options.
5. Develop a comprehensive finance strategy for disaster risk reduction.

6. Recommendations to Improve the Global Financial Resilience Landscape

The global infrastructure community should focus on the areas that have been identified in this report to improve the global resilience finance landscape.

These include a need for access to data on risk exposure and vulnerability, including ways of quantifying the reduction in vulnerability associated with incremental investments in resilience. In this context, GIRI provides a solid foundation for estimating AAL to a country's infrastructure system due to disasters. This database is being expanded to include subnational data split across various infrastructure sectors.

The definition of global resilience metrics is an important next step for comparing the vulnerabilities of assets, systems, and countries to disaster risks affecting infrastructure sectors. The current UNDRR initiative to develop such resilience metrics in partnership with government entities, insurers, lenders, and asset owners is very welcome.

The dissemination of resilience standards for specific infrastructure sectors can play a significant role in bridging knowledge gaps in various countries. Agencies such as CDRI are already working on this and should continue to provide an avenue for information and knowledge sharing.

This is closely connected to capacity building in LMICs and SIDS, as well as the sharing of best practices on disaster risk reduction. Various case studies in this paper have demonstrated both the benefits of reducing infrastructure vulnerability and ways to design and implement public policies. Such policies require funding and access to international sources of public and private capital, including insurance. There is a need for ongoing and improved access to technical assistance to ensure that LMIC and SIDS governments and related infrastructure agencies can mobilize such funding as part of a wider IFRF. CDRI can be an important partner in the development and implementation of such frameworks.

This should be part of a wider policy mix that integrates resilience planning in the design, planning, construction, financing, and operation and maintenance of infrastructure assets and systems. Embedding resilience is not just about preparing for the aftermath of a disaster. It should begin with the definition of resilience targets that can be quantified through resilience metrics, an implementation of standards that meet these resilience targets, an on-going monitoring of exposure and vulnerability to specific hazards, the mobilization of finance to fund risk reduction and ongoing asset maintenance. It should also be complemented by the appropriate mix of contingent funding to support respond and recover post-disaster.

Private-sector funding and risk pooling can play an important role in increasing the amount of funds available to the infrastructure sector both pre- and post-disaster. Policies conducive to mobilizing such funding sources should be further promoted. Subsidies from the development finance community to reduce the cost of contingent capital and insurance premiums are an important part of enhancing the funding mix available to LMICs and SIDS.

