Disaster Risk Financing

A GLOBAL SURVEY OF PRACTICES AND CHALLENGES

OECD

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Please cite this publication as:
OECD (2015), *Disaster Risk Financing: A global survey of practices and challenges*, OECD Publishing, Paris.
http://dx.doi.org/10.1787/9789264234246-en

ISBN 978-92-64-23423-9 (print)
ISBN 978-92-64-23424-6 (PDF)

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Foreword

Disasters present a broad range of human, social, financial, economic and environmental impacts, with potentially long-lasting, multi-generational effects. The financial management of these impacts is a key challenge for individuals and governments in developed and developing countries. G20 Finance Ministers and Central Bank Governors and Asia-Pacific Economic Co-operation (APEC) Finance Ministers have recognised the importance and priority of disaster risk management (DRM) strategies and, in particular, disaster risk assessment and risk financing.

The Organisation for Economic Co-operation and Development (OECD) has supported the development of strategies for the financial management of natural and man-made disaster risks, under the guidance of the High-Level Advisory Board of the OECD International Network on Financial Management of Large-scale Catastrophes and the Insurance and Private Pensions Committee. This work has included the elaboration of an OECD Recommendation on Good Practices for Mitigating and Financing Catastrophic Risks *as well as the organisation of a number of global events aimed at sharing experience on approaches to disaster risk financing (DRF) and identifying key challenges where international co-operation would be beneficial. In co-operation with other international organisations, the OECD has also responded to the G20 and APEC through the development of the* G20/OECD Methodological Framework for Disaster Risk Assessment and Risk Financing *and a report on* Disaster Risk Financing in APEC Economies: Practices and Challenges.

Disaster Risk Financing: A Global Survey of Practices and Challenges *builds on this work by providing an overview of the disaster risk assessment and financing practices of a broad range of economies relative to the guidance elaborated in* G20/OECD Framework for Disaster Risk Assessment and Risk Financing. *This report is based on input provided by OECD and APEC member economies in response to an APEC-OECD survey questionnaire as well as research undertaken by the OECD and other international organisations. The report provides an overview of the approaches that economies facing various levels of disaster risk and economic development have taken to managing the financial impacts of natural and man-made catastrophes.*

Disaster Risk Financing: A Global Survey of Practices and Challenges *benefited from particular contributions by Prof Alberto Monti, member of the OECD High-Level Advisory Board, and Ms Rachel Anne Carter, OECD consultant. The report also benefited from the support and input of the OECD's High-Level Advisory Board on the Financial Management of Large-Scale Catastrophes, the Insurance and Private Pensions Committee, the Asian Development Bank, World Bank and the United Nations Office for Disaster Reduction (UNISDR).*

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Abbreviations and acronyms

27F	Earthquake and ensuing tsunami that struck Chile on 27 February 2010
AACH	Chilean insurance association (*Asociación de Aseguradores de Chile AG*)
AAL	Annual Average Loss
ADB	Asian Development Bank
AFAD	Prime Ministry Disaster and Emergency Management Authority (Turkey)
AGDRP	Australian Government Disaster Recovery Payment
AI	Authorized Institutions (Hong Kong, China)
AIC	Agriculture Insurance Corporation of India Ltd.
APEC	Asia-Pacific Economic Co-operation
APRA	Australian Prudential Regulatory Authority
ARC	Africa Risk Capacity
ARV	Africa RiskView
ASEAN	Association of Southeast Asian Nations
ASF	Portuguese insurance and pensions supervisory authority (*Autoridade de Supervisão de Seguros e Fundos de Pensões*)
AusAid	Australian Agency for International Development
BCP	Business Continuity Plan or Business Continuity Planning
BBK	Federal Office of Civil Protection and Disaster Assistance (*Bundesamt für Bevölkerungsschutz und Katastrophenhilfe*) (Germany)
BNHCRC	Bushfire and Natural Hazards Cooperative Research Centre (Australia)
BNPB	Indonesian disaster management agency (*Badan Nasional Penanggulangan Bencana*)
CASEN	Chilean national socioeconomic charateristics survey (*Caracterización Socioeconómica Nacional*)
CAT-DDO	Catastrophe Deferred Drawdown Option
CCR	French public reinsurer (*Caisse centrale de réassurance*)
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CCS	Spanish public insurer (*Consorcio de Compensación de Seguros*)
CDD	Canadian Disaster Database
CEA	California Earthquake Authority
CENAPRED	Mexican disaster prevention centre (*Centro Nacional de Prevención de Desastres*)
CENEPRED	Peruvian disaster assessment, prevention and reduction centre (*Centro Nacional de Estimación, Prevención y Reducción de Riesgos de Desastres*)
CNSF	Mexican national insurance and bond commission (*Comisión Nacional de Seguros y Fianzas*)
CODISE	Italian continuity of service working group (*Continuità di Servizio*)
CONHAZ	Costs of Natural Hazards (European Union research project)

CONSOB	Italian securities and exchange commission (*Commissione Nazionale per le Società e la Borsa*)
CLIMBS	Cooperative Life Insurance and Mutual Benefit Services (Philippines)
CPIC	Citizens Property Insurance Corporation (Florida, United States)
CRAICP	Climate Risk Adaption and Insurance in the Caribbean Programme
CRED	Centre for Research on the Epidemiology of Disasters (Université catholique de Louvain, Belgium)
DaLA	Damage and Loss Assessment (methodology)
DFAA	Disaster Financial Assistance Arrangements (Canada)
DFID	Department for International Development (United Kingdom)
DRA	Disaster Recovery Allowance (Australia)
DRF	Disaster Risk Financing
DRM	Disaster Risk Management
DRP	Disaster Recovery Plan
EENIP	Extreme El Niño Insurance Product (Peru)
EM-DAT	Emergency Events Database (CRED)
ENSO	El Niño Southern Oscillation
EPIC	Earthquake Protection Insurance Corporation of the Philippines
EQC	Earthquake Commission (New Zealand)
EU	European Union
Europa Re	Europa Reinsurance Facility Ltd
FAO	Food and Agriculture Organisation
FEMA	Federal Emergency Management Agency (United States)
FONDEN	Mexican natural disasters fund (*Fondo de Desastres Naturales*)
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEM	Global Earthquake Model
GFDRR	Global Facility for Disaster Risk Reduction
GIS	Geographic Information System
GIZ	German technical co-operation agency (*Gesellschaft für Internationale Zusammenarbeit*)
GLIDE	Global Disaster Identifier Number
GPS	Global Positioning System
GSIS	Government Service Insurance System (Philippines)
GST	Goods and Services Tax
HARITA	Horn of Africa Risk Transfer for Adaptation
HKEx	Hong Kong Exchange
HKMA	Hong Kong Monetary Authority
IBLIP	Index Based Livestock Insurance Project (Mongolia)
ICI	Icelandic Catastrophe Insurance
ICRM	Institute of Catastrophe Risk Management (Nanyang Technological University, Singapore)
IFAD	International Fund for Agriculture Development
IGME	Spanish geological and mining institute (*Instituto Geológico y Minero de España*)
InaSAFE	Indonesia Scenario Assessment for Emergencies
IRDA	Insurance Regulatory and Development Authority (India)
IWE	Industry-wide Exercise

