
Boosting Financial Resilience to Disaster Shocks:

Good Practices and New Frontiers

World Bank Technical Contribution to the
2019 G20 Finance Ministers' and Central
Bank Governors' Meeting

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Abbreviations

ARC	African Risk Capacity
ASEAN	Association of Southeast Asian Nations
BMZ	Federal Ministry of Economic Cooperation and Development (Germany)
CAT DDO	Catastrophe Deferred Drawdown Option
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CCRIF SPC	Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company
CCS	Consortio de Compensación de Seguros (Spain)
FONDEN	Mexico's Natural Disaster Fund (Fondo de Desastres Naturales)
GDP	gross domestic product
GRIFF	Global Risk Financing Facility
HSNP	Hunger Safety Net Program (Kenya)
IFI	international financial institution
IMF	International Monetary Fund
KfW	German Development Bank
NDEF	National Drought Emergency Fund (Kenya)
NDRRA	Natural Disaster Relief and Recovery Arrangements (Australia)
NUSAF	Northern Uganda Social Action Fund (Uganda)
PCRAFI	Pacific Catastrophe Risk Assessment and Financing Initiative
PCRIC	Pacific Catastrophe Risk Insurance Company
PEF	Pandemic Emergency Financing Facility
PML	probable maximum loss
PPP	public-private partnership
SEADRIF	Southeast Asia Disaster Risk Insurance Facility
V20	Vulnerable Twenty Group

“Finance ministries have started integrating disaster risks in their wider macro-fiscal framework in order to better manage fiscal shocks from disasters.”

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Executive Summary

Governments face growing contingent liabilities from disasters as they tend to shoulder a significant share of disaster response and recovery costs.

These losses can arise from rapid-onset shocks as well as long-term stresses. Sources of government liabilities in the aftermath of a disaster vary. They include fiscal transfers to subnational governments, rehabilitation of damaged assets, immediate relief and livelihood support, assistance to uninsured households, assistance to small enterprises, and stabilization of the private sector. Long-term stresses can come from disruptions to agriculture value chains and energy price shocks—for example from reduced hydropower generation during a drought.

Disaster shocks tend to increase government expenditure and hamper economic activities.

A recent assessment by the International Monetary Fund (IMF 2018a) reveals that disasters' macroeconomic impacts can create a vicious cycle that lowers growth and increases debt, especially in small and vulnerable states; some countries, including the Dominican Republic, Samoa, and Vanuatu, have embedded macroeconomic assessment of disaster risk into debt sustainability analyses. Infrequent but severe disasters, such as earthquakes and tropical storms, can lower sovereign ratings, potentially increasing interest expenses (Standard & Poor's 2015).

An increasing number of countries are developing financial protection strategies—a suite of policies and financial instruments—as part of their macro-fiscal policy to secure access to pre-arranged financing and protect the fiscal balance and budget when disasters strike.

This approach ensures timely and efficient access to funds; and by making funding more predictable, it also improves the resilience of national and subnational governments, households, and businesses. Middle-income countries such as Indonesia are increasingly integrating these strategies in their macro-fiscal assessment and planning by identifying and quantifying their disaster-related contingent liabilities, with some countries starting to include the results in fiscal risk statements (OECD and World Bank 2018).

Investments in physical and social resilience complement and reinforce financial resilience.

This is reflected in the Sendai Framework for Disaster Risk Reduction, which calls on countries to invest in risk reduction and preparedness through structural and nonstructural measures. Risk-informed financial decisions can strengthen physical and social resilience in a sustainable manner through targeted public investment in risk reduction and preparedness. By reducing damages and the subsequent reconstruction costs, resilient infrastructure reduces disaster-related contingent liabilities, in turn contributing to macro-fiscal sustainability. Nonstructural measures, such as early warning and business contingency planning, can reduce potential disaster impacts by helping people and firms manage their risks. Developing the capacity of people and businesses to manage risk reduces the need for public intervention.

Pre-arranged risk financing can help governments reduce the fiscal cost of disasters.

Following a disaster, a government could rely on post-disaster financing instruments, including budget reallocation, borrowing, taxation, and international aid. However, it often takes a long time until these funds become available, which can delay disaster recovery and reconstruction. Pre-arranged risk financing instruments provide governments with immediate access to funds and mitigate the negative impact of disasters on economic activities and future fiscal costs. Financing can be tied in advance to efficient and transparent disbursement channels to ensure that resources reach the targeted beneficiaries on time. Pre-arranged disaster risk financing can also promote preparedness and recovery by supporting the adoption of clear rules that support additional measures to strengthen resilience of damaged assets.

Sovereign catastrophe risk pools, established to help especially low-capacity countries better access financial markets, are evolving toward multifunctional platforms to strengthen financial resilience in their region.

The existing regional facilities in Africa, the Pacific, and the Caribbean have developed new financial products, responding to specific demands from the participating countries. The newly developed Southeast Asia Disaster Risk Insurance Facility (SEADRIF) has been designed since its inception to provide multiple products and services to Southeast Asian countries, including middle-income countries. Beyond the provision of financial instruments, SEADRIF also acts as a platform for regional collaboration, financial innovation, and investment in public goods, with the aim of contributing to the development agenda of the participating countries.

Governments are moving toward adopting more sophisticated risk financing strategies that better match financial instruments to their liabilities, especially for public assets (including infrastructure), national-subnational cost sharing, and social safety nets.

This approach involves not only using more precisely targeted financial instruments, but also putting in place domestic mechanisms to clarify and quantify disaster risks, and then connecting these risks directly to funding mechanisms, whether from the budget, international partners, or financial markets. Domestic pools can also help deepen market-based catastrophe risk insurance solutions. These steps help governments manage their disaster-related contingent liabilities more efficiently. Indonesia, for example, launched the national disaster risk financing and insurance strategy, which includes the development of a pooling fund and insurance program for public assets.

New technology and innovations such as Earth Observation Data, Fintech, and big data have the potential to significantly enhance and boost systems for financial resilience against disaster shocks.

Countries are investing sizable technical resources in testing, developing, and scaling up new programs to collect and analyze data for risk-informed financial decisions. While technology can support the efficiency and effectiveness of those processes, it cannot replace the long-term underlying reforms needed to improve financial risk management.

Development partners continue to play a critical role in helping developing countries improve their financial protection strategies.

Countries may require additional incentives to develop pre-arranged financing and plans that reduce reliance on ad hoc humanitarian aid and budget reallocation. The newly established Global Risk Financing Facility (GRiF) aims to provide such incentives under a set of principles, which help public interventions maximize the impact of disaster risk finance and insurance solutions. GRiF is a member of the InsuResilience Global Partnership, launched in 2017 as a joint initiative of a number of countries in G20 and the Vulnerable Twenty Group (V20), to strengthen the financial resilience of developing countries against the impacts of disasters.

Recent experiences of G20 countries and others have led to three new frontiers on innovative crisis and disaster risk finance.

First, governments are stronger when they integrate financial resilience to shocks as a core component of macro-fiscal frameworks. For example, financial resilience could be integrated in key fiscal planning tools such as macro-models, fiscal risk statements, debt sustainability analyses, public expenditure reviews, public investment diagnostics, and poverty diagnostics. Second, governments can expand the scope of financial protection strategies and instruments to a range of other crises—from public health shocks, cyber risks, and risks of conflict, to famine and displacement and migration. Finally, governments can develop financial protection policies and instruments against interconnected risks. The growing awareness and strengthened management of multiple sources of real-world risks by finance officials will likely lead to increased consideration of government-wide financial risk management.

Although significant progress has been achieved in disaster risk finance, some limitations and challenges remain.

Disaster-related contingent liabilities can never be fully identified and quantified, as most of these liabilities are implicit, often based on a moral obligation without legal commitments. Better financial protection requires continued efforts by governments to enhance legal, institutional, and policy frameworks. Governments may also need to strengthen the appropriate regulatory and governance frameworks to implement sustainable disaster risk financing and insurance solutions.

All successful reforms start with concrete first steps and an ongoing focus on enhancing fundamental systems and institutions.

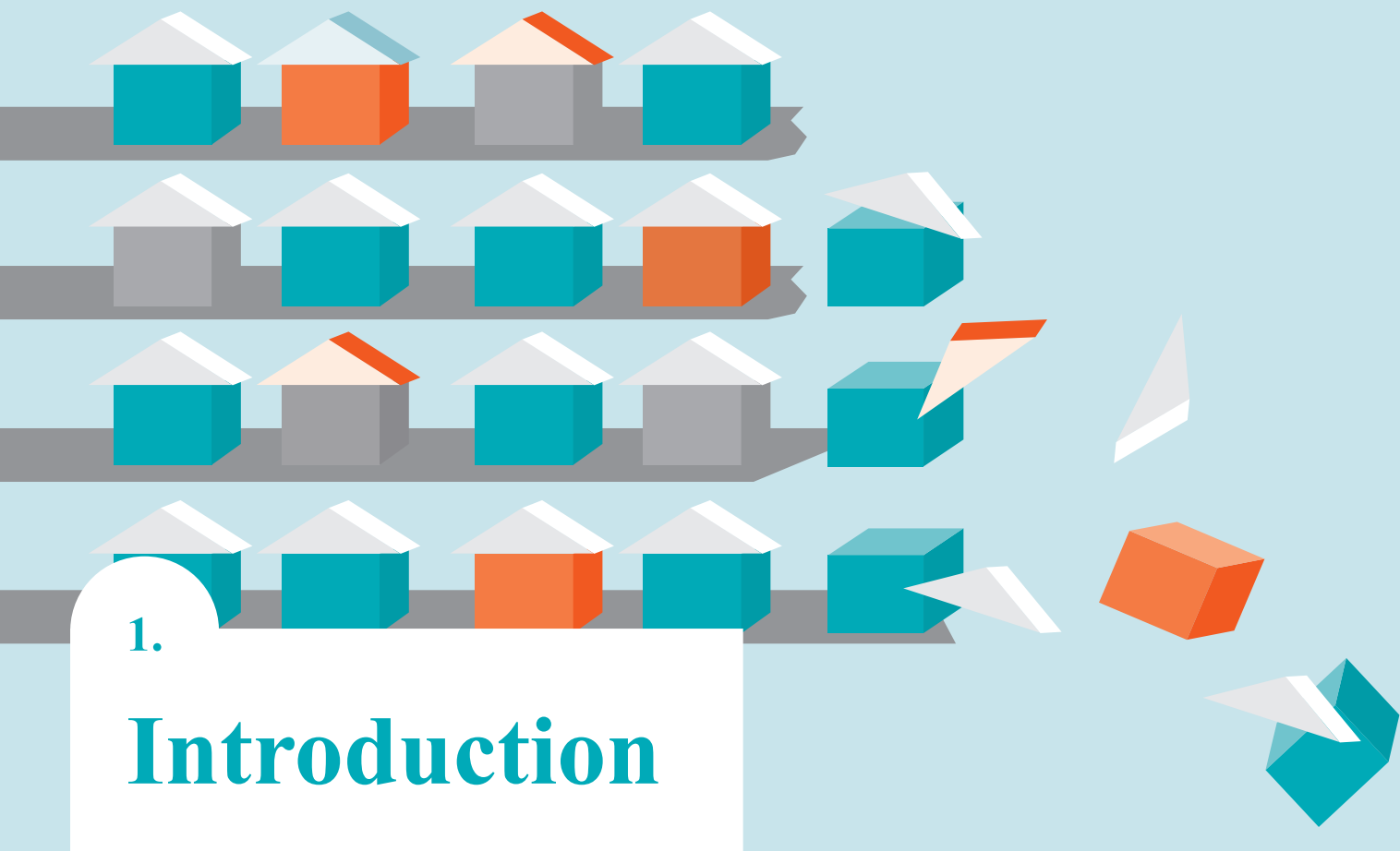
Developing disaster risk finance policies and instruments is an important step toward improving macro-fiscal policy frameworks and public financial management. Even advanced risk financing reforms start with and depend on getting the basic building blocks in place, such as risk assessment tools, public asset registries, and cash delivery systems. Ministries of finance can begin with basic reforms while testing and adding more advanced instruments and mechanisms over time.