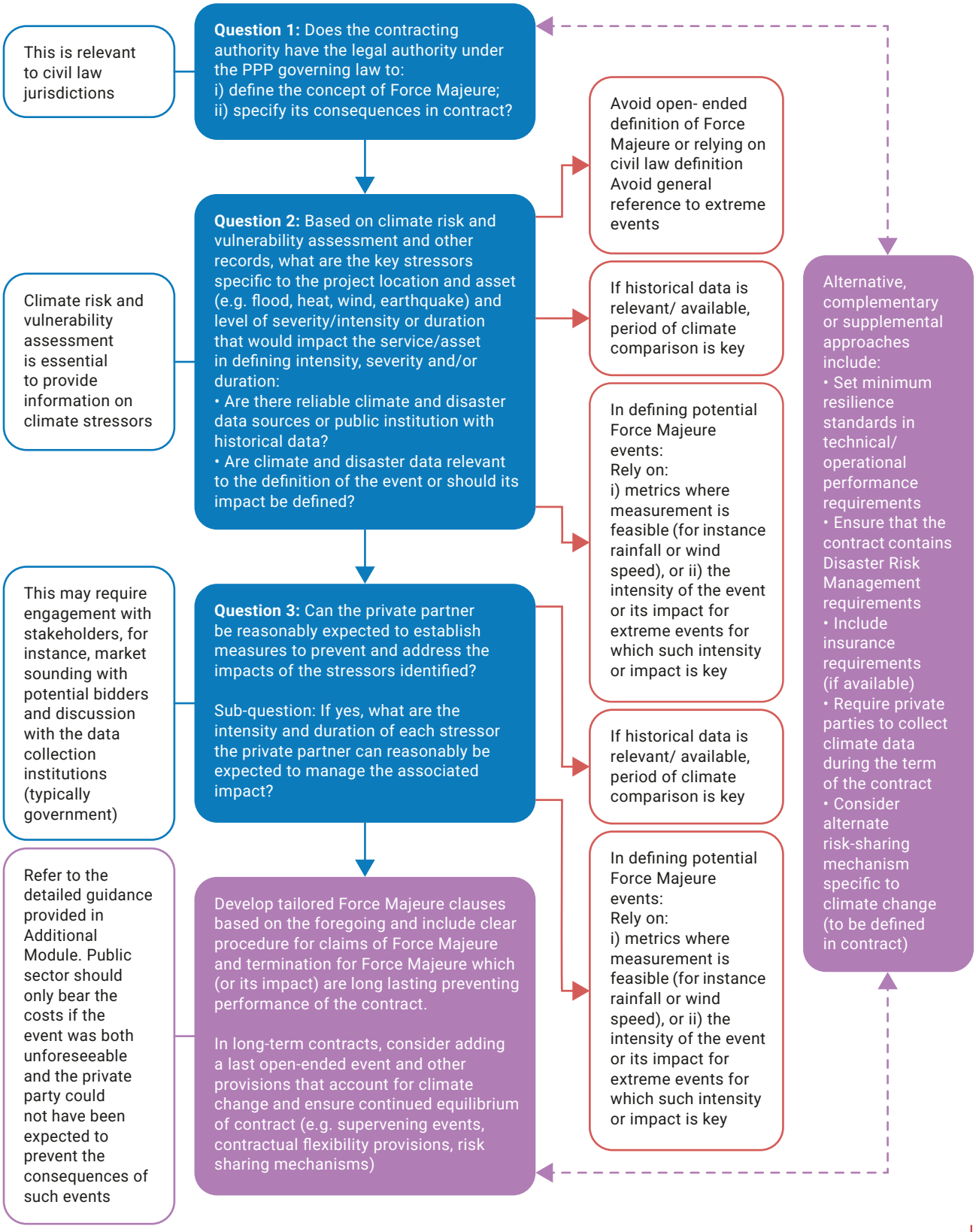
CDRI is well-positioned to work with Member Countries to help them address the different funding challenges they face and mobilize the financial resources needed to improve and maintain the resilience of their infrastructure systems.

Annex A. Overview of Key DRM Financing Instruments

Action	Capacity	Advantage(s)	Disadvantage(s)
Set up a dedicated fund	Absorb, respond, or recover using maintenance funds, disaster funds, or reconstruction funds	• Allows for rapid access to finance • Enables early response • Enhances financial preparedness	• Funds may be insufficient for large-scale disasters • Idle funds have opportunity costs • Poor governance can lead to misuse of capital
Add credit lines annual budgets	Absorb, respond, and recover using budgetary allocations for maintenance and upgrades, emergencies, and disaster recovery or through reallocation after a disaster	• Provides flexibility • Enables early response • Can be easily added to existing systems	• Funds may be insufficient for large-scale disasters • Poor governance can lead to misuse of capital
Obtain grants from international donors	Absorb, respond, and recover using grants for early warning systems, aid for immediate response, and funds for reconstruction	• Does not add to the debt burden	• Unpredictable • Slow to mobilize • Unsustainable in the long run
Obtain a green or resilience bond	Absorb and recover using bonds for upgrades to make infrastructure more resilient or to build new, resilient infrastructure	• Can be cheaper than issuing a regular bond • Opens up to new investors by leveraging capital markets	• Adds to the debt burden • Can be complex to set up • Lacks clarity on what constitutes 'resilience'
Pre-arrange credit lines with financial institutions	Response through a simple credit line with a local bank or the more sophisticated Cat DDO	• Quick liquidity • Lower cost of borrowing than traditional post-disaster borrowing	• Adds to the debt burden • Some instruments require Significant effort to be eligible e.g., prior actions for a Cat DDO
Buy parametric Insurance with a predetermined threshold and payout	Response	• Predictable • Quick turnaround time	• Covers only a small amount of actual damage
Buy general Insurance, which will pay based on a thorough analysis of post-disaster impacts	Recover	• Covers a larger amount of damage (but may still not equal actual damage) • Protects investment in key assets	• Claims management is complex and time consuming • Individual premiums can be expensive