JER	Japan Earthquake Reinsurance Co., Ltd
KNF	Polish financial supervisory authority (*Komisja Nadzoru Finansowego*)
LAPP	Local Authority Protection Programme disaster fund (New Zealand)
LIIP	Livestock Insurance Indemnity Pool (Mongolia)
Local DRRM Fund	Local Disaster Risk Reduction and Management Fund (Philippines)
MAS	Monetary Authority of Singapore
MCII	Munich Climate Insurance Initiative
MINVU	Chilean housing and urbanism ministry (*Ministerio de Vivienda y Urbanismo*)
NAIS	National Agricultural Insurance Scheme (India)
National DRRM Fund	National Disaster Risk Reduction and Management Fund (Philippines)
NCIF	National Catastrophe Insurance Fund (Thailand)
NDMC	National Disaster Management Centre (South Africa)
NDRRA	Natural Disaster Relief and Recovery Arrangements (Australia)
NDRRMC	National Disaster Risk Reduction and Management Council (Philippines)
NEMA	National Emergency Management Agency (Korea)
NERAG	National Emergency Risk Assessment Guidelines (Australia)
NFIP	National Flood Insurance Program (United States)
NHT	Netherlands terrorism insurance facility (*Nederlandse Herverzekeringsmaatschappij voor Terrorismeschaden*)
NOAA	National Oceanic and Atmospheric Administration (United States)
OECD	Organisation for Economic Co-operation and Development
OIC	Office of Insurance Commission (Thailand)
ONRN	French national observatory for natural risks (*Observatoire national des risques naturels*)
PCRAFI	Pacific Catastrophe Risk Assessment and Financing Initiative
PDMC	Provincial Disaster Management Centres (South Africa)
PDRFI	Pacific Disaster Risk Financing and Insurance
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PIE	Pacific Island Economies
PML	Probable Maximum Loss
RBNZ	Reserve Bank of New Zealand
REDAS	Rapid Earthquake Damage Assessment System (Philippines)
SAFRR	Science Application for Risk Reduction (United States)
SBIF	Chilean bank and financial institution superintendent (*Superintendencia de Bancos e Instituciones Financieras*)
SDC	Swiss Agency for Development and Co-operation
SDRF	State Disaster Response Fund (India)
SECO	Swiss Secretariat for Economic Affairs
SEEC CRIF	Southeast Europe and Caucasus Catastrophe Risk Insurance Facility
SIDA	Swedish International Development Co-operation Agency
SINAPROC	Mexican national civil protection system (*Sistema Nacional de Protección Civil*)
SME	Small and Medium-sized Enterprises
SMN	Mexican national meteorological service (*Servicio Meteorológico Nacional*)
SST	Sea Surface Temperatures

SVS	Chilean insurance and securities superintendent (*Superintendencia de Valores y Seguros*)
TAIP	Turkish Agriculture Insurance Pool
TCIP	Turkish Catastrophe Insurance Pool
TELES	Earthquake Loss Estimation System (Chinese Taipei)
TREIF	Residential Earthquake Insurance Fund (Chinese Taipei)
TREIP	Residential Earthquake Insurance Program (Chinese Taipei)
UNAM	Mexican national autonomous university (*Universidad Nacional Autónoma de México*)
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNESPA	Spanish insurance and reinsurance association (*Unión Española de Entidades Aseguradoras y Reaseguradoras)*
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Reduction
USGS	United States Geological Survey
WBCIS	Weather Based Crop Insurance Schemes (India)
WFP	World Food Programme
WRSI	Water Requirement Satisfaction Index
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research
WTS	Dutch calamities compensation act (*Wet tegemoetkoming schade bij rampen*)

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Executive summary

Recent years have seen a range of natural and man-made catastrophes affecting a large number of both developed and developing economies around the globe. These catastrophes have generated a broad range of direct and indirect impacts on all parts of society, including loss of life and damage to public and private property and infrastructure as well as fiscal impacts arising from recovery and reconstruction expenditures and decreased tax revenues. In many economies, particularly low income economies, annual disaster losses account for a significant share of Gross Domestic Product (GDP).

Restoring livelihoods and rebuilding economic and social infrastructure requires substantial financial resources, necessitating the development financial strategies to manage disaster risks. *Disaster Risk Financing: A Global Survey of Practices and Challenges* provides an overview of the disaster risk assessment and financing practices of a broad range of economies relative to the guidance elaborated in *G20/OECD Framework for Disaster Risk Assessment and Risk Financing*. Based on survey responses provided by 29 economies, as well as research undertaken by the OECD and other international organisations, this report provides a global overview of the approaches that economies facing various levels of disaster risk and economic development have taken to managing the financial impacts of natural and man-made catastrophes.

This report reviews the main components of a comprehensive strategy for the financial management of catastrophe risks. *Disaster risk assessment and risk modelling* provide the necessary information on hazards, exposures and vulnerabilities to disaster risks required for the development of disaster risk financing strategies. The elaboration of risk maps and collection of the necessary data on hazards, exposures, vulnerabilities and losses is well advanced in many economies - often with the support of dedicated research institutions and the private sector, particularly the insurance sector.

Supporting *comprehensive and affordable insurance coverage* of disaster risks across economies with varying levels of insurance market development remains a challenge in many economies. A number of economies have established *various forms of public-private co-operation* to support the coverage of disaster risks involving varying levels of government intervention to support the disaster insurance market. In some economies, the focus of government intervention has been on risk mitigation measures that support the insurability of high-frequency or high-impact events by the private sector. In other economies, tax incentives, subsidies and/or various form of compulsion have been used as means to ensure adequate coverage. Building *public awareness of disaster risks* and the need to secure financial protection against those risks is a key priority for many economies and is critical for providing the level of demand for insurance that is necessary for the economic viability of insurance coverage for many types of risks.

In many economies, insurance or reinsurance is provided directly by governments to support coverage of specific catastrophe risks or a broad range of disaster risks. In developing countries with limited insurance penetration (or a lack of insurance culture), a number of innovative initiatives have been established to provide *targeted coverage to vulnerable segments of society* such as agricultural producers or small entrepreneurs.

Where insurance coverage for disaster risks is limited, *financial assistance and compensation* to individuals, business and/or local levels of government affected by large-scale catastrophes is often provided by governments as a means to support recovery and restore economic activity. Securing a *fair, timely and efficient disbursement* of financial assistance and compensation can provide the necessary financing to support economic recovery.

Catastrophes can also result in significant *fiscal impacts*, necessitating the use of various risk financing and transfer tools as a means to manage those impacts. Governments are using a broad range of tools to manage their own exposures to disaster risks, including reserve funds, contingent credit arrangements and insurance of public assets. A few economies are making use of risk transfer mechanisms, such as catastrophe bonds and insurance for the management of fiscal risks.

Surveyed economies

The report benefitted from survey responses from 29 economies, including both OECD and APEC member economies as well as other economies: Australia; Belgium; Brunei Darussalam; Canada; Chile; China; Czech Republic; Germany; Hong Kong, China; Hungary; Iceland; Indonesia; Japan; Korea; Malaysia; Mexico; New Zealand; Peru; The Philippines; Poland; Portugal; Russian Federation; Singapore; South Africa; Switzerland; Chinese Taipei; Thailand; the United States; and Viet Nam.

Key findings

A wide range of approaches to the financial management of disaster risks have been implemented across economies, reflecting differing levels of disaster risk and economic development. However, a number of common challenges were identified across economies which suggests the need for further investment in developing comprehensive approaches to disaster risk financing.

- *Significant impediments remain to collecting and analysing the data on hazards and exposures that is necessary for the development of disaster risk financing strategies*
  - The technical and institutional capacity for risk assessment and modelling in many economies needs to be strengthened in order to provide a comprehensive, co-ordinated view of disaster risk across levels of government and segments of society.
  - Improving the quality, consistency and availability of data on hazards, exposures, vulnerabilities and losses is critical for the functioning of disaster insurance markets. Regional and international harmonisation of definitions and methodologies could support further international co-operation on the financial management of disaster risk and improve access to international (re)insurance markets.
- *Comprehensive coverage of disaster risks remains a challenge in many economies*
  - Enhancing the financial capacity of insurance companies to cover disaster losses requires the establishment of a supportive legislative and regulatory framework.

- Promoting awareness of the financial impacts of disasters and the need for insurance protection and investing in disaster risk prevention and risk reduction can make important contributions to the insurability of disaster risks.

- *Risk transfer tools to manage the fiscal impacts of disasters have been employed in only a few economies*
  - The complexity of financial instruments, such as catastrophe bonds and parametric insurance products, as well as constraints on access to international insurance and capital markets, have limited the broad use of risk transfer instruments by governments.
  - Research into the potential benefits of international co-operation on the management of fiscal exposures, including the use of regional risk pooling, is required to provide the necessary analysis of the effectiveness of different approaches.

The economies that provided input into this report identified a number of priorities for addressing the challenges related to the development of effective strategies for the financial management of catastrophe risks, including the need to:

- Strengthen risk and financial vulnerability assessment in order to better understand the impact of disasters (including interlinkages and interdependencies across economies), better target financial assistance and improve the cost-effectiveness of recovery assistance;
- Promote awareness of the need for financial preparedness to manage disaster risks based on a clear understanding of the allocation of responsibility for disaster costs;
- Encourage the development of disaster risk financing tools and markets, alongside enhanced prevention of disaster risks; and
- Enhance technical and institutional capacities and co-ordination among domestic stakeholders involved in the management of disaster risks.

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Chapter 1

Financial management of disaster risks

This chapter provides an introduction to the financial implications of catastrophes and guidance available to support economies in their efforts to manage those financial risks, including the OECD Recommendation on Good Practices for Mitigating and Financing Catastrophic Risks and the G20/OECD Methodological Framework for Disaster Risk Assessment and Risk Financing. It also outlines the significant responsibilities of Finance Ministries in the financial management of disaster risks.