Financial resilience requires the leadership of ministries of finance in coordination with other public agencies and the private sector.

Better management of contingent liabilities as part of broader fiscal risk management requires leadership by ministries of finance, in close collaboration with line ministries and disaster management agencies, to develop financial protection measures. For example, ministries of finance could ensure that each line ministry is responsible for developing its financial protection strategy (e.g., using a standard contingent liability approval framework) and that the overall fiscal risks related to natural disasters are consolidated and properly managed. In some countries, development partners play an important role in helping governments develop and implement financial protection strategies. The private sector can bring risk capital, innovative financial solutions, and new technology, as well as enhanced mechanisms to target beneficiaries.

At the request of G20 Finance Track members, this discussion note was prepared to

(i) take stock of the developments in fiscal management of disaster risks within the broader macro-fiscal framework; (ii) highlight recent progress by individual countries and the international community; and (iii) present new frontiers in disaster risk finance.



1.

Introduction

Natural disasters can cause significant economic and fiscal shocks to governments.

Major disasters have caused severe economic disruptions or even economic contractions. The cost of some disaster events has amounted to over 200 percent of gross domestic product (GDP) in small island states (IMF 2018a) and over 25 percent of GDP in middle-income countries—e.g., losses from the 2008–2011 drought in Kenya (Government of Kenya 2012). Even in advanced economies major disasters have caused damages worth up to 20 percent of GDP, such as the earthquakes in Chile and New Zealand in 2010 (OECD 2014). Damages to private assets such as buildings and factories directly impact households and businesses, interrupt economic activity, and ultimately reduce government revenue. Large multinational firms can suffer significant interruptions to production as just-in-time supply chains break down, causing potentially long-term economic impacts (Haraguchi and Lall 2015). These impacts affect the long-term growth and economic development of countries, and directly slow down efforts to reduce poverty and build shared prosperity.

Governments face growing contingent liabilities from disasters, as they tend to shoulder a significant share of the costs for disaster response and recovery.

Sources of government liabilities in the aftermath of a disaster vary. They include fiscal transfer to subnational governments, rehabilitation of damaged assets, immediate relief and livelihood support, assistance to uninsured households, assistance to small enterprises, and stabilization of the private sector, as well as long-term stresses such as disruptions to agriculture value chains and energy price shocks—due for example to reduced hydropower generation during a drought.

Public assets are one of the largest contributors to government expenditures following disasters, especially in middle- and high-income countries.

These assets include public buildings such as schools and hospitals, as well as infrastructure such as roads; costs to the government are especially high in countries where insurance coverage for such assets is low (OECD and World Bank 2018). Sharp and unexpected increases in expenditures, coupled with a decrease in government revenues as a consequence of economic disruptions, can lead to an increase in public debt. Recent work by the International Monetary Fund (IMF 2018b) highlights the significant and often unreported contribution of public assets to a country's overall balance sheet. Often these assets are not well managed and accounted for, so that a country's balance sheet likely underestimates the real impact of damage.

Disaster shocks tend to increase government expenditure and hamper economic activities.

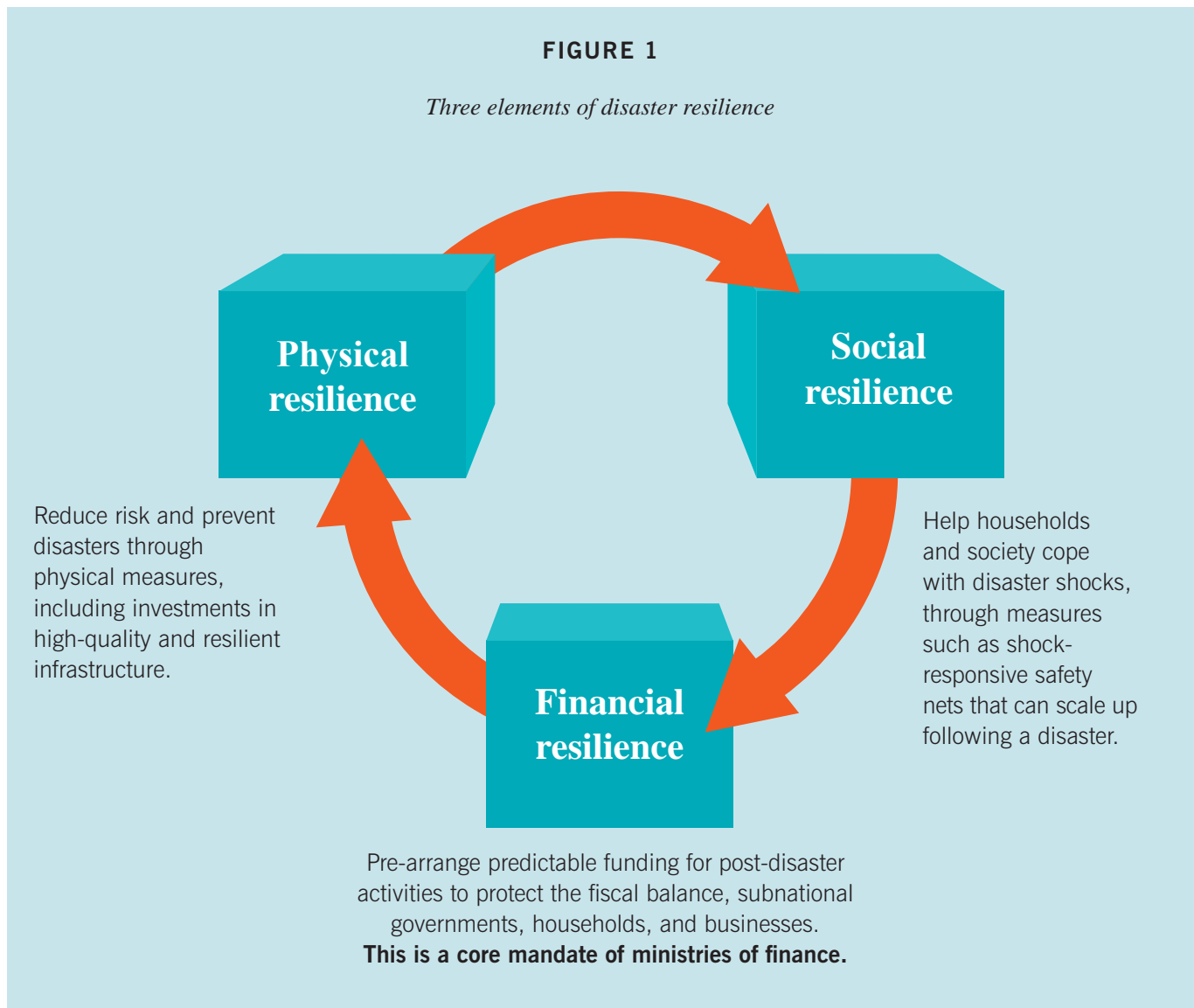
A recent assessment by the IMF (2018a) reveals that disasters' macroeconomic impacts can create a vicious cycle that lowers growth and increases debt, especially in small and vulnerable states; some countries, including the Dominican Republic, Samoa, and Vanuatu, have embedded macroeconomic assessment of disaster risk into debt sustainability analyses. Infrequent but severe disasters, such as earthquakes and tropical storms, can lower sovereign ratings, potentially increasing interest expenses (Standard & Poor's 2015).

Ministries of finance have started integrating these risks into their wider macro-fiscal framework to better manage fiscal shocks from disasters.

An increasing number of countries are developing financial protection strategies—a suite of policies and financial instruments—to secure access to financing in advance of shocks and protect the fiscal balance and budget when disasters strike. This approach ensures timely and sufficient access to funds. By making funding more predictable, it also improves the resilience of national and subnational governments, households, and businesses. Large middle-income countries such as Indonesia are increasingly integrating these strategies in their macro-fiscal assessment and planning by identifying and quantifying their disaster-related contingent liabilities, with some countries starting to include the results in fiscal risk statements (OECD and World Bank 2018).

Sustainable financial resilience requires physical and social resilience.

Investments in physical and social resilience complement and reinforce financial resilience. By reducing damages and the subsequent reconstruction cost, resilient infrastructure reduces disaster-related contingent liabilities. This effect is reflected in the Sendai Framework for Disaster Risk Reduction, which calls on countries to invest in risk reduction and preparedness through structural and nonstructural measures. Structural measures, such as physical construction and enhanced engineering technology, and nonstructural measures, such as early warnings and business continuity planning, can reduce potential disaster costs by improving resilience. For example, damages to Caribbean countries from Hurricanes Irma and Maria in 2017 could have been US\$16.5 billion less across all islands if buildings had been constructed by 2018 building codes (Centre for Global Disaster Protection and Lloyd's 2018). **Figure 1** shows three elements of resilience against disasters.



Risk-informed financial decisions can strengthen physical and social resilience through targeted public investment in risk reduction and preparedness.

Financing can be tied in advance to efficient and transparent disbursement channels to ensure that resources reach the targeted beneficiaries at the right time. Pre-arranged disaster risk financing can also promote preparedness and recovery by supporting the adoption of clear rules that support additional measures to strengthen resilience of damaged assets. Ultimately, developing the capacity of people and businesses to manage risk helps to reduce the need for public intervention.

Financial resilience benefits from and in turn helps build stable, equitable, and efficient markets, institutions, and economies.

Countries can better manage disaster-related expenditures when they fully integrate disasters shocks in budget planning and risk management. Where public resources are scarce, stable financial markets help share the risk among public and private stakeholders. A strong private sector that provides needed services can also increase the efficiency, transparency, and discipline of fund mobilization and execution; for example, the insurance industry, financial markets, and technology companies can develop and deploy innovative disaster risk assessment and financing instruments. Beyond risk transfer, strong payment systems help ensure that funding reaches the intended beneficiaries in an efficient manner.