Pool risks with other entities at the local, national, and regional levels	Recover	• Diversifies risk • Reduces costs due to economies of scale • Enables sharing of best practices and technical expertise with partners	• More complex to set up • Payouts may not cover actual damage
Issue CAT bonds based on parametric thresholds	Recover	• Can raise larger amounts compared with insurance • Transfers risk to capital markets • Rapid payout based on parametric data	• Expensive for low-income countries, with high transaction and structuring costs

Annex B. World Bank's Guidance to Prepare for Incorporating Resilience Considerations into Key Contractual Clauses (©World Bank, 2025e)



Annex C. Extracts from the Summary of Recommendations in CDRI's National Infrastructure Plan Study

Source: CDRI (2025b)

Policy and institutional aspects

1. Integrate resilience considerations with sectoral policies.
2. Create institutional mechanisms for data management and dissemination.
3. Initiate cross-sector collaboration mechanisms.
4. Enhance technical expertise and capacity-building initiatives.
5. Mandate risk and vulnerability assessment during project initiation.
6. Enable an environment for enhancing financial incentives for private players investing in resilience.
7. Standardize hazard risk assessment.
8. Determine hazard thresholds.
9. Embed resilience in contract documents.
10. Enhance disaster resilience capacity.
11. Include resilience expertise in projects.

Project processes for development of resilient assets

12. Explore historic and probabilistic data.
13. Detailed risk and vulnerability assessment of assets.
14. Design assets with additional resilience provisions.
15. Project level disaster risk management framework.
16. Regular quality checks and monitoring.
17. Incorporate 'build back better' principles in the post-disaster repair and reconstruction phases.

Financing requirements for infrastructure projects

18. Standardize the definition of 'resilient infrastructure investment.'
19. Conduct capacity-building programmes on disaster risk reduction and DRFI.
20. Create a dedicated infrastructure resilience fund to strengthen public infrastructure resilience against natural hazards.
21. Establish resilience criteria for project screening and evaluation.
22. Mainstream use of the resilience cost–benefit analysis tool.
23. Create a risk pool at the national and regional levels.
24. Create a sovereign risk capacity for pooling and diversifying risks.
25. Support the development of insurance and re-insurance markets.
26. Explore products for transferring disaster risks.
27. Develop quick mechanisms for funding emergency response.
28. Expand infrastructure insurance coverage.

Annex D. Integrating FRAs with Resilient Infrastructure Planning - Lessons from Fiji

Source: CDRI (2025a)

CDRI has conducted comprehensive disaster risk assessments at both national (Fiji, Mauritius, India, and Nepal) and subnational (the Indian states of Himachal Pradesh, Odisha, Gujarat, and Tamil Nadu) levels, analysing direct and indirect economic losses. The study introduces an FRA framework that highlights infrastructure-related disaster risks and the associated contingent liabilities. It also outlines integrated disaster risk financing strategies for governments to incorporate into broader DRM and public finance planning. The lessons learnt from the FRA in Fiji are presented below (CDRI, 2025a).

Background: Fiji exemplifies how recurrent disasters can severely compromize fiscal stability in SIDS. Disasters such as Cyclones Winston, Yasa, and Harold have inflicted substantial damage to Fiji's infrastructure and economy; Cyclone Winston alone accounted for losses amounting to 6.9 percent of the national GDP. Between 2020 and 2024, the country's debt rose by nearly 50 percent, while tax revenues dropped sharply. This underscores how climate-induced disasters create dual shocks of infrastructure damage and fiscal decline.

The Fiji FRA study's sectoral analysis reveals how infrastructure acts as both a victim and a vector of fiscal instability:

- **Power sector:** Highly exposed rural energy systems, especially diesel mini-grids and solar home systems, face recurring cyclone damage.
- **Transport sector:** Coastal Road networks and bridges, which are key to economic activity and disaster response, are frequently disrupted, increasing maintenance backlogs and reducing public service delivery.

The 2016 Cyclone Winston, the most powerful storm recorded in the Southern Hemisphere, caused losses worth $199.9 million in Fiji. The road sector alone suffered $129.5 million in damages, while power systems incurred losses of over $41 million. This destruction created a fiscal shock by diverting resources from development budgets, triggering a reliance on foreign debt, and leading to prolonged recovery in key sectors such as forestry and tourism. Economic modelling estimated GDP losses of over 30 percent in some sectors, with recovery taking multiple years. This exemplifies the high fiscal sensitivity of infrastructure-dependent economies to extreme climate events.