Recent years have witnessed a concentration of disaster events causing major human, social, economic and financial impacts. Seven of the ten most costly disasters since 1980 have occurred in the last decade including: the Great East Japan Earthquake in 2011 which caused USD (US dollar) 210 billion in overall losses and close to 16 000 fatalities; Hurricane Katrina in 2005 which caused USD 125 billion in losses and over 1 300 fatalities in the United States; and the 2008 Sichuan earthquake in the People's Republic of China which caused USD 85 billion in damages and an estimated 84 000 fatalities (Munich Re, 2015).

OECD and APEC economies are particularly vulnerable to the impacts of natural disasters. In 2014, six of the ten costliest disaster events of the year, measured by overall losses, occurred in OECD and/or APEC economies. At the top of the list were the severe winter storms that affected Japan in February, causing USD 5.9 billion in overall losses. Severe winter conditions also led to USD 2.5 billion in damages in the United States and Canada in early 2014 while severe storms and hail imposed significant losses in the United States in May and France, Belgium, and Germany in June. The Ludian earthquake in China in August led to USD 5 billion in losses and over 600 fatalities while Typhoon Rammasun caused USD 4.5 billion in overall losses and 195 fatalities across China, the Philippines and Vietnam (Munich Re, 2014). In March 2015, the small island economy of Vanuatu was devastated by a category 5 tropical cyclone that impacted half of the population, while in April 2015, Nepal suffered a devastating earthquake that caused damages equivalent to approximately 25% of GDP.

In view of the high economic costs incurred by many economies due to disasters in the recent past, as well as significant and growing risk exposures going forward (given the expected impacts of climate change as well as the continued accumulation of assets in disaster-prone regions), ***strengthening financial resilience to disasters has become a policy priority in many economies*** – across emerging and less developed markets as well as developed economies. The OECD has played a leadership role in supporting the development of strategies for the financial management of natural and man-made disaster risks, under the guidance of the High-Level Advisory Board of the OECD International Network on Financial Management of Large-scale Catastrophes and the Insurance and Private Pensions Committee. This work has included the elaboration of an *OECD Recommendation on Good Practices for Mitigating and Financing Catastrophic Risks*[1] as well as a number of global events aimed at sharing experience on approaches to disaster risk financing (DRF) and identifying key challenges where international co-operation would be beneficial.

G20/OECD Methodological Framework for Risk Assessment and Risk Financing

In 2012, G20 Finance Ministers and Central Bank Governors, along with G20 Leaders, recognised the importance and priority of disaster risk management (DRM) strategies and the role of financial strategies in supporting effective DRM. The G20 mandated the OECD to develop a voluntary framework that could strengthen disaster risk assessment and risk financing, considered to be two key interlinked components of DRM. A *G20/OECD*

Methodological Framework for Disaster Risk Assessment and Risk Financing (the "G20/OECD Methodological Framework" or the "Framework")[2] was developed by the OECD in response and was endorsed by the G20 in November 2012.

The G20/OECD Methodological Framework highlights the central role played by financial policy makers in DRM. Confronted with disasters that can present fiscal challenges in developed and emerging economies alike and that can impair economic activity, Finance ministries can take a lead role in the design and implementation of DRF strategies. These strategies can help to ensure that populations, businesses, and governments have the resources necessary to manage the adverse consequences of disasters, thereby ensuring financial and economic resilience (see Box 1.1).

Box 1.1. **Key responsibilities of Finance Ministries in DRM**

Financial policy makers play a central role in DRM given their responsibilities for economic, financial, fiscal and budget policy making, planning of public investment, and co-ordination of public expenditures. They play a pivotal role in DRM by:

- Ensuring that **financial vulnerabilities within the economy are addressed** through adequate and efficient compensation mechanisms, whether public or private.
- Ensuring **proper fiscal management** of risks by anticipating potential budgetary impacts and planning ahead to ensure adequate financial capacity and rapid release of funds.
- Establishing **clear rules regarding post-disaster financial compensation** to enable rapid compensation, demonstrating solidarity and ensuring sound incentives.
- Ensuring the **soundness and resilience of the financial sector** with respect to disaster risks, including through proper regulation, business continuity planning, and stress testing.
- Ensuring the **optimal allocation of resources for disaster risk management**, including assessment of the cost-effectiveness of major public investments in disaster risk reduction.

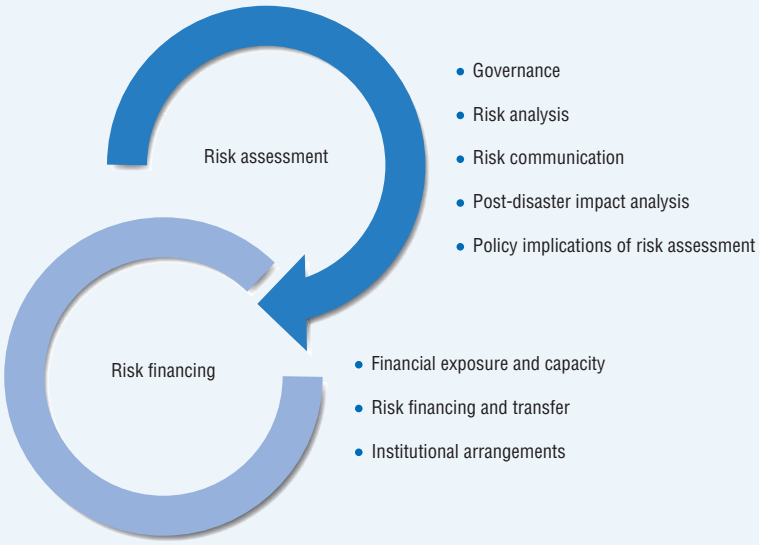
Finance Ministers thus have a key role in ensuring **financial resilience**, a critical component of effective DRM at all levels of government and society.

Source: G20/OECD Methodological Framework for Disaster Risk Assessment and Risk Financing, *www.oecd.org/daf/fin/insurance/OECD_APEC_DisasterRiskFinancing.pdf*.

The Framework provides a step-by-step guide for conducting comprehensive risk assessments and linking risk assessment to the development of effective financial strategies (see Box 1.2). *Risk assessment* enables a well-developed understanding of disaster risks and their underlying physical and societal drivers and is thus instrumental for DRM strategies and financial recovery strategies in particular. Financial strategies and especially *risk financing strategies* help to ensure prompt recovery and reconstruction.

While important in all economies, DRF strategies become particularly critical when an economy's disaster risks are substantial and insurance markets are absent or unable to cover these risks effectively, for instance where there is low insurance penetration or where insurance markets are underdeveloped or weakly capitalised, leaving the government with potentially large financial exposures. In these circumstances, governments may not only be expected to engage in emergency response activities, but also be called upon to cover a large proportion of damages and losses. Thus, in addition to causing major social, economic and environmental impacts, disasters can, in some economies, impose a significant drain on governmental resources.

Box 1.2. **G20/OECD Methodological framework**



Risk assessment	*Governance*	Establish an all-hazards approach, agreed procedures, transparency and accountability and structured interaction with stakeholders.
	Risk analysis	Identify hazards and threats and assess their probabilities and impacts based on the vulnerability of populations and assets to damage.
	Risk communication	Communicate results of risk analysis to policy makers and the public to enable decision-making and enhance risk awareness.
	Post-disaster impact analysis	Evaluate and quantify the impacts of disasters including financial, and update risk assessment information.
	Policy implications of risk assessment	Leverage risk assessment for the full range of disaster risk management actions, especially financial strategies.
Risk financing	*Risk exposure and risk-bearing capacity*	Identify risk exposures within the economy and risk-bearing capacities in order to identify financial vulnerabilities and the need for financial tools.
	Risk financing and risk transfer	Evaluate the availability, adequacy and efficiency of risk financing / risk transfer tools and consider alternative tools.
	Institutional arrangements	Design appropriate institutional arrangements, where government intervention is deemed to be necessary.

Source: Disaster Risk Financing in APEC Economies: Practices and Challenges.

Financial strategies can complement and reinforce broader disaster risk reduction initiatives,[3] as well as benefit from them, including investment in prevention which can contribute significantly to the reduction of financial exposure to disasters. In fact, the G20/OECD Methodological Framework emphasises the strong interconnections between disaster risk assessment, risk reduction and financial management, the key building blocks for dynamic and continually evolving DRM strategies.