At the request of the 2019 G20 Finance Track members, this discussion note was prepared to inform the discussions under the G20 Finance Track on financial resilience against disaster risks.

The note (i) takes stock of the developments in fiscal management of disaster risks within countries' macro-fiscal framework; (ii) highlights recent progress in actions taken by individual countries and the international community; and (iii) presents new frontiers in disaster risk finance and expected future developments.

“Even in advanced economies major disasters have caused damages worth up to 20 percent of GDP. This can be up to 200 percent in small island states”



2.

Financial Resilience as Part of a Country's Macro- Fiscal Framework

Ministries of finance have started integrating disaster risks in their wider macro-fiscal framework to better manage fiscal shocks from disasters.

This approach complements and supports long-term efforts to enhance macro-fiscal policies and public financial management: strong fiscal buffers help countries absorb shocks and crises, including those arising from disasters; and sound public financial management—which requires long-term commitment and reform efforts by governments—helps facilitate quick mobilization and effective delivery of financial resources after a disaster.

Financial resilience reinforces but also requires physical and social resilience.

An increasing number of countries are strengthening physical risk mitigation measures, including physical construction, regulation, and maintenance of infrastructure assets as well as associated training of personnel. Social resilience has also been enhanced—for example, through disaster risk insurance arrangements for homeowners and small enterprises. These actions can enhance financial resilience by decreasing the potential disaster costs.

Financial resilience can be further strengthened through regional collaboration.

Increasingly over the past decade, countries are successfully working together, complementing their national level efforts with regional disaster risk finance vehicles and initiatives.

2.1

National Strategy for Financial Resilience

National financial protection strategies set out the policies and financial instruments to increase countries' financial resilience to disaster shocks.

Such strategies include the plan for pre-arranging or quickly mobilizing the required resources, as well as for effectively executing these funds. Ultimately, these strategies mitigate long-term financial impacts on the public budget as well as on households and businesses. Efficient risk management by countries starts with efforts to strengthen management of budgetary resources through strong public financial management processes. These can be complemented with support from international partners and financial instruments such as insurance.

Ministries of finance play a leading role in implementing effective disaster risk finance policies, in close collaboration with line ministries and disaster risk management agencies.

This is due to their dual role as financiers (ministries of finance must ultimately fund the response to shocks) and as conveners across the government (given that risk management is an inherently cross-cutting agenda). Beyond their role in raising and allocating public funds, ministries of finance also consolidate the government's spending programs, determine adequate allocation of funds across sectors, and manage transfers across levels of governments. They are uniquely positioned to align incentives for line ministries to invest in risk reduction and adequate financial protection. Given their expertise in raising funds from markets and managing public debts, ministries of finance are also well placed to introduce new financial mechanisms that utilize financial markets to develop innovative risk transfer and financing instruments.

“Countries can mitigate the long-term fiscal impact of disaster shocks by developing a strategy that supports policy objectives at the national, subnational, and individual levels.”

Appropriate quantitative financial information is essential to design a national financial protection strategy that includes an optimal mix of financial instruments and policies.

Such information is found in advanced risk assessments, which can provide governments with data on historical hazard impacts and the probable future cost of disasters. Under Mexico's leadership, the 2012 G20 policy dialogue focused on the importance of linking disaster risk assessment to disaster risk financing mechanisms. A comprehensive stocktaking of lessons across G20 nations informed a policy framework to guide ministries of finance in conducting a comprehensive risk assessment, building on the past G20 studies on disaster risk finance (see **box 1**).

BOX 1

SUMMARY OF PAST G20 WORK ON DISASTER RISK FINANCE

G20 members have previously highlighted disaster shocks as key external risks. In 2012, the G20 Finance Ministers welcomed efforts by the World Bank and Organisation for Economic Co-operation and Development (OECD) to inform discussions on, and support the development of, a voluntary framework for disaster risk assessment and risk financing. In 2017, a number of G20 leaders stressed the need to increase resilience against climate risks, launching the InsuResilience Global Partnership as a joint initiative with V20, which built on the World Bank's technical contribution to the G20 on sovereign disaster risk pooling. The relevant reports are summarized below.

A special joint publication by the World Bank and the Government of Mexico in 2012 highlighted the importance of integrated disaster risk financing strategies and innovative financial solutions in strengthening resilience. It revealed that policy makers need better information on risks and associated economic, fiscal, and social impacts in order to arrive at informed decisions; and it called for increased global efforts to improve the exchange of risk data and risk assessment methodologies.

Source: Government of Mexico and World Bank 2012.

A G20/OECD voluntary methodological framework was developed to provide a tool for ministries of finance and other stakeholders in developing effective disaster risk management strategies based on country practices and existing international frameworks. It offered a series of concrete steps for promoting these strategies, with risk analysis as the key first step, followed by risk communication, strategy development, and design of risk financing and risk transfer tools.

Source: OECD 2012.

The 2017 World Bank technical contribution to the G20 focused on sovereign catastrophe risk pools as instruments to enhance financial protection against natural hazards. It discussed the efficiency, effectiveness, and sustainability of existing pools from a political, operational, and financial perspective. It also recommended a set of priority action areas for G20 countries and developing countries to strengthen climate and disaster risk finance and insurance solutions, including risk pooling.

Source: World Bank 2017b.

Over the past decade, four core principles for effective disaster risk financing policies have emerged from international experience.

These are summarized in **box 2**.

BOX 2

GOOD PRACTICE IN THE DESIGN OF FINANCIAL PROTECTION STRATEGIES AGAINST DISASTERS

The following four core principles guide good practice in designing financial protection strategies against disasters:



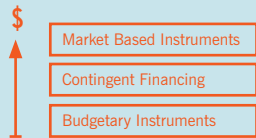
1. Data and analytics

To make sound financial decisions, governments need the right information. Appropriate risk information allows public and private decision makers to assess the costs of disasters and make informed investment decisions in allocating public resources.



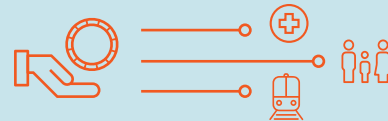
2. Timeliness of funding

Speed matters, but not all resources are needed at once. While rapid mobilization of funds is crucial to support relief efforts and early recovery, the government has more time to mobilize resources for reconstruction.



3. Risk layering

No single financial instrument can meet funding needs for all risks. The combination of financial instruments making up the government's financial protection strategy should match the frequency and severity of expected disaster events along with associated funding needs.



4. Disbursement of funds

How money reaches beneficiaries is as important as where it comes from. Governments require dedicated mechanisms and expertise to effectively allocate, disburse, and monitor recovery and reconstruction funds.

Source: World Bank 2018a.

A growing number of countries develop financial protection strategies as part of their broader macro-fiscal policies.

The experience of developing a strategic approach to financial resilience differs across countries. High-income economies such as Australia, Japan, New Zealand, and the United Kingdom are more likely to incorporate disaster risk finance planning in their broader fiscal or disaster risk management policies. In a growing number of middle-income countries, such as Colombia, Indonesia, Kenya, Peru, the Philippines, and Serbia, the ministries of finance have developed dedicated financial protection strategies against disasters.

Disaster risks create contingent liabilities on countries' balance sheets, but often these liabilities cannot be fully captured.

Contingent liabilities are government obligations that are triggered when a potential but uncertain future event such as a natural disaster occurs. They are categorized as explicit or implicit liabilities. Explicit liabilities are those underpinned by legal obligations, such as guarantees and pre-arranged insurance agreements. Implicit liabilities, on the other hand, are expenditures the government is expected to make due to a perceived moral obligation, without formal legal commitment; in some cases, these liabilities include support for public-private partnerships (PPPs) or state-owned enterprises. Many disaster-related contingent liabilities are implicit and difficult to quantify. **Table 1** gives examples of explicit and implicit contingent liabilities from natural disasters.

TABLE 1

Disaster-related explicit and implicit contingent liabilities

TYPE	EXAMPLES
Explicit contingent liabilities	Cost-sharing arrangement with subnational governments Recovery and reconstruction of damaged public assets Government guarantees for public corporations or PPPs Legal commitments for government compensation of losses to private assets, farmers, or companies
Implicit contingent liabilities	Moral obligation to fiscally support ministries, agencies, private firms, and citizens in the aftermath of disasters Expanding ex ante commitments Tax reductions or economic support for small businesses

Identifying, disclosing, and mitigating disaster-related contingent liabilities enables governments to integrate disaster-related fiscal risks into macro-fiscal planning and the formulation of national budgets.

Ministries of finance in some countries have advanced their contingent liability management systems. For instance, HM Treasury in the United Kingdom has introduced a contingent liability approval regime, where line ministries are required to go through an approval process with the Treasury to take on new contingent liabilities. Such a supervising system for contingent liabilities could enable ministries of finance to actively monitor, manage, and mitigate contingent liabilities across the government (HM Treasury 2017).

Governments generally seek to protect their country at multiple levels.

Financial protection strategies usually aim to mitigate the long-term fiscal impact of disaster shocks on national and subnational governments, to support businesses and households in better managing their risk, and to reduce the impact of disasters on the poor and vulnerable. Countries can achieve these goals by developing strategies that support policy objectives at the national, subnational, and individual levels. At the individual/household level, for example, domestic disaster risk insurance schemes for homeowners are now in place in some G20 countries and beyond, including Japan, Switzerland, Turkey, the United Kingdom, and the United States. **Box 3** sets out examples from Mexico, Australia, Japan, and Spain for the various levels.

BOX 3

GOOD PRACTICES FOR DOMESTIC DISASTER RISK FINANCE POLICIES



Mexico: Protecting the federal budget

Mexico's Natural Disaster Fund (FONDEN) adopts a layered financial risk management strategy. It receives a mandatory annual budget allocation,

which it complements with innovative financial instruments to smooth government expenditure on disasters. More specifically, FONDEN transfers disaster risk through indemnity-based reinsurance

(to cover public buildings and infrastructure) and through catastrophe bonds; it has also purchased risk transfer instruments to cover exposure that exceeds the budget allocation by issuing catastrophe bonds through the World Bank. FONDEN was designed based on insurance principles to support the rapid and targeted disbursement of funds for disaster response and for rehabilitation of public infrastructure. It relies on a transparent damage reporting system and clear rules of disbursement.

Source: World Bank 2012a.



Australia: Enhancing the financial resilience of subnational governments

To enhance the financial resilience of subnational governments against disaster risk, the Australian government both provides subnational governments with financial assistance and encourages them to reduce their disaster risk. Through the Natural Disaster Relief and Recovery Arrangements (NDRRA), the Commonwealth formalizes conditions of financial assistance to subnational entities. State governments develop insurance funds to provide standardized insurance coverage for public assets and access to international reinsurance capacity. State governments are also required to undertake independent assessments of their insurance arrangements every three years and submit the results to the Commonwealth for review.