Fiji has developed multiple disaster risk financing instruments:

- Cat DDO (World Bank): $40 million available yet not integrated into a formal DRF strategy
- National Disaster Relief and Rehabilitation Fund (NDRRF): Underfunded with only $352,000 average annual allocation (2017–2023).
- Disaster Rehabilitation and Containment Facility (DRCF) (Reserve Bank of Fiji): Expanded to cover micro, small, and medium-sized enterprises, with $200 million total available credit
- Fiji National Provident Fund (FNPF) withdrawals: Enabled 182,571 members to access post-disaster funds after Cyclone Winston.

Despite establishing mechanisms like the NDRRF and DRCF and accessing international instruments such as the World Bank's Cat DDO and Japan International Cooperation Agency's standby loan, the study found that Fiji lacks a structured, layered disaster risk financing strategy, sector-specific insurance penetration, and fiscal tagging to track the efficacy of disaster risk reduction investments.

Strategic takeaways for other LMICs: Fiji's experience highlights the importance of:

- Catastrophe risk modelling to inform risk-based budgeting.
- Layering disaster risk financing mechanisms tailored to sectoral vulnerabilities.
- Embedding resilience in infrastructure planning to avoid future liabilities.

Bibliography

Adam, B., Hallegatte, S., & Mahul, O. (2025). Mobilizing public–private solutions to manage the financial impacts of natural hazards in emerging market and developing economies. World Bank. https://doi.org/10.1596/43027

African Development Bank Group. (2025, January 29). Africa delivers the first mechanism for international cooperation on climate change adaptation under the Paris Agreement. https://www.afdb.org/en/news-and-events/press-releases/africa-delivers-first-mechanism-international-cooperation-climate-change-adaptation-under-paris-agreement-80535

African Risk Capacity. (2023). ARC risk pools. https://www.arc.int/risk-pools

Atlantic Council. (2025, June 16). Scaling up private capital for climate investment in emerging markets. https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/scaling-up-private-capital-for-climate-investment-in-emerging-markets/

Bernhofen, M., Burke, M., Puranasamriddhi, A., Ranger, N., & Shrimali, G. (2024). Integrating physical climate risks and adaptation into sovereign credit ratings: Implications for financial stability and fiscal policy at the sovereign-bank nexus. Smith School of Enterprise and the Environment and Environmental Change Institute. https://www.eci.ox.ac.uk/sites/default/files/2024-09/Integrating%20Physical%20Climate%20Risks%20and%20Adaptation%20%282024%29.pdf

Brazil Sovereign Sustainable Finance Committee. (2024). Brazil's sovereign sustainable bonds. Allocation and Impact Report 2024. https://thot-arquivos.tesouro.gov.br/publicacao/50693

Cambridge Centre for Risk Studies, & AXA XL. (2020). Optimising disaster recovery: The role of insurance capital in improving economic resilience. https://axaxl.com/-/media/axaxl/files/optimizing-disaster-recovery.pdf

Cambridge Centre for Risk Studies, & XL Catlin. (2018). Disaster recovery case studies, US storms 2012: Superstorm Sandy. https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/crs-case-study-superstorm-sandy.pdf

Caribbean Catastrophe Risk Insurance Facility. (2024). Company overview. https://www.ccrif.org/about-us?language_content_entity=en

Coalition for Disaster Resilient Infrastructure. (n.d.). Global Infrastructure Risk Model and Resilience Index (GIRI): Measuring risk and resilience in infrastructure sectors [Data set]. https://giri.unepgrid.ch/

Coalition for Disaster Resilient Infrastructure. (2023). Global infrastructure resilience: Capturing the resilience dividend (1st ed.). CDRI Secretariat. https://cdri.world/upload/biennial/CDRI_Global_Infrastructure_Resilience_Report.pdf

Coalition for Disaster Resilient Infrastructure. (2023a). DRI Lexicon – Shared understanding of terms that matter for disaster resilient infrastructure (PDF). https://driconnect.cdri.world/resources/cdri-publications/dri-lexicon