Disaster Risk Financing in APEC Economies: Practices and Challenges

In support of the G20 initiative, APEC[4] Finance Ministers launched, in August 2012, an initiative seeking to strengthen financial resilience against disasters. In a Joint Ministerial Statement, they affirmed that "integrated disaster risk financing policies are part of overall

disaster response preparedness" and indicated that "in developing these policies, attention should be given to advance planning and preparation by financial authorities, including the maintenance of effective and resilient payment systems and, where appropriate, the introduction or expansion of risk sharing and risk transfer market products." APEC Finance Ministers called for the exchange of knowledge and practices on financial strategies among APEC member economies, in collaboration with international organisations, with a view to identifying relevant innovations and good practices. This initiative resulted in the survey report, *Disaster Risk Financing in APEC Economies: Practices and Challenges*, prepared by the OECD with input from APEC economies and presented to APEC Finance Ministers in 2013.

Disaster Risk Financing: A Global Survey of Practices and Challenges

G20 and APEC Finance Ministers have since called for further work in this area: G20 Finance Ministers asked the OECD, World Bank, and other international organisations to leverage the G20/OECD Methodological Framework to address remaining challenges, while APEC Finance Ministers called for a further sharing of experiences to explore effective approaches that could facilitate the implementation of key priorities identified in the survey report.

This report builds on the report prepared for APEC, through the addition of further examples and case studies drawn from other regions of the world, including from a large number of OECD economies. It aims to present a wide range of examples on approaches to DRF with a view to promoting the exchange of knowledge and practices, illustrating the progress being made in strengthening financial resilience against disasters, and identifying common challenges encountered in implementing DRF strategies.

The examples and case studies provide illustrations of the concrete ways in which DRF strategies might be implemented in different economic contexts, including in economies with scarce financial resources and less developed insurance markets. They are largely drawn from the responses of participating economies to a survey questionnaire. They are also drawn from other OECD work and the work of other international organisations such as the Asian Development Bank (ADB), Association of Southeast Asian Nations (ASEAN), United Nations Office for Disaster Risk Reduction (UNISDR), and World Bank. The experiences of other economies are presented when relevant to broaden the perspective and enrich the report. Moreover, while most examples focus on natural catastrophes, examples and practices linked to man-made disasters such as terrorism and industrial accidents are also presented.

The structure of this report captures the main elements of the G20/OECD Methodological Framework, namely: disaster risk assessment and the monitoring of disaster impacts; disaster risk financing tools and markets, most notably for disaster insurance; and government financial aid arrangements and sovereign risk financing strategies. The report concludes with a presentation of priorities for strengthening financial resilience as identified by economies. The report is usefully read in conjunction with the G20/OECD Methodological Framework and relevant publications on DRF, such as the G20 publication on disaster risk assessment and risk financing issued by the government of Mexico and the World Bank in 2012, which brings together the contributions of fifteen G20 members and invited economies, as well as the OECD.[5]

This global survey report on DRF practices will support the advancement of DRF strategies as well as promote regional and global efforts on DRF, for instance within APEC,

the ASEAN, the G20, and other regional and international fora. It will provide input into the further development of global guidance, most notably planned revisions in 2015 to the *OECD Recommendation on Good Practices for Mitigating and Financing Catastrophic Risks* and the development of effective approaches to DRF.

Notes

1. The OECD Recommendation on Good Practices for Mitigating and Financing Catastrophic Risks (2010) provides practical guidance on the core elements of disaster risk financing, including risk assessment, awareness and management, disaster response and principles for the use of insurance and other financial tools. The Recommendation is available at: *www.oecd.org/pensions/insurance/47170156.pdf*.
2. The Methodological Framework benefited from input from the G20 Economy Steering Group on DRM and the OECD's High-Level Advisory Board of the OECD International Network on Financial Management of Large-scale Catastrophes, Insurance and Private Pensions Committee, Committee on Financial Markets and High-Level Risk Forum, as well as from the Asian Development Bank, the United Nations Office for Disaster Risk Reduction and the World Bank. The Framework is available at *www.oecd.org/finance/g20oecdframeworkfordisasterriskmanagement.htm*.
3. The need for more reliable funding and resources in DRM, as well as for the establishment of national risk financing strategies that build on all available financial mechanisms was recently recognised also by the UNISDR in the 2013 edition of the Global Assessment Report on Disaster Risk Reduction (UNISDR, 2013).
4. APEC has 21 member economies: Australia; Brunei Darussalam; Canada; Chile; China; Hong Kong, China; Indonesia; Japan; Korea; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; the Philippines; Russia; Singapore; Chinese Taipei; Thailand; the United States; and Viet Nam.
5. The publication benefited from contributions by: Argentina, Australia, Brazil, Chile, China, Colombia, France, Germany, Italy, Japan, Republic of Korea, Mexico, Turkey, the United Kingdom, and the United States. A World Bank contribution introduces the economy experiences, outlining the main issues, while an OECD chapter examines policy options for promoting risk transfer and risk financing tools. The OECD contribution also presents and discusses issues related to the quantification of disaster losses and exposures.

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Chapter 2

Assessment of disaster risks, financial vulnerabilities and the impact of disasters

This chapter provides an overview of the risk assessment practices of surveyed economies. It begins by outlining the importance of assessing and quantifying disaster risk and losses. This is followed by an overview of the various approaches to completing risk assessments, including scenario analysis and probabilistic risk assessment and modelling as well as approaches to assessing the indirect economic impact of disasters. Specific efforts to identify financial vulnerabilities in some economies are described. The following section describes efforts to collect and publish information on disaster losses, including in the private insurance sector. The chapter concludes with a discussion of common implementation challenges to comprehensive assessment of disaster risks, exposures, vulnerabilities and losses.

Understanding the economic and financial dimensions of disasters

Disasters present a broad range of impacts, with potentially long-lasting, multi-generational effects. In addition to causing direct damages to lives, buildings, equipment and infrastructure, they may produce major indirect consequences such as business interruption, loss of employment and output, decreased tax revenues, impaired institutional capacities and a rise in poverty levels.

These direct and indirect impacts generate losses for households, businesses, governments, and other segments of the economy, with lost income and destroyed wealth, and may be catastrophic for some. As highlighted by the G20/OECD Methodological Framework, Finance Ministries need to understand the nature and scale of these impacts and their relevance to financial, economic, and fiscal management strategies and policies for which they have central responsibility.

As outlined in the Framework, in order to design and implement targeted DRF strategies to ensure that the financial consequences of disasters can be managed efficiently by populations, there needs to be an assessment of the expected financial impacts of disasters on the economy and the risk-bearing capacities of exposed populations and economic sectors (i.e. the capacity to absorb and recover from losses).

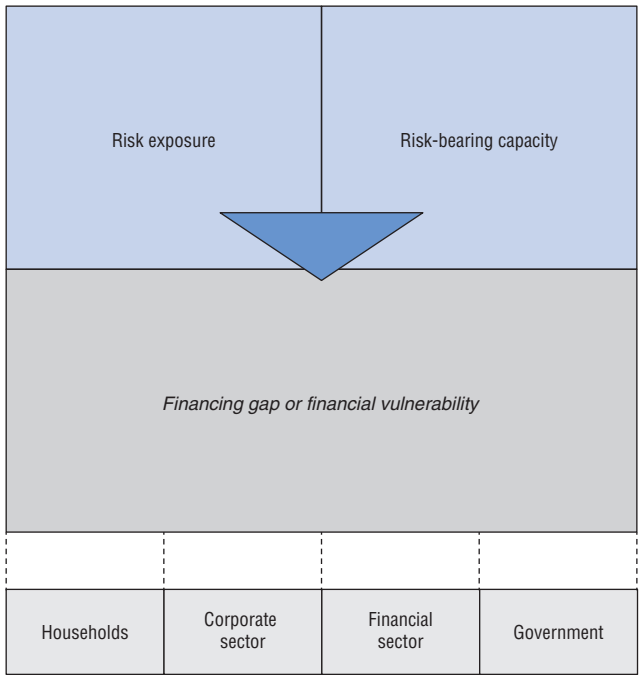
In particular, the scale and distribution of risks across the territory and major segments of the economy – namely, households, the corporate sector, the financial sector, and government (both central and local) – and the financial capacities to absorb these risks – need to be evaluated with a view to identifying possible *financial vulnerabilities* or *financing gaps* (see Figure 2.1).