Most states have developed a self-insurance system, such as government-owned captive insurers and mutual insurance pools for critical state-owned assets. According to an assessment conducted by Australia’s Department of Finance and Deregulation (2011), most states have abundant and cost-effective insurance arrangements for nonroad assets, which meet the NDRRA’s obligations. A number of local governments insure non-road assets through a mutual pool arrangement or commercial insurance.

Source: Commonwealth of Australia, Department of Finance and Deregulation 2011.



Japan: Protecting homeowners against earthquakes

Japan’s Ministry of Finance has developed a public-private earthquake insurance program for residential assets based on risk sharing between the private insurance sector and the government-backed Japan Earthquake Reinsurance Co. (JER). Payouts are not proportionate to damage, but instead rely on a four-step system of total, large, small, and partial losses, corresponding to 100 percent, 60 percent, 30 percent, and 5 percent of the earthquake insurance policy limit. This simple

system allowed claims to be settled quickly after the Great East Japan Earthquake, which caused US\$300 billion in losses in 2011 and resulted in total payouts of around ¥1.27 trillion (US\$11.4 billion).^a Satellite images were used to identify total losses for buildings. As a result, 60 percent of claims were paid within two months and 90 percent within five months.

Cooperative mutual insurers also independently provide earthquake insurance coverage, accessing international reinsurance and capital markets for reinsurance protection. An estimated 39 percent of households are covered against earthquake risks by the existing programs. The insurance case in Japan illustrates that public-private partnerships and fully private insurance programs can coexist successfully to provide rapid and effective financial compensation to homeowners.

Source: World Bank and GFDRR 2012. Tsuda 2019.



Spain: Insurance for individuals and businesses against “extraordinary risks”

Spain’s Consorcio de Compensación de Seguros (CCS), a state-owned enterprise, provides additional coverage for “extraordinary risks” that are not covered by private insurance policies for individual and business properties (e.g., residential assets, personal properties, cars, railway vehicles) and personal injury. In Spain, it is mandatory to cover “extraordinary risks,” including natural disasters (e.g., flood, earthquake, tsunami, volcanic eruption, and wind storm) and violent events (e.g., terrorism). To avoid adverse selection, the CCS’s surcharge is applied to all the relevant insurance policies regardless of CCS’s actual coverage, and is calculated based on specific rates determined for the type of insurance policies and covered assets, no matter the location or risk profile of the properties or individuals. The surcharge is collected through the insurers that provide the main insurance policy. The total amount of surcharge for the property insurance policies was US\$690 million^b in 2015, and the aggregated insurance payout between 1971 and 2015 was US\$10.4 billion.

Source: CCS 2016.

a. The Japanese yen is converted to U.S. dollars at the rate of ¥112 per US\$1. b. The euro is converted to U.S. dollars at the rate of €0.9 per US\$1.

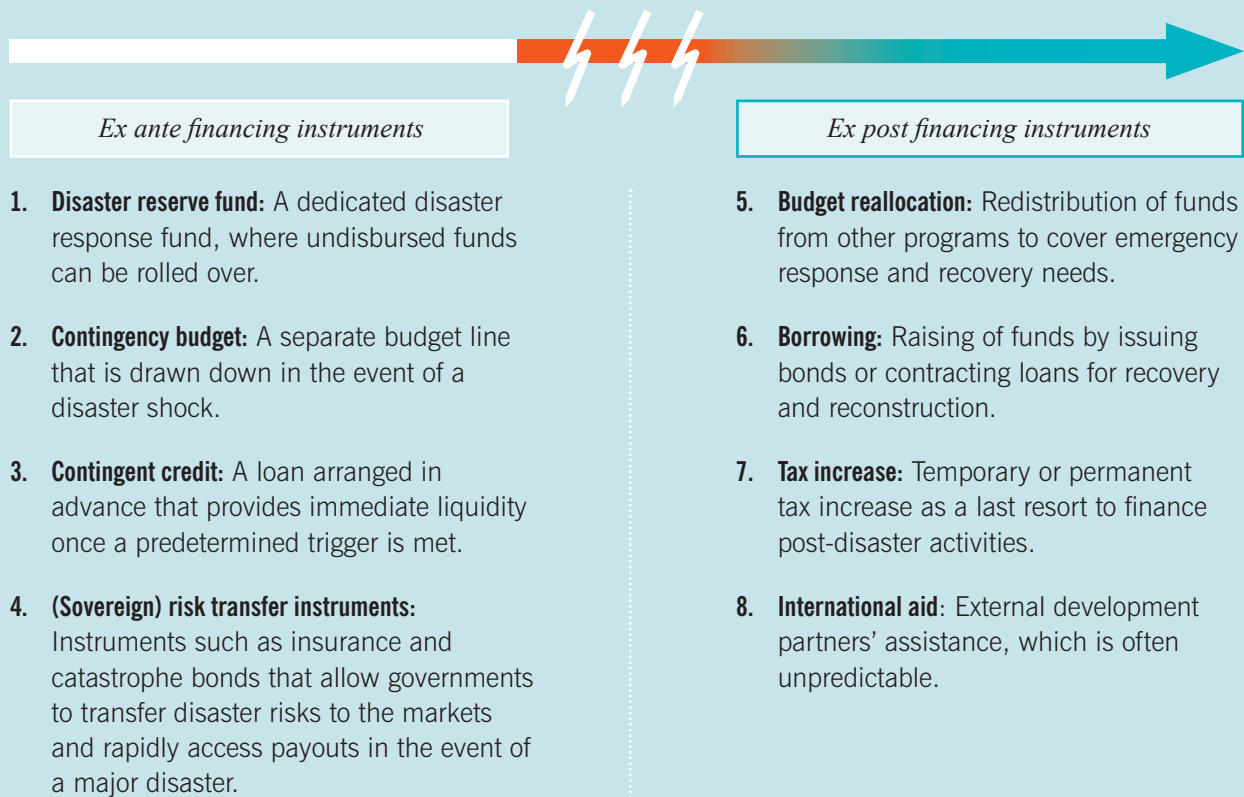
Pre-arranged risk financing can help governments reduce the fiscal cost of disasters.

Disaster shocks tend to increase government expenditure and hamper economic activities—for example, by damaging critical infrastructure assets. Following a disaster, a government could rely on post-disaster financing instruments, including budget reallocation, borrowing, taxation, and international aid. However, it often takes a long time until these funds become available, which can delay disaster recovery and reconstruction and cause long-lasting negative impacts on economic activities, raising public debt and lowering sovereign ratings, and in turn potentially increasing interest expenses. Pre-arranged risk financing instruments provide governments with immediate access to funds and mitigate the negative impact of disasters on economic activities and future fiscal costs (**box 4**).

BOX 4

OVERVIEW OF DISASTER RISK FINANCING INSTRUMENTS

There are multiple financing instruments that allow governments to finance the cost of disasters. These instruments can be categorized as those arranged before a disaster (ex ante) versus those mobilized after a disaster (ex post). The list below offers examples of financial instruments that have been used to finance post-disaster activities.



Source: World Bank 2017a.

— Governments also need to ensure that their regulatory and governance frameworks are appropriate to implement sustainable financial protection strategies.

A sound legislative basis enables governments to develop and implement long-term disaster risk financing and insurance arrangements even through changing administrations. Institutional arrangements—including the establishment of dedicated fiscal risk management units or a cross-ministerial risk managing board—can also enhance comprehensive financial management against disaster risks in the long run.

— Financial instruments can serve as both short-term measures to support evolving systems and long-term risk management mechanisms.

For example, in countries with weak public financial management systems, a private sector insurance scheme can help the government build fast, transparent, and accountable disbursement schemes while it undertakes longer-term reforms to improve the transparency and speed of its budgetary processes. On the other hand, financial instruments can also enhance already advanced and efficient budget processes through more cost-effective financial solutions.

2.2

Enhancing National Financial Resilience through Regional Collaboration

— Regional collaboration has proven an effective way for countries to improve their national financial protection strategies.

Sovereign or supranational catastrophe risk pools, for example, have provided governments with financial instruments (such as parametric insurance) that enable rapid, cost-efficient access to liquidity for emergency relief. First-generation sovereign catastrophe risk pools have aggregated country-specific catastrophe risks into a single, more diversified portfolio, retained some aggregate risk through joint reserves, and transferred excess risk to reinsurance and capital markets when this approach is the most cost-effective choice.

— Catastrophe risk pools help reduce insurance premiums through lower capital requirements and lower operating costs.

Consider the Pacific Catastrophe Risk Insurance Company (PCRIC), which pools catastrophe risks of five Pacific island states: the 1-in-250-year return period loss for the pool's combined portfolio is 65 percent lower than the sum of country-specific 1-in-250-year return period losses. The result is a premium reduction in excess of 40 percent. Similar benefits arise from regional catastrophe risk pools in Africa and the Caribbean; the average total premium income of the existing three pools is US\$45.5 million (World Bank 2017b). Beyond the financial solutions, such pools also promote political cooperation and public goods.

Three sovereign catastrophe risk pools have been established to date, covering 26 countries in the world's most disaster-vulnerable regions:

the Caribbean Catastrophe Risk Insurance Facility (CCRIF SPC), the African Risk Capacity (ARC), and the PCRIC. All three risk pools relied on development partners' support for their establishment, and they continue to benefit from development partners' technical and financial assistance. More information on the risk pools is in **box 5**.

BOX 5

OVERVIEW OF THREE EXISTING SOVEREIGN CATASTROPHE RISK POOLS



The Caribbean Catastrophe Risk Insurance Facility (CCRIF) has been in existence since 2007 and was the first sovereign catastrophe risk pool established. CCRIF is a segregated portfolio company (CCRIF SPC) owned by the CCRIF special purpose trust whose beneficiaries are CCRIF members. As of 2017, 14 Caribbean countries participated in the pool. As part of the ongoing expansion of the CCRIF into Central America, Nicaragua purchased a policy in 2018. As of 2018, CCRIF had made total payouts of US\$136.3 million, including more than \$50 million during the 2017 hurricane season. The latest payout, US\$5.8 million to Barbados, was triggered by excess rainfall in October 2018.



African Risk Capacity (ARC) was launched by the African Union in 2012, and ARC Insurance Company Ltd. was established in 2014 as a mutual insurance company owned and overseen by its members—the African Union member states and development partners. ARC issued its first insurance contracts in 2014. As of 2017, six west African countries had policies in ARC (Burkina Faso, The Gambia, Mali, Mauritania, Niger, and Senegal). A total of US\$34.4 million has been paid out since its inception, including more than US\$26.3 million to Niger, Mauritania, and Senegal in 2015 in response to drought.



The Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) launched a pilot insurance program in 2013 and in 2016 set up the **Pacific Catastrophe Risk Insurance Company (PCRIC)**, owned by a foundation whose governing body consists of the participating counties and development partners. As of 2017, five Pacific island states—namely the Cook Islands, the Marshall Islands, Samoa, Tonga, and Vanuatu—participated. A total of US\$6.7 million has been paid out to countries to date, including US\$3.5 million to Tonga in response to Cyclone Gita in 2018.

Source: World Bank 2017b.

In over a decade of experience with risk pools, important lessons have emerged on bringing such facilities to scale. (see box 6)

Under Germany's leadership, the 2017 G20 included discussions on sovereign catastrophe risk pools as a mechanism to help strengthen financial resilience.

BOX 6

LESSONS ON BRINGING SOVEREIGN CATASTROPHE RISK POOLS TO SCALE

A decade of experience has shown that political commitment, sound operational design, and financial sustainability are essential for successful catastrophe risk pools.



Political commitment is both a precondition for successful catastrophe risk pools and a byproduct of collaboration. Pools require strong political commitment from the participating countries as well as development partners' support, especially during the design and preparation stage. The development and implementation of the pools also facilitate regional policy dialogue and improve collaboration between participating countries and development partners.



Sound operational design maximizes impact and generates public goods. Pools can encourage the participating countries to develop pre-agreed disaster response plans to ensure timely, transparent, and efficient use of funds following disasters. The creation of risk pools has also driven the development of public goods such as data infrastructure, risk models, and improved institutional capacity.



Financial sustainability allows catastrophe risk pools to provide access to cost-effective insurance as part of a strategic approach to financial protection. Pools can offer cost-effective insurance solutions in various ways, including through risk diversification, joint reserves, and facilitated access to international markets. The benefits of pools can be enhanced by combining different financial instruments to address different needs. The participating countries are encouraged to shift toward proactive risk management by up-front premium payment.

Source: World Bank 2017b.

Joint catastrophe bonds (cat bonds) are another financial instrument that has been successfully executed for the first time through regional collaboration.

In 2018, with support from the World Bank, Colombia, Chile, Mexico, and Peru issued the first joint cat bond under the Pacific Alliance framework (see **box 7**).

BOX 7

JOINT CATASTROPHE BOND FOR THE PACIFIC ALLIANCE:

Colombia, Chile, Mexico, and Peru



In 2018, the World Bank issued a joint cat bond for the four Pacific Alliance countries—Colombia, Chile, Mexico, and Peru—that provided total earthquake coverage of US\$1.36 billion. The issuance consists of five classes of bonds to cover earthquake risks: one each for Chile, Colombia, and Peru, and two classes for Mexico. The bond enables Chile, Colombia, and Peru to access international capital markets for the first time to receive insurance coverage against natural disasters. The insurance coverage of the cat bond is US\$500 million for Chile, US\$400 million for Colombia, US\$260 million for Mexico, and US\$200 million for Peru. Earthquakes exceeding a pre-agreed severity will trigger the cat bond, releasing an insurance payout to the countries, and the investor will lose part or all of the capital. The joint cat bond has contributed to risk diversification for investors, achieved economies of scale, and secured better premium rates for the four participating countries.

Source: World Bank 2018f.

“Regional collaboration has proven an effective way for countries to improve their national financial resilience strategies.”



3.

Disaster Risk Finance 2.0: What's Next in Developing Countries?

Much progress has been achieved in disaster risk finance, but policies and instruments keep evolving.

It is important for governments to start with fundamentals even while looking to new developments.

Instruments and vehicles for financial resilience have seen rapid development over the past decade, and they continue to evolve in response to clients' diverse needs and as countries seek to strengthen macro-financial stability against external shocks. New policies and tools will contribute to instruments and vehicles that are more flexible and that make better use of technology, helping countries better manage disaster risk as part of their overall fiscal and risk management framework.

While looking to see where innovation is possible and perhaps leapfrog some steps taken by their peers, governments should not lose sight of the fundamentals. Officials who are just beginning the effort to increase their country's financial resilience to disasters should not be discouraged by advanced mechanisms that look too complex. It is important to progress step by step and focus on getting the fundamentals right. It is equally important to rapidly show initial results that help sustain momentum.

3.1

Catastrophe Risk Pools: Sharing More than Catastrophe Risks

Sovereign catastrophe risk pools are evolving toward full-service regional platforms to support the development agenda of their members.

They are becoming an effective channel by which public sector risk can more efficiently reach financial markets, market failure can be overcome, and investments can be made in public goods and political coordination. Initially all three existing catastrophe risk pools were set up to offer specific (parametric) catastrophe risk insurance products to participating countries. Over the years they have started to offer new financial products. For example, CCRIF now offers excess rainfall insurance products and is exploring fisheries insurance. PCRIC is establishing a dedicated private sector window to provide domestic insurers with reinsurance capacity that will enable them to underwrite tropical cyclone insurance for homes with lower building quality, which would not otherwise be acceptable to markets. In late 2018, ARC launched the first “replica” coverage, through a policy that pays out to the Start Network (a network of humanitarian NGOs) if a drought hits Senegal. The newest regional facility to be established—the Southeast Asia Disaster Risk Insurance Facility (SEADRIF)—was set up from inception as a platform to offer different products and services to countries in Southeast Asia, a very diverse region in terms of exposure, hazards, and economic development.

From insurance to disaster risk finance services. Catastrophe risk pools are moving beyond insurance as their primary value proposition and expanding their additional services to include broader risk financing trainings and public goods. ARC and PCRIC are helping participating countries develop standardized contingency plans to enhance post-disaster delivery mechanisms and accountability. All regional platforms have invested extensively in developing customized regional probabilistic catastrophe risk models, giving many participating countries first-time access to state-of-the-art risk assessment and financing tools. These are useful not only for insurance solutions but also for broader financial and risk management decision making.

From product providers to centers of expertise. Risk pools build specialized expertise in risk management and finance that is often scarce in the countries they support. Recognizing this, countries are increasingly looking to regional facilities for extended hands-on technical support and training. Offering the benefit of economies of scale and the support of external partners, regional facilities can develop into regional centers of expertise to provide crucial capacity for risk management in vulnerable countries. Given that expertise in risk financing is both highly specialized and scarce, it is easier to establish such capacity in regional centers rather than individual countries. This arrangement is also easier for international partners to support, and

risk pools can then act as mechanisms to disseminate expertise to participating countries.

Growth through diversity. The shift toward disaster risk financing platforms will likely lead to new solutions, including for larger and more developed countries, and will offer more customized financial instruments. Risk pools may also develop further to better link financial products to risk reduction and prevention, by helping to quantify risk and drive limited investment in risk reduction to projects with the highest impact and cost-benefit ratio. For example, SEADRIF is developing a flood risk pool for its low-income members. The pool has been designed from the beginning to also help large middle-income countries manage and transfer risk to markets more efficiently (see **box 8**).

BOX 8

SOUTHEAST ASIA DISASTER RISK INSURANCE FACILITY



The Southeast Asia Disaster Risk Insurance Facility was agreed in December 2018 to launch as an ASEAN+3 initiative, with the goal of helping member countries in ASEAN (Association of Southeast Asian Nations) enhance their financial resilience against disasters. Supported by the technical assistance of the World Bank and the financial and political support of Japan and Singapore, SEADRIF is designed as a platform that offers members customized financial

solutions to disaster shocks as well as knowledge sharing and technical assistance, including for insurance market development. The first financial program developed under SEADRIF is a regional catastrophe risk pool for the Lao People's Democratic Republic, Myanmar, and possibly Cambodia. SEADRIF is also starting to work with middle-income countries in ASEAN.

While discussions with ASEAN middle-income countries such as Indonesia, the Philippines, and Vietnam are just starting, indicative analysis can illustrate the potential benefits of developing a joint catastrophe risk program under SEADRIF. (**Figure 2** sets out an indicative structure for such a program). Based on a set of realistic assumptions, **figure 3** shows that a hypothetical combined portfolio generates a 38 percent reduction in the 1-in-200-year probable maximum loss (PML) compared to the sum of country-specific values. If countries pooled their risk and purchased insurance jointly under SEADRIF, the reduced capital requirement, combined with potential reduction in operating and transaction costs, could result in significant premium savings. Such analysis could be refined and applied to various potential schemes, including a joint risk pool for public assets.

FIGURE 2

Indicative structure of a joint catastrophe risk insurance program for ASEAN middle- income countries

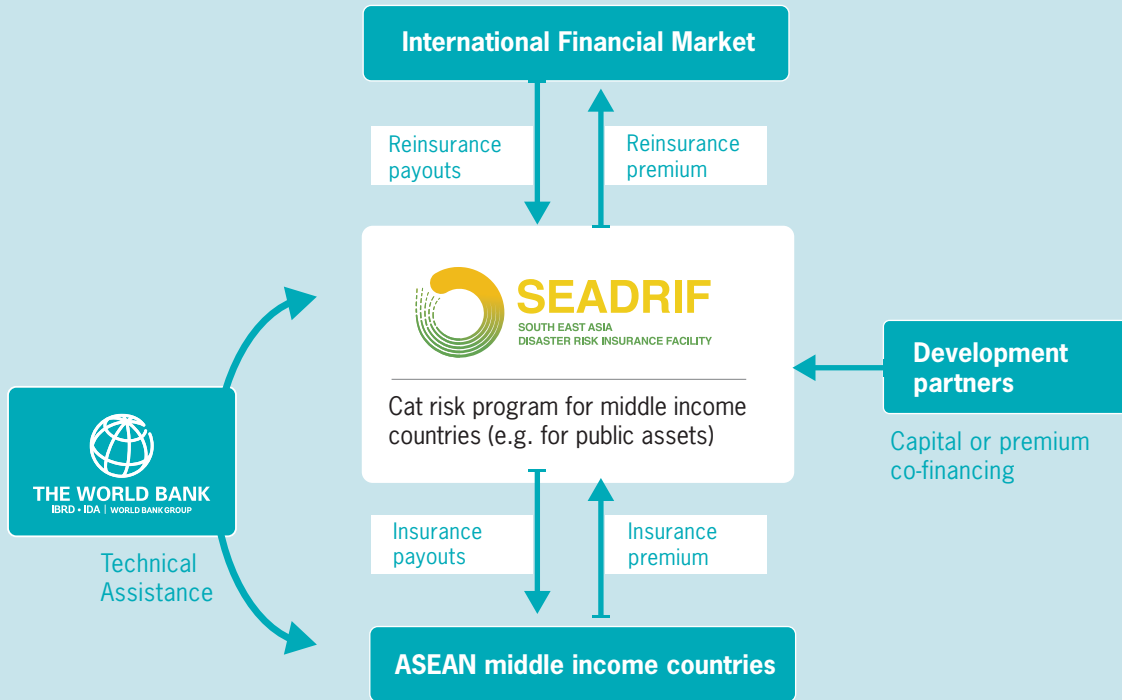
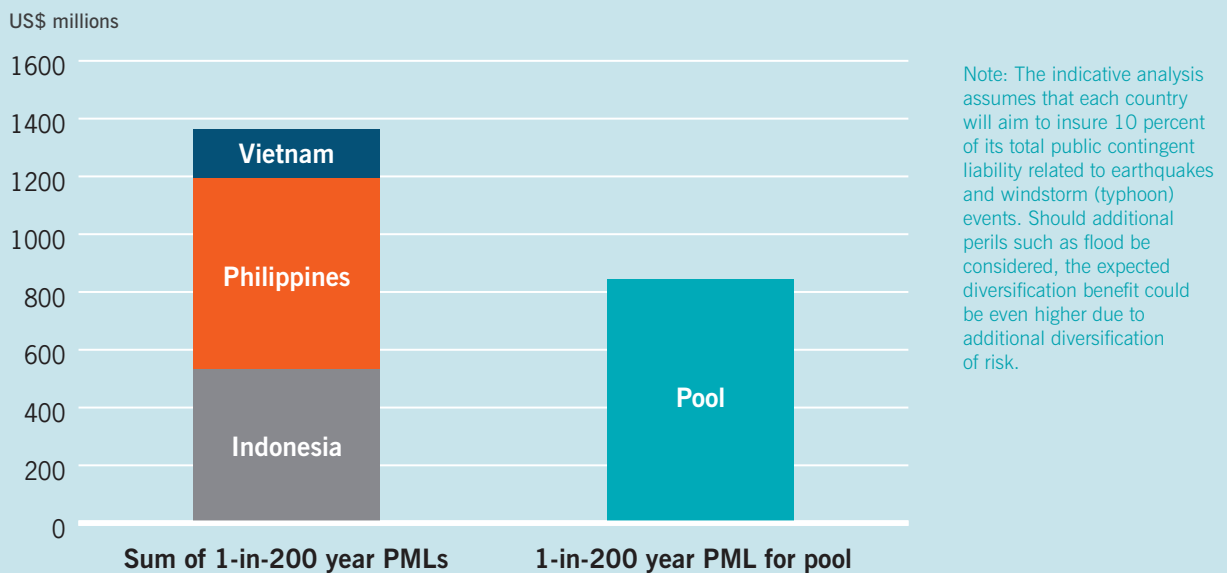