CDRI (2025). Global Infrastructure Resilience 2025 Report. Coalition for Disaster Resilient Infrastructure, New Delhi. https://cdri.world/global-infrastructure-resilience-report-2025-capturing-the-resilience-dividend-2/

Coalition for Disaster Resilient Infrastructure. (2025a). Fiscal risks assessment study of critical infrastructure sectors in Fiji. https://cdri.world/finance/fiscal-risks-assessment-study-of-critical-infrastructure-sectors-in-fiji/#resources

Coalition for Disaster Resilient Infrastructure. (2025b). Mainstreaming disaster resilience into infrastructure projects: Insights from India's National Infrastructure Pipeline. https://dymez6ioe12by.cloudfront.net/media/wp-content/uploads/2025/09/10095922/Mainstreaming-Disaster-Resilience-into-Infrastructure-Projects-1.pdf

Climate Bonds Initiative. (2024). Climate bonds resilience taxonomy methodology. https://www.climatebonds.net/files/documents/Climate-Bonds_Resilience-Methodology_2024.pdf

Climate Policy Initiative. (2020). African risk capacity. https://www.climatepolicyinitiative.org/gca-africa-adaptation-finance/case_studies/african-risk-capacity-2/

Climate Policy Initiative. (2025a). Global landscape of climate finance data dashboard [Data set]. https://www.climatepolicyinitiative.org/wp-content/uploads/2000/06/compressed_Global-Landscape-of-Climate-Finance-2025.pdf

Climate Policy Initiative. (2025b). Global landscape of climate finance 2025. https://www.climatepolicyinitiative.org/wp-content/uploads/2000/06/compressed_Global-Landscape-of-Climate-Finance-2025.pdf

Climate Policy Initiative. (2025c). Primer for climate-related engagement with the IMF: Realizing the potential of the resilience and sustainability facility. https://www.climatepolicyinitiative.org/wp-content/uploads/2025/04/Primer-for-Climate-related-Engagement-with-the-IMF.pdf

Delforge, D., Wathelet, V., Below, R., Sofia, C. L., Tonnelier, M., Van Loenhout, J. A. F., & Speybroeck, N. (2025). EM-DAT: The Emergency Events Database. International Journal of Disaster Risk Reduction, 124, 105509. https://doi.org/10.1016/j.ijdrr.2025.105509

EMDE Investor Taskforce. (2025). EMDE Investor Taskforce: Focus areas. https://emdeinvestortaskforce.org/about/focus-areas/

Ferrucci, G., Cappiello, L., Maddaloni, A., & Veggente, V. (2025). Creditworthy: Do climate change risks matter for sovereign credit ratings? SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5776683

Financial Protection Forum. (2023, March 21). Strategies for paying less on the disaster bill [Blog]. https://www.financialprotectionforum.org/blog/strategies-for-paying-less-on-the-disaster-bill

FORTIFIED. (2025). Incentives for residents of Alabama. https://fortifiedhome.org/incentives-alabama/

Foster, V., Rana, A., & Gorgulu, N. (2022). Understanding public spending trends for infrastructure in developing countries. World Bank. https://doi.org/10.1596/1813-9450-9903

Global Center on Adaptation. (2020, July 24). What are resilience bonds and how can they protect us against climate crises? https://gca.org/what-are-resilience-bonds-and-how-can-they-protect-us-against-climate-crises/

Global Center on Adaptation. (2021). Climate-resilient infrastructure handbook. https://gca.org/wp-content/uploads/2025/06/Climate-Resilient-Infrastructure-Handbook_20250613.pdf

Global Commission on Adaptation. (2019). Adapt now: A global call for leadership on climate resilience. https://doi.org/10.1596/32362

Global Infrastructure Hub. (2018). Global infrastructure outlook: Forecasting infrastructure investment needs and gaps [Data set]. https://outlook.gihub.org

Hallegatte, S., Rentschler, J., & Rozenberg, J. (2019). Lifelines: The resilient infrastructure opportunity. https://doi.org/10.1596/978-1-4648-1430-3

Hurley, G., Panwar, V., Wilkinson, E., Lindsay, C., & Mami, E. (2024). Breaking the cycle of debt in small island developing states. ODI Working Paper. https://media.odi.org/documents/ODI_SIDS_Breaking_the_cycle_of_debt_main_paper.pdf