Financial vulnerabilities exist when economic agents would be unable, given their resources, to absorb and recover from losses in the event of a major disaster, thus causing financial harm or economic disruption. These vulnerabilities can be addressed through risk reduction measures (thus reducing risk exposure and disaster costs) or the use of risk financing tools (thus securing post-disaster financial resources to meet disaster costs).

Given the central role of governments in supporting disaster relief and recovery, it is important for governments to assess their capacity, at central and local levels, to manage the public finance implications of disaster risks arising from contingent liabilities, both explicit (e.g. direct costs or losses linked to emergency response, damage to government property and infrastructure, pre-arranged financial aid) and implicit (e.g. *ad hoc* pay-outs given expectations of disaster aid), and from expected changes in macroeconomic conditions, for instance due to supply disruptions.

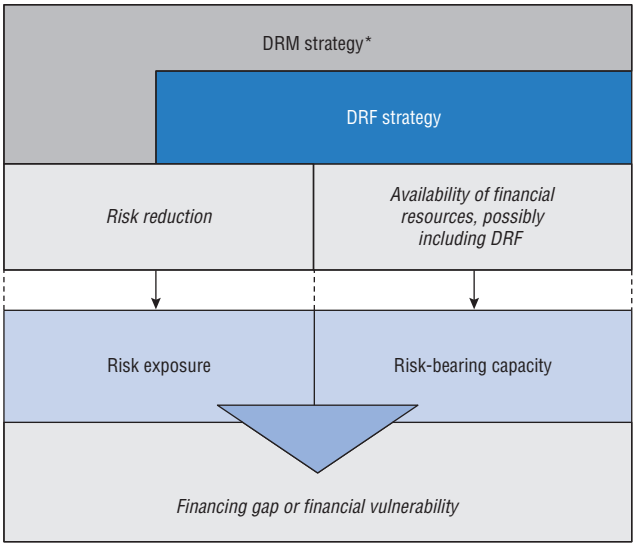
DRF strategies should seek to ensure the adequacy of financial resources to meet the costs of the full potential range of disaster events, with the overall goal of strengthening financial resilience within the population and economy (see Figure 2.2). DRF objectives are achieved through own resources or debt financing, risk financing tools such as reserves and insurance, and risk reduction. They are a critical component within broader DRM strategies aimed at reducing and managing risks, including through investments in risk prevention.

Figure 2.1. **Assessing disaster risk and financial vulnerabilities**



Source: Disaster Risk Financing in APEC Economies: Practices and Challenges.

Figure 2.2. **Role of DRF strategies in strengthening financial resilience**



* Includes other elements such as emergency preparedness and response and physical reconstruction.
Source: Disaster Risk Financing in APEC Economies: Practices and Challenges.

Thus, the first challenge in the development of a DRF strategy is to perform a forward-looking analysis of disaster risks, based on the identification of hazards and threats and an assessment of their likelihood and impacts, following a well-governed process and using relevant data. The provision of accurate, accessible and transparent information on disaster risks thus becomes an essential precondition for sensible decision making in the public and private sectors (OECD, 2012; UNISDR, 2013).

The outcome of comprehensive risk assessments can be used as a starting point for gauging the level of disaster risk exposure and assessing disaster-related financial vulnerabilities across the respective area and within the economy. However, the results will likely need to be complemented and augmented by a more detailed, comprehensive analysis of financial impacts and affected parties.

The quantification of disaster risks and losses

Working to quantify disaster risk as part of a disaster risk assessment, while not costless, is beneficial in that it supports the development of targeted measures to reduce financial vulnerabilities as well as the evaluation of risk financing tools. Quantification is, for instance, important for governments when evaluating the use of risk financing tools to mitigate the fiscal costs of disasters or secure post-disaster liquidity, or when considering major public investment projects in disaster risk reduction. For the insurance sector, quantification is critical for sound disaster risk underwriting.

From an operational viewpoint, the quantification of disaster risks should be based on a periodic analysis and assessment of past direct and indirect disaster losses, taking into account evolutions in the frequency and intensity of natural hazards (for instance, due to climate change) and in risk exposure – including changes in the concentration of assets, populations and economic activities. The systematic collection of data is key to the success of any risk assessment effort. Yet, as shown by the devastating earthquakes that occurred in 2011 in Japan and New Zealand, past loss experience alone may prove to be insufficient in determining the full range of potential risks and impacts. Rather, it is necessary to consider the full range of disaster scenarios, including worst-case scenarios that may not yet have occurred in recorded history, but which can be expected to cause major impacts.

Catastrophe models can provide relevant outputs in this regard: the *probabilistic approach* may be considered – in which the full spectrum of potential disaster events and their respective probabilities are accounted for – as well as the *scenario approach* – in which specific disaster events are constructed to determine their potential impacts and spill-over effects. If risk is evaluated from a probabilistic perspective, it can be assessed and measured according to specific metrics, namely:

- **Risk cost:** Quantification of the expected Annual Average Loss (AAL) for the risk over a long period of time (i.e. the sum of each event loss multiplied by its respective probability of occurrence) measures the annualised risk cost and provides the basis for risk pricing; and,
- **Probable maximum loss** (PML): The maximum amount of loss that can be expected to be incurred in a year with a certain probability. Knowledge of PML enables the management of risk, for instance through risk transfer.

These metrics enable a better understanding of disaster costs and scale of impacts and thus promote more informed decision-making related to financial strategies. Probabilistic risk assessment uses probability distributions to characterise the variability in risk estimates, as opposed to deterministic methods that are based on single-point estimates and discrete (stress case) scenarios.

Computer-based catastrophe models for measuring potential disaster losses enable a rapid calculation of disaster impacts. These models link information on natural hazards, exposed assets, structural vulnerabilities, and historical loss occurrences to produce loss estimates. Modelled loss results provide insight into the frequency and potential severity

of disaster losses and the volatility of these losses over time. Catastrophe risk models require, however, substantial amounts of reliable data on hazards, exposures and vulnerabilities for model construction and validation.

Measuring the costs of disasters, whether conducted as part of a forward-looking assessment or as part of an estimation of damage and losses following a disaster, requires an estimation of financial and economic impacts, both direct and indirect.[1] A methodology to support these estimations can bring rigour and consistency to the analysis. Methodologies have been developed to support governments in the *ex post* valuation of damages and economic losses, for instance the Damage and Loss Assessment (DaLA) methodology developed by the United Nations Economic Commission for Latin America and the Caribbean (UNECLAC) (World Bank, 2010b). These methodologies[2] provide a framework for governments to assess post-disaster needs, permitting an efficient targeting of resources in the disaster recovery phase by including estimation of:

- **Direct damages:** The replacement value of totally or partially destroyed physical assets (e.g. infrastructure, buildings, installations, machinery and equipment, transportation vehicles, damage to farmland, irrigation works and reservoirs).
- **Indirect losses:** Losses in the flows of the economy that arise from the temporary absence of productive damaged assets (e.g. losses due to lost industrial production, decreased agricultural yield due to flooding or prolonged droughts, increased transportation costs).
- **Macroeconomic effects:** The resultant impact on post-disaster macroeconomic performance, e.g. economic growth, balance of payments, and fiscal position.

The importance of a methodological approach to estimating disaster costs was highlighted by a major research project sponsored by the European Union (EU) (Costs of Natural Hazards, or CONHAZ) in which a comprehensive review of existing cost assessment approaches and key knowledge gaps was undertaken, with a focus on natural hazards (see Box 2.1) (Meyer et al., 2013). The CONHAZ project highlights the different methods that might be used to assess the costs of disasters. These methodologies employ a variety of terminologies and approaches for different types of hazards and different impacted sectors (World Bank and United Nations, 2010), which impedes efforts to obtain comprehensive and comparable cost figures.

A consistent domestic or international approach to post-disaster economic damage and loss assessment does not necessarily mean achieving a uniform approach, but one that produces consistent and comparable results and is based on agreed principles.

Box 2.1. **EU CONHAZ (Costs of Natural Hazards)**

A Co-ordination Action Project funded by the EU 7th Framework Programme, CONHAZ aimed at compiling and synthesising current knowledge on cost assessment methods to strengthen integrated natural hazard management and adaptation planning. CONHAZ, which ran from February 2010 to January 2012, adopted a comprehensive approach, considering natural hazards ranging from droughts, floods and coastal hazards to Alpine hazards, as well as different impacted sectors (including housing, industry, transport, agriculture, the environment, and human health) and cost types. Its specific objectives included compiling state-of-the-art methods for cost assessment and analysing these methods in terms of technical aspects, terminology, data quality and availability, and research gaps.