FIGURE 3

Indicative diversification benefits modeled for Indonesia, the Philippines, and Vietnam



Source: Estimates based on country catastrophe risk profiles in World Bank 2012b.

3.2

Targeted Financial Solutions to Address the Drivers of Contingent Liabilities

Many disaster risk financing instruments have provided budget support to recipient governments.

This support gives recipient governments the flexibility to manage shock response and allows them to meet national priorities. But such instruments do not support countries in managing their portfolio of assets and liabilities in the most efficient way.

Governments are moving from a fairly basic liability management approach toward a more sophisticated strategy that better matches financing instruments to liabilities.

This latter approach involves not only using more precisely targeted financial instruments, but also putting in place domestic mechanisms to clarify and quantify contingent liabilities, and then connecting these directly to funding mechanisms, whether from the budget, international partners, or financial markets. Domestic specialized pools can also help make previously uninsurable risks insurable and more manageable. These steps help governments manage their disaster-related contingent liabilities more efficiently. Experience suggests that three areas have significant potential to be directly linked with risk financing instruments: public assets, national-subnational cost sharing, and social safety nets.

Public assets and infrastructure. Damage to public assets and infrastructure is one of the largest drivers of disaster losses (OECD and World Bank 2018). The Asian Development Bank estimates that in Asia alone, developing countries will need to invest US\$26 trillion in new infrastructure by 2030 if the region is to maintain its economic growth and pace in poverty reduction (ADB 2017). To avoid a continued increase in disaster-related contingent liabilities from public assets and to protect their critical services, governments must continue investing in high-quality infrastructure, continue developing financial risk management mechanisms, and ensure sufficient investment in operations and maintenance throughout the life of the assets. A growing number of countries, including G20 countries such as Indonesia, are developing insurance, self-insurance, and other financial schemes to protect the provision of public services, help smooth government expenditures on asset rehabilitation and reconstruction, and increase transparency and discipline in government spending. Mexico's FONDEN (box 3) is an early example of such an approach, under which the government finances infrastructure reconstruction in line with very clear rules. It then protects itself through an excess-of-loss indemnity insurance policy (which starts covering losses once the fund's expenditures exceed a threshold) and through parametric risk transfer for especially severe events. Insurance companies can also contribute to

investment in physical resilience of infrastructure through financing structural and non-structural measures. In Switzerland, approximately 25 percent of the revenues from the insurance premium paid to public insurance agencies for the mandatory coverage of private and subnational governments' buildings against natural hazards is spent on disaster prevention measures including for infrastructure (Swiss Federal Department of Finance 2019).

National-subnational cost sharing. Especially in larger economies, financial support to subnational governments is often a large driver of post-disaster costs. Local governments, including cities and municipalities, bear a large share of disaster costs—partly because they act as first responders and partly because they are responsible for maintaining a significant share of affected assets and public services. As the case of Australia (box 3) demonstrates, clear rules on the post-disaster fiscal responsibility of national and subnational governments can help national governments plan ahead, and can encourage subnational governments to invest in fiscal, physical, and social resilience. As fiscal transfers continue to play a crucial role in funding disaster-related expenditures, countries can set up additional schemes to better manage this liability through pre-arranged fiscal mechanisms or financial instruments. For example, in 2017 the Philippines established the world's first subnational risk insurance pools, bundling together the typhoon risk of 25 provinces and transferring it to reinsurance markets, intermediated through the World Bank in local currency for the Philippines. Schemes that similarly aim to increase the predictability and efficiency of post-disaster co-financing are being explored in many other countries. Setting up pre-arranged financing rules also allows countries to utilize additional international financial instruments to meet this liability. Such arrangements could also be increasingly relevant for large cities and municipalities, which could establish mechanisms to better manage the costs of shocks—for example, by pre-arranging national government support or by working together to pool their risks.

Safety net programs. Clear pre-arranged disbursement channels for delivering funds directly to the most affected households are also a growing priority for many countries, especially the least-developed countries, including in Africa. This approach includes adaptive social protection programs, where safety net systems such as conditional cash transfer programs are enhanced with clear and predetermined rules and build on disaster risk finance principles to serve as immediate disaster response mechanisms. The rules indicate in advance when a safety net will scale up, along with the triggers, the beneficiaries, and the response plans to be financed. Once the government explicitly agrees to directly provide support to vulnerable households through such a program, and once the trigger and coverage are determined, the ministry of finance can start quantifying the risks and contingent liabilities. The rules for scaling up can then be directly linked to payouts from financial instruments, so that payouts directly match the costs of emergency transfers. For instance, Kenya has set up the National Drought Emergency Fund (NDEF) and is linking this to its existing Hunger Safety Net Program (HSNP) to enable immediate financing for scale-up of drought response interventions. It is further enhancing this system with risk transfer for more severe events.

3.3

Technology and Innovation to Enhance Financial Resilience

New technology and innovations have the potential to significantly enhance and boost systems for financial resilience against disaster shocks.

They can help make risks more understandable, improve the efficiency of existing solutions and new mechanisms being developed, and open up entirely new areas of engagement. For example, technology can improve the real-time availability of hazard information, the accuracy of disaster risk assessments, and the targeting of funds to affected communities. The three fields of innovation discussed in this section all contribute to a shift from data that are complex, scarce, and partially available to global indicators that are highly detailed, continuously produced, and used to track change and process response in near real time. These are all enabling technologies for enhanced risk-informed financial decision making and fiscal risk management.

But countries should proceed with caution when adopting new technologies.

Technology has the potential to radically transform many areas of work, but it is important to test and deploy new approaches cautiously. While technology can support reforms to enhance the efficiency and effectiveness of many processes, it cannot simply replace the required but often slow reforms needed to improve the functioning of fundamental systems. New technology should be carefully tested to ensure it is the right solution for the problem and not a quick fix for a symptom. Similarly, officials should be careful to ensure that new approaches actually deliver better results than existing and well-tested tools.

3.3.1

Earth Observation Data

The remote measurement or monitoring made possible by the latest satellite technology is enabling powerful new applications that support more accurate and timely financial decisions in response to shocks.

From exposure mapping to post-disaster damage estimation and near-real-time monitoring for emergency response coordination, the range of applications is broad and the added value significant. Europe's Copernicus program is providing unprecedented volumes of free satellite data, in a comprehensive, accurate, repeatable, and timely manner. Rapid-onset flooding, landslides, and large-scale drought events can now be tracked and monitored, enabling greater understanding of risk in territories that had previously been largely unmodeled. The quantity and timeliness of information provided also contribute to improved forecasts, early warnings, and post-event loss estimates. These advances are of particular importance for the most complex

crises and pave the way to manage new risk, forecast-based financing applications for disasters, and crises that are interrelated such as famine, drought, and political conflict. Often it is the combination of satellite data with ground measurements that proves to be especially valuable, providing governments with access to the most accurate and timely information available on the potential occurrence and impact of disasters in near real time.

For example, SEADRIF is supported by a flood risk assessment tool that leverages the latest satellite technology to improve availability of risk information for governments.

It combines radar and optical satellite data for monitoring water surfaces by using the latest space technologies and imagery-processing capabilities along with hydrological models to determine the likely extent of any flood in near real time. As ground measurements are scarce across the region, remote sensing observations are an important source of complementary data to estimate the extent of large-scale floods and provide reliable near-real-time data in crises. Data generated by this tool will be processed into estimations of disaster response needs and emergency costs, while also serving as triggers for the parametric insurance offered by SEADRIF. By making risk data readily available, this tool allows for quick damage assessment and analysis, which in turn lowers the related fiscal risks.

Other examples are offered by African countries, where satellite data have been used to monitor drought conditions and to calculate insurance triggers.

Kenya uses satellite data to calculate an index-based livestock insurance trigger that enables rapid insurance payouts. In Uganda, an index of satellite-based observations of ground vegetation serves as an indicator of drought conditions and as the trigger for implementing a scale-up of the Northern Uganda Social Action Fund (NUSAF), a targeted social safety net program.

“Unprecedented volumes of free satellite data enable greater understanding of risk in previously largely nonmodeled territories”

3.3.2

Financial Technologies (Fintech and InsurTech)

Fintech and InsurTech are transforming the financial sector, yet their application in disaster risk finance in the public sector is still only incipient.

Technology in this space has many potential applications that could fundamentally transform and digitize disaster risk finance, but further engagement is needed to build a better understanding between innovators and public sector officials. This step is especially important to ensure that any technology solutions are not product driven, but instead respond to a carefully defined and identified problem. In addition, innovations need to be carefully evaluated together with more traditional solutions to identify the most appropriate and best-fit solution for the problem at hand.

Innovations in digital payment systems have transformed access to finance and enabled new ways to provide financial assistance to poor communities.