Inter-American Development Bank. (2017, September 12). Fact sheet: The economic impacts of natural disasters in Latin America and the Caribbean. https://www.iadb.org/en/news/fact-sheet-economic-impacts-natural-disasters-latin-america-and-caribbean

Inter-American Development Bank. (2023, April 4). Bidding proposals received for construction of Interurban Train North Axis. https://www.iadb.org/en/news/bidding-proposals-received-construction-interurban-train-north-axis

Internal Displacement Monitoring Centre. (2024). 2024 Global report on internal displacement. https://www.internal-displacement.org/global-report/grid2024/

Institutional Investors Group on Climate Change. (2024, August 15). PCRAM in practice: Outputs and insights from climate resilience in action. https://www.iigcc.org/resources/pcram-in-practice-climate-resilience-risk-assessment-case-studies

Insurance Development Forum. (2024). Blended EM infrastructure debt: IDF blueprint. https://unfccc.int/sites/default/files/resource/IDF%20and%20BlackRock%20-%20Fact%20Sheet%20June%202024%20%281%29.pdf

International Monetary Fund (2026). IMF Data [Data set]. https://data.imf.org/en

International Monetary Fund. (2025). Resilience and Sustainability Trust. https://www.imf.org/en/topics/resilience-and-sustainability-trust

International Monetary Fund. (2024, August 30). IMF Executive Board completes the third reviews under the Precautionary and Liquidity Line and the arrangement under the Resilience and Sustainability Facility with Jamaica [Press release No. 24/314]. https://www.imf.org/en/News/Articles/2024/08/29/pr24314-jamaica-imf-exec-board-completes-3rd-rev-pll-arr-rsf

International Recovery Platform. (2023). Good practices in financing recovery and building back better: 30 cases of good practices from 18 countries. https://g20drrwg.preventionweb.net/media/88831/download?startDownload=20260306

Lambert, D., & Shah, S. (2015, September 23). First bond issue under guarantee facility can be a boon for Indian infrastructure. Asian Development Blog. https://blogs.adb.org/blog/first-bond-issue-under-guarantee-facility-can-be-boon-indian-infrastructure

Marto, R., Papageorgiou, C., & Klyuev, V. (2018). Building resilience to natural disasters: An application to small developing states. Journal of Development Economics, 135, 574–586. https://doi.org/10.1016/j.jdeveco.2018.08.008

Meenan, C. (2024). Hurricane Beryl: Record parametric payouts underline the evolution of CCRIF's role in the Caribbean [Blog]. Centre for Disaster Protection. https://www.disasterprotection.org/blogs/hurricane-beryl-record-parametric-payouts-underline-the-evolution-of-ccrifs-role-in-the-caribbean

Ministério da Fazenda, Governo Brasileiro. (n.d.). Fundo Clima [The Climate Fund]. https://www.gov.br/fazenda/pt-br/acesso-a-informacao/acoes-e-programas/transformacao-ecologica/programas-em-destaque/fundo-clima

Ministry of Home Affairs, Government of India. (n.d.). National Disaster Risk Management Fund (NDRMF) and State Disaster Risk Management Fund (SDRMF). https://ndmindia.mha.gov.in/ndmi/response-fund

Mühlhofer, E., Bresch, D. N., & Koks, E. E. (2024). Infrastructure failure cascades quintuple risk of storm and flood-induced service disruptions across the globe. One Earth, 7(4), 714–729. https://doi.org/10.1016/j.oneear.2024.03.010

NHPC Limited. (2025). NHPC Limited sustainability report 2023–2024. https://www.nhpcindia.com/assests/pzi_public/gallery/1739941924.pdf

Organisation for Economic Co-operation and Development. (2017). Investing in climate, investing in growth. https://doi.org/10.1787/9789264273528-en

Organisation for Economic Co-operation and Development. (2024). Infrastructure for a climate-resilient future. https://doi.org/10.1787/a74a45b0-en

Organisation for Economic Co-operation and Development. (2025). Global outlook on financing for sustainable development 2025: Towards a more resilient and inclusive architecture. https://doi.org/10.1787/753d5368-en

Plichta, M. (2025). More countries are using Cat DDOs [Blog]. Centre for Disaster Protection. https://www.disasterprotection.org/blogs/more-countries-are-using-cat-ddos-here-are-three-things-to-know

Plichta, M., & Poole, L. (2025). The state of pre-arranged financing for disasters. Centre for Disaster Protection. https://static1.squarespace.com/static/61542ee0a87a394f7bc17b3a/t/6941354a225bf873420f296c/1765881162126/PAF+2025+Reportv5.pdf

Puranasamriddhi, A., Ranger, N., & Hall, J. (Upcoming). The fiscal implications of probabilistic disaster risks in low- and middle-income countries: A cross-country analysis.