Box 2.1. **EU CONHAZ (Costs of Natural Hazards)** *(cont.)*

CONHAZ defined the following working terminology on cost categories:

- **Direct tangible damages:** Damages to property due to the physical contact with the hazard, i.e. physical destruction of buildings, inventories, stocks, infrastructure or other assets at risk. "Tangible" implies that a market exists for these goods or services;
- **Losses due to business interruption:** Business interruption takes place, for example, if people are not able to carry out their work because their workplace is destroyed or not reachable due to a hazard or if industrial or agricultural production is reduced due to water scarcity;
- **Indirect costs:** Losses which are not caused by the hazard itself but which are induced by either direct damages or losses due to business interruption. This includes, for example, induced production losses of suppliers and customers of affected companies, or the costs of traffic disruption;
- **Intangible costs:** Damages to goods and services which are not (or at least not easily) measurable in monetary terms because they are not traded on a market (non-market values or costs). The intangible effects of natural hazards include, for example, environmental impacts, health impacts and impacts on cultural heritage; and
- **Cost of risk mitigation:** The cost of risk reduction, including adaptation to anticipated changing risks as a result of climate change, can be regarded as part of the total costs of natural hazards, and these investments are therefore considered an essential cost category.

Source: CONHAZ – *www.conhaz.org*.

Disaster risk assessment and modelling initiatives

Several noteworthy initiatives are presented below, including initiatives that have been undertaken at the regional level. They aim to assess disaster risks and their economic and financial impacts on the population and the economy, by collecting and analysing data on hazards, exposures, vulnerabilities and losses. The examples cited may not necessarily be used for the elaboration of DRF strategies but may instead serve other purposes in a DRM strategy, such as emergency preparedness and urban planning.

In a number of economies, risk assessment of financial and economic impacts is built on a more ***comprehensive risk assessment*** covering the whole territory, following a ***scenario-based approach***. In **Canada**, the potential financial impacts of future hazard events are assessed through the federal All Hazards Risk Assessment exercise, conducted on an annual basis and co-ordinated by Public Safety Canada with substantive input from a number of departments and agencies. As one of the six impact categories that this initiative examines, "Economy" involves an assessment of the direct and indirect economic cost of emergency events, as estimated by the finance ministry, Finance Canada. A basic methodology is used for this estimation based on an identified extreme scenario (see Box 2.2). Fictitious worst-case, but credible, scenarios are selected that permit subject matter experts to judge the potential impacts that the scenario might produce.

Hungary is in the process of assessing pertinent disaster risks nationally, with a comprehensive, inter-ministerial risk assessment process recently finalised. Its national risk assessment involves analysing financial and economic impacts (such as the total – direct and indirect – economic losses for specific risk scenarios, the extent of business interruption,

Box 2.2. **Canada: All Hazards Risk Assessment (AHRA) initiative – "Economy" impact category**

Within the federal All Hazards Risk Assessment initiative, the "Economy" impact category captures the monetary value following damage(s) or loss to economically productive assets and disruptions to the normal functioning of the Canadian economic system, which may result in the loss of service as a result of a risk event occurring. This loss is broken down into the following:

Direct Economic Loss

Direct economic loss (stock losses) is the immediate economic damage generated by the disaster. These losses can be measured by the repair or replacement costs (at the pre-event price level) for assets that have been damaged or destroyed. In particular, this would include damage to:

- ***Building construction*:** industrial, commercial, and institutional buildings (e.g. plants, offices, recreational facilities, hospitals, etc.).
- ***Engineering construction*:** road infrastructure, water systems, marine construction (irrigation, docks, terminals, etc.), other transportation, electric power, and oil and gas engineering.
- ***Machinery and equipment*** used in the production process (furniture, agricultural and industrial machinery, computers and software, telecommunication equipment, trucks, etc.).
- ***Residential housing and contents***.
- ***Raw materials*:** mineral fuels (coal, crude oil, natural gas), grains (crops ready to be harvested), animal and animal products (e.g. cattle and hogs-swine for slaughter, milk and eggs, fish), wood, ferrous and non-ferrous metals, non-metallic minerals, etc.

Indirect Economic Loss

Indirect economic loss (flow losses) refers to the flows of goods and services which will not be produced due to damages to productive assets and economic infrastructure. This interruption or reduction in production should be measured in terms of value-added to avoid double-counting issues. For instance, this would include:

- ***Production or service provision losses*** due to the full or partial paralysis of activities (e.g. losses in agricultural/industrial production due to damage to factories or shortages of raw materials/energy supplies).
- ***Higher operational costs*** due to the destruction of productive assets or losses to production and income (e.g. a ban on beef and cattle exports would first translate into higher maintenance cost due to rising inventory levels of live animals).
- ***Lost production due to linkages effects*** (e.g. the destruction of a factory reduces the economic activities of suppliers who have no alternative markets or of clients who have no other suppliers).
- ***Additional costs incurred*** due to the need to use alternative and potentially inferior means of production or provision of essential services (e.g. greater operating costs arising from reduced transportation or energy capacity).
- ***Costs of required government response*** (e.g. emergency and rescue operations).

Estimates of indirect losses are undertaken with caution as some effects might be difficult to identify or quantify. It is suggested that only relevant external factors that significantly modify the estimate of the economic loss should be considered. Indirect losses should be made relative to the duration of the disruption. Also, the assessment should ensure that no double-counting takes places: if effects are calculated on the

Box 2.2. **Canada: All Hazards Risk Assessment (AHRA) initiative – "Economy" impact category** *(cont.)*

production side, they must not be included again on the income side. For example, government compensation to farmers affected by an outbreak of foot and mouth disease should not be included in addition to the associated production losses.

There may also be counterbalancing factors, such as built-in mechanisms or behavioural changes that offset impacts, e.g. reallocation of resources, use of alternative transport routes. It is considered important to capture these counteractions as assumptions along with the rating of the Economy category. In addition, disasters may produce benefits that must be estimated and deducted from the estimate of total losses.

Once all the contributions to the economic loss have been identified, all costs are added and the rating for this category is based on the final monetary figure (scale from 0 to 5 based on an exponential path of values).

Macroeconomic studies provide a complementary way to assess the repercussions of direct and indirect economic losses. For instance, estimates of macroeconomic effects would take into account that some indirect effects could be exacerbated or mitigated in the aggregate by changes in prices or flexibility in the production process (e.g. through reallocations in spending/production across sectors or through the mobilisation of production factors if production is not at full capacity). Estimates of high-order impacts of disasters require the use of more sophisticated economic models.

Source: Public Safety Canada (*www.publicsafety.gc.ca/ahra*).

etc.) and investigation of the level of vulnerability of the exposed communities and elements. Risk scenarios are used to model specific disaster events, with risk matrices employed to assign risk levels for each scenario. In **Japan**, scenario analysis is currently employed as part of a comprehensive assessment of impacts of potential major events such as Tokyo Inland Earthquakes and Nankai-Trough Great Earthquake, which considers not only expected human and physical damages but also expected economic losses from such events (Government of Mexico [G20 Presidency] and World Bank, 2012: Chapter 11). For instance, in the case of the Nankai-Trough Great Earthquake, the possible impact on economic activities was estimated to be approximately JPY (Japanese Yen) 30.2 trillion. On the basis of these risk assessments, the government has taken measures to reduce economic impacts. In **Germany**, a method for risk assessment for civil protection (*Methode zur Risikoanalyse im Bevölkerungsschutz*) has been prepared by the Federal Office of Civil Protection and Disaster Assistance (BBK) and communicated to the Federal States (*Laender*). It provides a scenario-based risk assessment approach based on area of interest, hazard, occurrence probability and damage magnitude. The "Joint Hazard Estimation of the *Laender* and the Federal Government" compiles information on hazards (natural/technological/man-made) exceeding "day-to-day" hazards/crisis situations of national concern and identifies risk hotspots.