Many social protection or social assistance programs have tapped into digital innovations to make financial assistance to households more accessible and effective, especially in countries where poor communities may be hard to reach through physical cash transfers or traditional bank transfers. The rapidly growing penetration of cell phones has enabled new ways of accurately targeting social assistance and speeding up its delivery. In Kenya, for example, mobile money services along with traditional banking services enabled insurance companies to make payouts directly to beneficiaries less than a month after a severe drought triggered a US\$2.1 million payout from a national livestock insurance program in February 2017.

Technologies such as blockchain, digital payment systems, and digitization of insurance hold significant potential to improve financial instruments in disaster risk finance.

These technologies could be especially powerful when combined with other data collection and data analytics technologies such as satellite data and big data. For example, the integration of technology and finance/insurance could enable much more dynamic risk management, including automated underwriting and risk transfer in near real time; moreover, it could increasingly break up insurance transactions into smaller and more customized coverage instead of large standardized policies that are adjusted and negotiated only once a year.

Blockchain is a new technology that promises to further increase the flexibility, traceability, and speed of financial services, but it has not been fully tested.

This technology has seen a rapid rise in popularity and may hold significant potential to be adopted by both government assistance programs and disaster risk insurance providers. But as with any new and untested technology, officials and solution providers should proceed with caution, making sure to test blockchain and identify applications where it makes significant gains.

“Technology has the potential to radically transform many areas of work. But it cannot simply replace the required reforms to improve systems and institutions.”

3.3.3

Big Data, Machine Learning, and Artificial Intelligence

The application of big data and machine learning can enhance disaster risk financing before, during, and after an event.

Data play an integral part in risk financing; they enable quantitative financial and economic analysis and risk-informed decision making. Data are also at the heart of designing financial instruments. But while data sets have tremendous value, understanding them requires significant analysis, specific skill sets, and novel ways to process them. Breakthroughs in artificial intelligence, computer vision, crowdsourcing, and other sophisticated analytical approaches are converging to allow the detection of patterns in data that would otherwise elude even the most expert risk modeler. Examples include classifying damage from an earthquake, predicting smallholder crop yields, identifying flood risks (e.g., through the SEADRIF risk platform), and addressing the most complex crisis risks (e.g., famine and political conflict). Businesses and governments can use big data for decision making, and can use machine learning to inform policy design and decisions in many sectors. Innovations that leverage big data can make disaster risk finance instruments quicker, more effective, more accessible, more engaging, and better able to visualize data to support decision making and financing solutions (**box 9**). At the same time, increased reliance on computer-driven decision making introduces new risks, including errors in data processing and misinterpretations of data inputs. Equally, the decisions generated by computers are only as good as the data provided by humans; thus, for example, any systemic bias or exclusion in data inputs will also lead to biased outputs. It will be particularly important to pay attention to design of robust grievance address mechanisms and feedback loops.

BOX 9

**APPLICATIONS OF BIG DATA FOR DISASTER RISK FINANCE
BEFORE, DURING, AND AFTER A DISASTER**



Before a disaster

Asset data collection. Collect and monitor information about (public and private) assets, e.g., through data collected from Internet of Things—enabled monitoring sensors, technology in vehicles, mobile phones, or satellites, to inform risk assessments and financial decisions such as insurance pricing.

Financial risk assessments. Aggregate and process large volumes of historical information to identify and visualize long-term disaster-related spending patterns and trends.

Financial product design. Set specifications for financial mechanisms—for example, through algorithms that can reduce basis risk in parametric triggers by building and calibrating many trigger points (e.g., grid cells).

Visualization of risk information. Collect and process large data sets in real time to help visualize risk in increasingly user-friendly ways to inform financial decisions by policy makers.

Direct risk mitigation and prevention. Improve understanding of exposure and risk to help governments invest more efficiently in risk mitigation and prevention.

During a disaster

Damage and impact forecasting. Collect and process data as an event is unfolding (months, weeks, or days before the event, depending on perils)—for example, by combining climate, commodity, market, and political information to predict an event's impact on food security, or using cell phone data to understand population movements.

Automated triggers for financial instruments. Design more sophisticated triggers for parametric financial instruments—for example, by combining and analyzing live data feeds and existing data sets in real time to determine threshold values.

Response coordination. Help decision makers understand an unfolding situation by processing and combining a large number of data feeds—for example, by ground-truthing data.

Targeting of financial mechanisms. Combine forecasting and triggers to target financial assistance to the most affected areas and population—for example, by automatically adjusting adaptive safety nets.

After a disaster

Insurance claims settlement. Automate loss adjustment and claims settlement to accelerate payouts of indemnity insurance.

Damage and loss estimation. Analyze data sets for damage estimation—for example, through change detection in satellite imagery, or by combining physical observations with user-generated data.

Monitoring of impact and targeting of interventions. Calibrate crisis response mechanisms—for example, through tracking movement of refugees in rural locations and inferring levels of welfare using machine learning based on satellite metrics (e.g., type of dwelling, night light data), and identifying hot spots for possible conflict.

These three areas of innovation—big data, machine learning, and artificial intelligence—can inform a country’s approach to strengthening risk financing.

In most cases, several of these technologies will work hand in hand, as they are closely related. **Box 10** provides a sample vision for such a system. The application to public asset management it outlines is just one example, and similar systems could be designed for other sectors. For instance, an end-to-end agricultural insurance system could rapidly deliver payouts directly to farmers’ or herders’ bank accounts. Such payouts could be triggered based on an index (satellite, yield, weather) continuously monitored by a computer, which would automatically notify insurance companies of a triggering event and transfer funds from the insurance company to the bank/mobile money operator, and on to the beneficiaries.

BOX 10

AN END-TO-END PUBLIC ASSET FINANCIAL RISK MANAGEMENT SYSTEM?

The financial risk management of public assets could benefit enormously from new technologies. An effective system begins with systematically understanding liabilities from public assets, investing in the underlying data to quantify the potential impact, and developing policies and systems to mitigate and manage the associated risk. Comprehensive asset registries bring together information such as asset location, vulnerability, and value, and thus help integrate the disaster risk financing strategy under the wider macro-fiscal framework.

Technology could facilitate a shift from piecemeal approaches to comprehensive financial risk management of public assets. Today few developing countries have well-maintained, digital, and comprehensive asset registries or management systems. In most countries, assets are managed in silos across government departments; data are often outdated, incomplete, and stored on systems that do not communicate with each other. Methods for financial risk management are limited. Drawing on the technologies described above, we can envision an end-to-end system that goes from data collection to asset management to financial risk management. An integrated and largely automated technology system could innovate in all steps of the financial risk management process:

- **Data collection.** Asset exposure mapping from satellite data or other remote sensing mechanisms, crowdsourced data, or scraping of online data could close data gaps and collect asset information at unprecedented speed, directly feeding into an asset registry with automatic updates.
- **Data storage and analytics.** A fully digital asset registry, leveraging data analytics, could combine basic asset information with functionalities such as real-time integration with other government information systems; analysis of drivers of data uncertainty and validation to ensure data accuracy; automatic asset valuation through artificial intelligence; scenario analysis to plan for future investment, asset acquisition and disposal, operations and maintenance spending, and risk reduction; and highly visual decision support tools.
- **Risk view.** Real-time integration with a probabilistic catastrophe risk model could provide a near-real-time view of the risk faced by assets to inform decision making on risk reduction, maintenance and new investment planning, and financial risk management.

- **Data fit for insurance.** The format, accessibility, and transparency of the risk information provided would ensure it is fit for supporting insurance product development, effective risk pricing, and attractive risk transfer coverage. This could easily highlight key drivers of premium (regions, assets, peril types) to optimize insurance product design against risk appetite, or coverage against premium.
- **Financial risk management.** Financial analysis to provide a quick comparison of financial risk management options with pre-arranged integration in a self-insurance fund and commercial insurance providers could allow adjustments to the portfolio risk management strategy with the click of a button. This includes decisions on how much risk to retain and how much to transfer. Increasingly, digitized insurance and integration with risk carriers could enable near-real-time risk transfer, in incremental parts of the whole portfolio or individual assets, with smart contracts for automatic settlement of insurance payouts. A self-insurance fund directly linked to a regional platform could automatically transfer any excess risk to an internationally diversified portfolio, which would automatically acquire reinsurance if needed on a real-time basis.
- **Damage assessment and recording.** Data from satellites or drones could provide quick damage estimates following a shock and feed directly into the asset registry, complemented with on-the-ground data for granular yet still rapid damage data. The results could inform rehabilitation and reconstruction, efficiently allocating limited post-disaster funds to the most critical and high-impact assets and targeting future maintenance.
- **Compensation and claims handling.** Digital damage records, attached to the asset information, could submit claims to the self-insurance fund or to commercial insurance providers. This would allow tracking of payouts and expenditures all the way to the agency or contractor reconstructing an asset, and would record information on the restored asset in the database while increasing transparency in public spending.

A growing number of countries, including Indonesia, the Philippines, and Vietnam, are upgrading their public asset management database systems. Technology, together with strong institutional leadership and governance frameworks, can help these countries upgrade and transform the way they collect and manage public asset data so that data feed into risk management policies and reduce the government's fiscal exposure.



3.4

Revisiting the Support of Development Partners to Financial Resilience

The support of development partners continues to play a critical role in helping developing countries design and implement financial protection strategies.

Development partners' support has been invaluable in improving the basis of disaster risk information in developing countries through technical assistance and investment in public goods such as collection of exposure data and development of catastrophe risk models. It has been equally critical in testing new approaches and experimenting with financial instruments where no market existed previously. Grant financing is also important in providing vulnerable countries with extensive and highly technical implementation support for building new and untested risk management systems. Last, development partners' assistance is critical for capacity building in developing countries. Through such assistance, development partners have facilitated the adoption of financial protection instruments such as disaster risk insurance. The Program Alliance of the InsuResilience Global Partnership is one forum established to bring together development partners and implementing programs and scale up coordinated efforts to strengthen developing countries' financial capacity to cope with disasters (**Box 11**).

BOX 11

THE INSUREILIENCE GLOBAL PARTNERSHIP

The InsuResilience Global Partnership promotes and enables the adoption of disaster risk financing and insurance solutions by poor and vulnerable countries. The Partnership was officially launched in 2017 at the 23rd annual Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change (COP23) as a collaborative initiative of a number of G20 and V20 countries. A diverse group of stakeholders engaged in the field of disaster and climate resilience— multilateral institutions, the private sector, civil society organizations, and academia.

The Partnership aims to promote and enable a substantial scale-up in the use of climate and disaster risk finance and insurance solutions by developing countries. It ultimately contributes to strengthened resilience by enabling faster, more reliable, and cost-effective responses to disasters. In its vision and activities, the Partnership contributes to the implementation of the post-2015 frameworks that widely recognize the importance of strengthening wider resilience.

...