Ranger, N., Low, L. P., & Singer, B. (2021). Financial protection of critical infrastructure services. World Bank. https://doi.org/10.1596/36902

Rozenberg, J., & Fay, M. (2019). Beyond the gap: How countries can afford the infrastructure they need while protecting the planet. World Bank. https://doi.org/10.1596/978-1-4648-1363-4

S&P Global. (2015). Storm alert: Natural disasters can damage sovereign creditworthiness. https://www.spglobal.com/ratings/en/research/articles/150910-storm-alert-natural-disasters-can-damage-sovereign-creditworthiness-9327571

Sasson, I., Choi, J., Richmond, M., Upadhyaya, N., & Ortega Pastor, A. (2021). Building climate resilience in cities through insurance. Climate Policy Initiative. https://www.climatepolicyinitiative.org/wp-content/uploads/2021/10/Building-Climate-Resilience-in-Cities-Through-Insurance.pdf

Seethapathy, R. (2025). Towards an engineered climate change resiliency framework. Discussion paper.

Swiss Re Institute. (2023). Restoring resilience: The need to reload shock-absorbing capacity. NDC Partnership. https://ndcpartnership.org/knowledge-portal/climate-toolbox/restoring-resilience-need-reload-shock-absorbing-capacity

United Nations Department of Economic and Social Affairs & United Nations Office for Disaster Risk Reduction. (2022). Gaps, challenges and constraints in means of implementing the Sendai Framework for Disaster Risk Reduction in Small Island Developing States. https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/sids_drr_gap_assessment_report_on_moi_digital_version_final_november2022_0.pdf

United Nations Office for Disaster Risk Reduction. (n.d.). The Sendai Framework terminology on disaster risk reduction. https://www.undrr.org/drr-glossary/terminology

United Nations Office for Disaster Risk Reduction. (2024). Financing options for resilient solutions: Input paper to the G20 DRR Working Group. https://g20drrwg.preventionweb.net/media/102120/download?startDownload=20260306

United Nations Office for Disaster Risk Reduction. (2025). 2025 Global assessment report on disaster risk reduction. https://www.undrr.org/gar/gar2025

United Nations Office for Disaster Risk Reduction, & World Metereological Organization. (n.d.). Global Observatory for Early Warning System Investments [Data set]. https://earlywarningsforall.org/site/early-warnings-all/dashboards/global-observatory-ews-investments

United Nations Conference on Trade and Development. (2023). World investment report 2023: Investing in sustainable energy for all. United Nations Publications. https://unctad.org/system/files/official-document/wir2023_en.pdf

United Nations Trade and Development. (2025). A world of debt 2025: It is time for reform. United Nations Publications. https://unctad.org/system/files/official-document/osgttinf2025d4_en.pdf

World Bank. (2017a). Laos: Disaster risk finance diagnostic 2017. https://www.financialprotectionforum.org/publication/drf-country-diagnostic-note-lao-pdr

World Bank. (2017b). Resilient infrastructure public–private partnerships (PPPs): Contracts and procurement. The case of Japan. https://thedocs.worldbank.org/en/doc/221901515466795175-0090022018/original/ResilientInfrastructurePPPsContractsandProcurementJapanCase.pdf

World Bank. (2018a). Converting disaster experience into a safer built environment: The case of Japan. https://doi.org/10.1596/30015

World Bank. (2018b, January 10). Uruguay buys insurance against lack of rain and high oil prices. https://www.worldbank.org/en/results/2018/01/10/uruguay-insurance-against-rain-oil-prices

World Bank. (2019). Resilient infrastructure public–private partnerships: Policy, contracting, and finance. https://documents1.worldbank.org/curated/en/925691571416771609/pdf/Technical-Brief-on-Resilient-Infrastructure-Public-Private-Partnerships-Policy-Contracting-and-Finance.pdf