In **Iceland**, the Icelandic Catastrophe Insurance (ICI), a specialised state-owned insurance company, has developed a response plan that considers in detail the impact of potential events on the institution and its capacities to respond, including the need for human resources, payments for damage compensation, etc. This response plan was elaborated on the basis of nine scenarios, each of which led to a calculation of financial impacts. In **Chinese Taipei**, the Residential Earthquake Insurance Fund (TREIF) has developed an earthquake risk model, the Residential Earthquake Insurance Fund –

Earthquake Risk Assessment, in order to strengthen TREIF's earthquake risk assessment capacity. The risk model has supported TREIF's understanding of its insurance exposure, claim settlement criteria, and premium ratings. There is also an Earthquake Loss Estimation System (TELES), which is a real time seismic loss estimation system that can be used to improve risk analysis. In **Spain**, the *Consorcio de Compensación de Seguros* (CCS) and the geological and mining institute of Spain (*Instituto Geológico y Minero de España* or IGME) have jointly implemented the GeoMEP pilot project, a Method for Geological Risk Assessment (flood, earthquake and volcano eruption). The pilot project focuses on the Canary Islands and is aimed at determining the level of potential financial liability of the CCS for covered events.

In contrast, ***probabilistic risk assessment*** has been employed, or is currently under development, in some economies, sometimes as part of a strategy to develop risk financing options for governments. A well-known example is **Mexico**, which has developed sophisticated probabilistic risk assessment methods to evaluate the scale of disaster risks threatening the economy. Based on the results of these studies, which initially focussed on seismic, flood and tropical cyclone risks,[3] Mexico has designed financing mechanisms to protect the financial resources of the federal government fund (*Fondo de Desastres Naturales* or FONDEN) that shares the cost of recovery and reconstruction with impacted states. These studies were also aimed at assessing the risk profile of government assets in order to support the establishment of insurance coverage for public infrastructure (amongst other objectives). By aiming to meet the data/information needs of (re)insurance and capital markets, there is a strong incentive to quantify the vulnerability of major federal assets. This has required a high degree of co-ordination among institutions in order to collect accurate data on the assets exposed to risk as well as co-operation between various experts (scientists, public officers, advisors).

The effort in Mexico to collect high quality information for risk assessment, and ultimately the assessment of risk financing options, has resulted in the creation of a physical inventory of assets for each of the government institutions that manages public assets: roads and bridges, water distribution, hospitals, schools, and others. This inventory was the first step towards building the capability for estimating the vulnerability of each agency's assets, an exercise that also required:

- **Location data:** In order to determine damages from hazards such as floods, for which high-resolution, geo-coded information about infrastructure, terrain and nearby water bodies is vital for the accuracy of estimations.
- **Structural type and original design:** Materials, structure, use, and contents of structures included in the asset inventory contributed to the estimation of losses by allowing for an evaluation of the resistance of structures to the impact of natural elements (such as ground acceleration, wind speed, and water depth). This information was also useful for estimating human exposure inside the assets, such as statistics of occupation, demand for services, and working personnel.
- **Replacement or reconstruction cost:** To obtain economic losses derived from damages to assets, an economic valuation of the infrastructure was obtained. Information about the cost of reconstructing the asset to replace it with similar characteristics was crucial for insurance-based risk transfers.
- **History of losses:** Whenever possible, data for historical losses were used to calibrate loss modelling or verify the accuracy of estimates.

- **Inventory of hazard characteristics:** Historical data from meteorological and seismic stations, soil characteristics, orography maps, LIDAR (remote sensing) information regarding terrain, etc. were centralised, requiring close collaboration with specialised public institutes.

Once information was gathered, the next step was to identify the fundamental variables on hazards necessary to generate useful loss estimates (see Box 2.3).

Box 2.3. **Mexico: modelling disaster risk at the federal level**

The case of Mexico demonstrates the importance of a well-developed technical infrastructure for conducting probabilistic risk assessment within the public sector and the need for strong co-ordination among government departments and with research institutions.

The **first step** in developing loss models capable of estimating damages to infrastructure, considering all hazards, was to guarantee the availability of technical and human resources. The federal government of Mexico drew on the scientists devoted to researching natural hazards and structural engineering. In particular, the National Autonomous University of Mexico (*Universidad Nacional Autónoma de México* or UNAM), through its Engineering Institute, was engaged to construct the risk models. An ample body of research was made available for this purpose, holding more than 40 years of research on natural hazards (particularly earthquakes), probabilistic simulation hazard models, and vulnerability functions all focusing on Mexico.

The **second step** was to catalogue enough information on natural phenomena to feed the models in order to simulate a range of natural hazard events. Event catalogues produced through the years by UNAM, the National System for Civil Protection (*Sistema Nacional de Protección Civil* – SINAPROC), the National Disaster Prevention Centre (*Centro Nacional de Prevención de Desastres* – CENAPRED), and the National Meteorological Service (*Servicio Meteorológico Nacional* – SMN) were compiled. In addition, these organisations provided fundamental information to develop, feed, and calibrate models for earthquakes by performing seismic sources analysis, verifying attenuation dynamics, site effects studies, and historical loss information for earthquakes. For tropical cyclones, these institutions provided a wind model, topographical effect studies, storm surge models and flood precipitation models, among others. This information was combined with the data collected in the inventory of public assets. Gathering information for public assets was fundamental (location, characteristics and replacement costs) since this information provided the needed input for developing vulnerability functions. Federal government departments supplied this data, in many cases with a high degree of quality.

The **third step** was to develop computational tools adequate to analyse disasters. The main tool produced is known as R-FONDEN, a tool capable of producing probabilistic simulation and replicating historical as well as potential material and human losses. R-FONDEN estimates losses for a single scenario or for the entire catalogue of modelled events at any geographic zone within Mexican territory using vulnerability functions for every kind of infrastructure included in the database. For a given portfolio of assets, the system provides the fundamental financial risk measures necessary to design financial risk transfer schemes, such as the "annual average loss" and the "exceedance probability curve", and identifies the scenarios that produce the highest risk. Visualisation of results and information can be produced in any geographic information system (GIS).

Source: Secretaría de Hacienda y Crédito Público, Mexico.

In **Indonesia**, studies are underway to provide preliminary estimates of future possible public spending linked to disasters. Data on past events, estimated from the number of buildings destroyed and damaged, has been used as a basis for simulating possible future spending needs related to natural hazards. Moreover, risk metrics such as Annual Average Loss (AAL) and Probable Maximum Loss (PML) are being calculated. While the annual economic impact of natural disasters is estimated at 0.3% of GDP over the last decade, simulations show that a major earthquake (with a return period of 250 years) could cause losses in excess of USD 30 billion (approximately 3% of GDP) (World Bank, 2011).

In **Peru,** as part of its efforts to design a financial management strategy for disaster risks linked to natural hazards, estimations are going to be carried out to assess both probable maximum losses due to seismic risk (by the Ministry of Economy and Finance) and to assess flooding risks by river basin (by the National Centre for Estimation, Prevention and Reduction of Disaster Risks, *Centro Nacional de Estimación, Prevención y Reducción de Riesgos de Desastres* or CENEPRED). A Seismic Risk Profile that quantifies probable maximum losses for several periods was created in 2009.

In the **Philippines**, a catastrophe risk modelling exercise is underway to assess the risk to public assets and determine appropriate risk financing arrangements for the public sector. A similar initiative is underway to evaluate models for crop insurance to improve the public crop insurance scheme. In parallel, the Department of Finance, with the support of the World Bank, is elaborating a policy strategy to determine appropriate actions to be taken to reduce the economy's overall fiscal and economic vulnerability.

Papua New Guinea is one of the fifteen economies[4] involved in the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI),[5] a project launched in 2007 aimed at providing Pacific Island Economies (PIEs) with state-of-the-art disaster risk assessment and modelling tools. The initiative also aims to engage PIEs in a dialogue on integrated financial solutions for the reduction of their financial vulnerability to extreme natural hazards and to enhance their broader DRM and climate change adaptation agenda (see Box 2.4). PCRAFI

Box 2.4. **Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)**

PIEs are among the world's most vulnerable to natural hazards such as tropical cyclones, earthquakes, tsunamis and volcanic eruptions, based on annual expected disaster losses scaled by GDP. Reportedly, every year on average, the PIEs experience losses caused by disasters estimated at USD 284 million. In the past, financing for disaster recovery has been left to the international donor community since PIEs are constrained by their limited size, borrowing capacity and access to international insurance and financial markets.