The Program Alliance, the Partnership's alliance of implementing programs, brings together organizations working across a broad spectrum of solutions to address the different resilience needs of vulnerable countries, taking into account different country risk profiles and corresponding gaps in financial protection mechanisms. As of April 2019, the Partnership supports 25 programs, including GRiF, in 78 countries.

The Partnership also facilitates collaboration between the public and private sector. For example, the InsuResilience Solutions Fund was launched in 2017 by the German Development Bank (KfW) on behalf of the Federal Ministry of Economic Cooperation and Development (BMZ) to catalyze joint initiatives by national public entities and the private insurance sector. The InsuResilience Investment Fund has also been set up as a PPP by KfW on behalf of BMZ, combining private debt and private equity investments, to connect the value chain and provide technical assistance and funding for the development of markets in climate insurance.

Source: InsuResilience Global Partnership 2018.

The newly established GRiF pilots and scales up pre-arranged risk financing instruments, including insurance, to boost financial resilience to shocks and promote the role of countries as effective risk managers (World Bank 2018c).

GRiF is a new mechanism established within the World Bank with initial support by Germany and the United Kingdom. It will not offer any risk financing instruments directly, but rather provide grant funding for country-owned systems and instruments in line with the vision and principles of the InsuResilience Global Partnership; the aim is to promote sustainable financial protection and investment in disaster risk reduction measures, including high-quality and resilient infrastructure. GRiF seeks to strengthen countries' financial resilience to disasters by supporting more timely and reliable disaster response through pre-arranged financing as well as recovery systems linked to it. GRiF represents a significant step beyond existing support programs focused on technical work; it focuses instead on providing the financing needed to reduce the barriers to scale-up of innovative mechanisms and instruments under the guiding principles and appraisal criteria (**box 12**). The facility will specifically invest in taking many of the forward-looking trends discussed in this paper to scale.

BOX 12

KEY GUIDING PRINCIPLES OF GRIF SUPPORT

GRiF has established a set of guiding principles for its grant financing to help developing countries maximize the impacts of risk financing instruments and mechanisms. The principles include both strategic allocation and technical appraisal that can be applied to any relevant financial supports.

Following are examples of these principles.



Country ownership and readiness. The country should demonstrate readiness to work on disaster risk financing and insurance solutions—for example, an existing or requested disaster risk financing strategy, an adequate legal and regulatory framework, and/or political commitment.



High-quality, open, and accessible data and risk modeling. The data and model underpinning an instrument must be open, assessed against minimum standards, and fully transparent to avoid information asymmetries between risk carriers, clients, and development partners.



Participatory process. The process to design, implement, and evaluate the instrument and systems should strive for the inclusive, meaningful participation of all relevant stakeholders who can inform and champion these solutions, especially communities, civil society, and the private sector.



Value for money and suitability of the product. Products should be priced based on sound actuarial principles that adequately account for risks and operating expenses and should provide value for money relative to alternatives.



Improvements in preparedness and resilience. GRiF should create incentives for disaster prevention, preparedness, and resilient reconstruction. Even in countries with a strong disaster preparedness system in place, the use of grants as subsidies should lead to clear improvements to the existing system. All projects supported by the GRiF should demonstrate clear additionality.



Competitive procurement process and non-preferential treatment. Providers of subsidized financial instruments should be selected following a competitive, robust, and transparent procurement process with the aim of leveraging the private sector in a way that provides most value for money.



4.

New Frontiers in Building Financial Resilience

Disaster risk finance policies and instruments are increasingly used by ministries of finance to improve countries' financial resilience to disaster shocks.

The experience and good practices of G20 countries and beyond provide an opportunity for looking ahead at future risk financing developments that may take place as countries seek to enhance overall macro-fiscal resilience to shocks.

1. *Increasing integration of financial resilience to shocks as a core component of macro-fiscal frameworks.* Given increasing disaster risks, governments are likely to further integrate natural disasters, and the financial impact of other physical shocks, into their wider fiscal planning and risk management framework. This may lead to further integration of these issues in key planning tools such as macro-models, fiscal plans, fiscal risk statements, debt sustainability analyses, public expenditure reviews, public investment diagnostics, and poverty diagnostics.

- 2. *Building financial resilience through integrated financial solutions***
Various financial instruments are offered by multiple providers, such as contingent credit by (development) banks and risk transfer instruments by catastrophe risk pools. Consolidated financial solutions could be offered as a financial package to allow governments to be protected against shocks of different frequency and severity, where the structuring of the financial packages is based on the cost-efficient combination of the financial products.
- 3. *Expanding financial protection strategies to cover other crises and complex risks.*** Governments, international organizations, and development partners are starting to apply disaster risk finance policies and tools to other crisis risks. In 2017, with intermediation by the World Bank, the Pandemic Emergency Financing Facility (PEF) structured for the first time a market-based financial product for better pandemic preparedness. This can be compared to the first catastrophe bonds in the 1990s. There is growing interest in exploring financing solutions for new crisis risks, both to more efficiently retain risk and to transfer risk. Moreover, just as financial mechanisms have evolved for natural disaster risk, the financing of other risks will likely mature to be more efficient and to utilize more complex financial structures, triggers, and targeted contingency plans. This development may lead to financial protection strategies against risks from health shocks and pandemics, cyber risks, and risks of conflict, famine, and displacement and migration. Development of financing for such risks will entail experimentation and innovation in data collection, risk modeling, structuring of financial mechanisms and market-based instruments, trigger testing, feedback loops, and disbursement channels.
- 4. *Growing financial protection policies and instruments against interconnected risks.*** Multiple risks may interact in unexpected ways and create compound risks to governments (WEF 2018). Finance officials' growing awareness and strengthened management of multiple sources of real-world risks may lead to development of government-wide financial risk management tools or institutions. Several countries have established dedicated fiscal risk management units, which also account for traditional sources of fiscal risk. Improved financial management of complex risk, combined with the strengthened leadership of ministries of finance, may lead to the further development of comprehensive risk financing policies, strategies, and plans. It may lead as well to institutional changes in designating risk management functions, to operational and technical reforms for implementing these plans, and to portfolio approaches to risk financing in countries.

5. *Shifting financial protection of infrastructure from assets to critical services.* Strengthening the resilience of critical infrastructure is a key step for countries to better manage the short-term budgetary and long-term development costs. Ministries of finance increasingly recognize that the continuity of critical public services following disasters is key to economic, fiscal and social resilience. This is one of the components of quality infrastructure investment discussed through the G20 process. Optimal investment in financial and physical resilience of infrastructure relies on the systemic nature of infrastructure and individual assets' roles for the network. This may require a shift from conventional risk management of individual assets and their potential damages to comprehensive financial risk management for maintaining a level of critical public service delivery and network over the life-cycle of infrastructure even during and after disasters.

All successful reforms start by taking basic first steps and enhancing fundamental systems and institutions.

Developing disaster risk finance policies and instruments is an important step toward improving macro-fiscal policy frameworks and public financial management. These policies and instruments include many of the tools and frameworks discussed in this paper, such as risk assessment tools, public asset registries, and cash delivery systems. But even advanced risk financing reforms start with and depend on getting the basic building blocks in place. Ministries of finance can begin with basic reforms while testing and adding more advanced instruments and mechanisms over time.



5.

Reinforcing Roles of Governments, Development Partners, and the Private Sector

Financial resilience requires leadership by ministries of finance in coordination with other public agencies, development partners, and private sector actors.

Ministries of finance can collaborate with line ministries and disaster risk management agencies to ensure that the overall fiscal risks related to natural disasters are consolidated and properly managed. Ministries of finance are responsible for integrating contingent liabilities, including disaster risks, into wider macro-fiscal frameworks. This requires managing the consolidated fiscal risks related to natural disasters and coordinating with line ministries and disaster risk management agencies to develop their own financial protection strategies, such as standard contingent liability approval frameworks. Carrying out this responsibility may require extra capacity in ministries of finance, which could potentially be added by establishing a specialized unit or inter-ministerial risk board to undertake the central fiscal risk management role.

Line ministries and disaster risk management agencies are responsible for developing and implementing disaster risk management policies and devising disaster prevention strategies, including enhancing regulations. While ministries of finance often play the leading role in the disaster risk finance agenda, coordination with other agencies and stakeholders is crucial to ensure effective planning and implementation of recovery and reconstruction activities. Disaster risk assessment, mitigation, and preparation should be conducted, as appropriate, by line ministries and disaster risk management agencies throughout the government. Given growing investments in infrastructure in developing countries, close collaboration between line ministries and ministries of finance could be further explored to develop resilient infrastructure and help ensure the delivery of lifeline services through rapid disaster recovery and reconstruction of critical infrastructure.

Development partners play a critical role in helping developing countries devise and implement financial protection strategies. Getting countries to devise pre-planned approaches, and so reduce reliance on ad hoc humanitarian aid and budget reallocation, may require additional incentives in some cases. Development partners could provide countries with incentives to implement a comprehensive financial package for early action on disaster shocks and to scale up risk financing mechanisms for other crises. The newly established GRiF has set out guiding principles to maximize the impact of disaster risk finance and insurance solutions, which can be applied to any public interventions to build financial resilience and help the governments ensure value for money in risk financing instruments, including insurance and other private sector solutions.

International financial institutions (IFIs) can continue to provide advisory, financial, and convening services to boost financial resilience. To support countries in developing and implementing financial protection strategies, IFIs provide technical assistance and, where appropriate, promote efficient and practical use of innovative approaches and tools such as Earth Observation Data and digital payments. IFIs also provide countries with financial and technical support to develop regional sovereign catastrophe risk insurance pools or platforms. IFIs can also provide dedicated financial services; examples include the contingent lines of credit (Catastrophe Deferred Drawdown Option, or CAT DDO) provided by the World Bank, and various market-based catastrophe risk transactions such as issuance of cat bonds. New financial solutions could be developed by IFIs to enable countries to further explore new frontiers of financial resilience such as the guarantee of a level of critical public service delivery, including rapid reinstatement of infrastructure at a required level when faced with disasters. IFIs are working together on the financial resilience agenda through joint studies and programs, further integrating disaster risk assessment into macro-economic analysis.

The private sector is an important source of finance and innovation in building resilience. Specialized risk carriers from financial markets can take risk from the government. The insurance, finance, and technology industries can also provide services to increase the efficiency, transparency, and discipline of fund mobilization—for example, by developing and deploying innovative disaster risk assessment and financing instruments. Beyond risk transfer, technology can enhance payment systems to enable efficient disbursement of funds to beneficiaries. Design and pricing for these services need to offer value for money, and development partners can help facilitate private sector contributions.

Coordinated financial protection across a government requires strong commitment by and collaboration among multiple stakeholders.

The experience of many countries seeking to establish macro-prudential committees after a financial crisis suggests that a dedicated national committee—comprised of ministry of finance, line ministries, central bank, state governments, and other stakeholders—could enable a key reform to strategically manage disaster-related financial risks across the government.

“Financial resilience requires leadership by ministries of finance in coordination with other public agencies, development partners, and private sector actors.”



6.

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