World Bank. (2020). Indonesia: Disaster risk finance and insurance project. World Bank Group. http://documents.worldbank.org/curated/en/316601611543685552

World Bank. (2022a). Building fiscal and financial resilience for subnational governments against natural disasters. http://documents.worldbank.org/curated/en/099051106222210881

World Bank. (2022b). Climate toolkits for infrastructure PPPs. https://www.worldbank.org/en/topic/sustainableinfrastructurefinance/brief/climate-toolkits-for-infrastructure-ppps

World Bank. (2022c). Colombia's Cat DDO: Strengthening resilience to disasters, climate change and health risks. https://thedocs.worldbank.org/en/doc/e135e628a36f17eeddf68a1b272c36be-0340012022/original/Case-Study-Colombia-Cat-DDO.pdf

World Bank. (2022d). Reducing disaster risks from natural hazards. https://doi.org/10.1596/IEG173891

World Bank. (2022e). Supporting Egypt's inaugural green bond issuance. https://www.worldbank.org/en/news/feature/2022/03/02/supporting-egypt-s-inaugural-green-bond-issuance

World Bank. (2022f). Uganda: Disaster risk finance diagnostic 2022. http://documents.worldbank.org/curated/en/099752511072337998

World Bank. (2022g). Colombia: The first sovereign green bond in local currency in Latin America (Case study). https://thedocs.worldbank.org/en/doc/bc687cc79a64b1640b0a1e7af7a56142-0340012022/original/WB-Colombia-Greenbond-CaseStudy-Final.pdf#:~:text=In%202021%2C%20Colombia%20issued%20its,currency%20and%20to%20adopt%20the

World Bank. (2023). Disaster risk management in the Philippines. https://openknowledge.worldbank.org/server/api/core/bitstreams/a4a1c553-8974-4ae5-b4c9-2150d78a703f/content

World Bank. (2024a). Climate resilient debt clauses—FAQ. https://thedocs.worldbank.org/en/doc/c81fdf80718a5eb9b3d18c178b5307be-0340012023/original/CRDC-FAQ.pdf

World Bank. (2024b). IBRD development policy loan with catastrophe deferred drawdown option (Cat DDO). https://thedocs.worldbank.org/en/doc/ab4dba2d33ec13b86a413fcd3bf0a26f-0340012023/original/IDA-CAT-DDO-Product-Note.pdf

World Bank. (2024c). Indonesia's experience in designing and implementing a public assets insurance program: A five-year journey. http://documents.worldbank.org/curated/en/099111424193525525

World Bank. (2024d). Infrastructure for safer and resilient schools. https://documents1.worldbank.org/curated/en/099061024172038738/pdf/BOSIB-5ba9705c-1e2a-4b53-a8d6-27d5209696d6.pdf

World Bank. (2024e, February 1). World Bank Group expands its crisis toolkit to empower countries amid intertwined crises [Factsheet]. https://www.worldbank.org/en/news/factsheet/2024/02/01/world-bank-group-expands-its-crisis-toolkit-to-empower-countries-amid-intertwined-crises

World Bank. (2024f). World Bank issues $420 million in catastrophe bonds for renewed disaster risk protection for Mexico. https://www.worldbank.org/en/news/press-release/2024/04/17/world-bank-issues-420-million-in-catastrophe-bonds-for-renewed-disaster-risk-protection-for-mexico

World Bank. (2025a). Financing climate adaptation and nature-based infrastructure. https://doi.org/10.1596/43189

World Bank. (2025b, June 24). Insurance and disaster risk finance. https://www.worldbank.org/en/topic/financialsector/brief/insurance-and-disaster-risk-finance#4\

World Bank. (2025c). Preparing, procuring and implementing climate-smart PPPs. https://ppp.worldbank.org/climate-smart/climate-smart-clean-technology-ppps/preparing-procuring-and-implementing-climate-smart-ppps

World Bank. (2025d). Somalia: Disaster risk finance diagnostic 2024. http://documents.worldbank.org/curated/en/099618001282524663

World Bank. (2025e). Transport resilience financing, resources and opportunities. https://doi.org/10.1596/43267

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