Under the auspices of PCRAFI, technical tools have been developed to support *ex ante* disaster risk reduction measures, such as planning, emergency preparedness, climate change adaptation, disaster risk financing, and post disaster support such as rapid assessments. The tools developed so far, include:

- ***A regional historical hazard and loss database*** for major disasters which contains a historical earthquake catalogue covering approximately 115 000 events of magnitude 5 or greater that occurred in the region between 1768 and 2009 and a historical tropical cyclone catalogue that includes 2 422 events from 1948 to 2008;
- ***Hazard models***,[1] which cover earthquakes (both ground shaking and tsunamigenic) and tropical cyclones (wind, storm surge, and excess rainfall);

Box 2.4. **Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)** *(cont.)*

- ***A regional GIS exposure database*** containing components for buildings and infrastructure, agriculture, and population. For the building and infrastructure data set, more than 400 000 building footprints and structural classifications were digitised from high-resolution satellite images;
- ***Probabilistic catastrophe risk models*** specific to each economy have been developed integrating data collected and produced through the risk modelling process and including maps that show the geographic distribution of hazards, assets at risk, and potential losses and can be used to prioritise DRM interventions.

According to the Secretariat of the Pacific Community's Applied Geoscience & Technology Division, the historical hazard and loss database is the result of an effort in collecting, merging, and processing data from multiple sources on historical Pacific earthquakes and tropical cyclones and the monetary losses and impact on populations caused by such events. The "consequence" database contains approximately 450 events from 1831 to 2009 that impacted at least one of the 15 PIEs. Reportedly, this database shows that, on average, these economies have collectively experienced losses in the order of USD 1 billion per decade, and as high as USD 4 billion in both the 1980s and the 1990s.[2]

Having assembled, processed, developed, and organised a wide collection of **geo-referenced data** for hazard modelling in the region, including satellite imagery, topographic maps, bathymetry maps, surface geology maps, surface soil maps, land use/land cover maps and geodetic and fault data, PCRAFI produced detailed **probabilistic hazard models** for all 15 PIEs, such as Tropical Cyclones with Winds, Storm Surge, Rain, Earthquake with Ground-shaking, and Tsunami.[3]

Concerning the **exposure databases**, while most commercial risk models used in the (re)insurance industry only include insurable residential, commercial and industrial assets, PCRAFI made a significant effort to take a holistic view of the impact of extreme natural hazards in the region, including direct effects on population, all structures, including housing for the poor and squatted properties, as well as on public and infrastructure assets and major crops. The database includes building location, number of stories, replacement cost, and structural characteristics that affect vulnerability to natural perils. The spatial distribution of the estimated 3.5 million buildings in the database, which covers all known built areas, was assembled at varying levels of resolution and accuracy.

Catastrophe risk models specific to each economy have also been developed along with catastrophe risk profiles using the hazard and exposure databases. The risk profiles integrate data collected and produced through the risk modelling process and include maps showing the geographic distribution of hazards, assets at risk, and potential losses. They also include an analysis of the distribution of the potential cost of natural disasters by magnitude over time for each economy, as measured by the expected return period for losses of a specified amount.

The impact of simulated events on population is measured by the number of people affected, in terms of fatalities, injuries and displacements, while the impact on the built environment and crops is quantified in monetary terms. The losses reflect both the cost needed to repair or replace the damaged assets, and the emergency response costs that economies may face as a result of providing necessary relief, including debris removal, cost of temporary shelters, and food and medicine.

Box 2.4. **Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)** *(cont.)*

The risk profiles can **support several different applications** for both public and private stakeholders, including: urban and development planning; prioritising physical risk reduction investments; residual disaster risk financing and insurance solutions; locating vulnerable areas and communities; and *ex ante* budget planning options to increase the financial resilience of economies against natural hazard risks. Relevant information for the development of building codes, in terms of specific seismic and wind loads, can also be derived from the hazard models. These databases also provide reliable baseline data for conducting post-disaster loss assessments.

The PacRIS is a GIS platform designed to provide the PIEs, development partners and the private sector with the data and tools needed to develop disaster risk reduction applications. It includes the data and mapped information captured in the databases and makes them available in a web-based portal ("Pacific Risk Information System"). PCRAFI is now supporting the first set of applications using the PacRIS platform. These include the development of a risk financing and insurance pool for the Pacific, urban and infrastructure planning applications for selected locations, and a post disaster loss assessment tool.

1. The tropical cyclone and earthquake hazard models have been subjected to a comprehensive independent peer review conducted by researchers at Geoscience Australia.
2. The consequence database also includes the 29 September 2009 M_w 8.1 earthquake that caused a tsunami in Samoa and Tonga and affected a number of other Pacific economies.
3. The threat posed by earthquakes considers both ground shaking intensity and the effects of earthquake-generated tsunamis. Tsunamis may be caused either by local events or by distant events along the entire Pacific Rim. The effects of tropical cyclones include wind and flood caused both by precipitation and storm surge.

Source: PCRAFI – *http://pcrafi.sopac.org/*.

offers an illustrative example on how to conduct a quantitative analysis of disaster risk for the purpose of risk financing and transfer. It shows that a detailed, quantitative understanding of potential costs to the fiscal budget allows for the subsequent design and implementation of sovereign disaster risk financing strategies tailored to the needs of the economy. It also shows that ensuring local participation in the development of the pilot program increases the likelihood of the establishment of a longer term strategy.

A number of economies have made tailored efforts to develop pre-disaster impact analysis and risk modelling to ***address specific DRM purposes***, such as emergency management and urban planning. For instance, in **Korea**, in order to move away from the traditional post-disaster approach, the National Emergency Management Agency (NEMA) has developed an IT-based initiative known as the "One Step Ahead Response System" aimed at anticipating future disasters and assessing their potential impacts for the purpose of emergency planning. The *Countermeasures against Natural Disaster Act* ensures that local governments prepare pre-disaster impact analyses to facilitate DRM planning, which is decentralised but which receives central government support. In **Indonesia**, a hazard impact modelling tool for emergency planning, the Indonesia Scenario Assessment for Emergencies (InaSAFE), has been developed to improve understanding of the likely impacts of disasters such as floods, earthquakes or tsunamis (see Box 2.5). It is a recent example of fruitful international collaboration in the field of disaster risk assessment.

Box 2.5. **Indonesia Scenario Assessment for Emergencies (InaSAFE)**

InaSAFE, a new hazard impact modelling tool in Indonesia, is used to produce realistic disaster scenarios for the purpose of contingency planning. Designed to help Indonesia and other economies in the region effectively prepare for natural disasters by better understanding the likely impacts of disasters such as floods, earthquakes or tsunamis, InaSAFE was developed by the Australian Agency for International Development (AusAID) and Indonesia's national disaster management agency (*Badan Nasional Penanggulangan Bencana* or BNPB) with support from the World Bank.

InaSAFE is a free open source software that anyone with basic computer skills can use to produce realistic disaster scenarios for contingency planning. InaSAFE is designed to use and combine existing data from scientific agencies, local governments and communities. Normally, information on the location of people and important assets are provided by local communities and government departments responsible for each sector, often through a facilitated component of disaster preparedness and planning exercises. The more communities, scientists and governments share data and knowledge, the more realistic and useful the InaSAFE scenario becomes.

AusAID and BNPB, through the Australia-Indonesia Facility for Disaster Reduction, have been developing training material to teach Indonesian disaster managers how to use InaSAFE. To date, this pilot program has trained over 150 Indonesian disaster managers across six provinces on the fundamentals of using participatory mapping techniques, such as OpenStreetMap and Quantum GIS, for collecting data and on using InaSAFE for analysing this data and informing contingency planning.

Source: Australia-Indonesia Facility for Disaster Reduction – *www.aifdr.org/* or *www.inasafe.org/*.

In the **United States**, an application called Hazus developed by the Federal Emergency Management Agency (FEMA) enables governments at the federal, state and local levels to identify the potential impacts of earthquakes, floods and hurricanes. Based on a standardised methodology, Hazus contains models that enable users to determine the physical, economic and social impacts of disasters and corresponding loss estimates. The use of GIS within Hazus supports the visualisation of the spatial relationships between populations, assets and resources, and natural hazards, thus enabling the development of pre-disaster mitigation, recovery, preparedness and response plans. The United States Geological Survey (USGS) uses the Science Application for Risk Reduction (SAFRR) to facilitate scenario development to assist in disaster preparedness, response and resilience. Initially developed in 2006 with the Multi Hazards Demonstration Project in California to analyse and support decision-making related to earthquake and windstorm scenarios, the scope of SAFRR has expanded. Currently, SAFRR has developed scenarios for earthquake (ShakeOUT), storm and storm surge (ARkStorm), tsunami and wildfire. After developing scenarios, SAFRR analyses the scenarios with the objective of quantifying the most likely economic costs and informing the decision-making process for reconstruction. The economic impact category (one of the three main categories analysed) is focussed on business interruption arising from damage to physical infrastructure and the longer term impacts arising from interruptions to business activity in a disaster-affected area.

In **Australia**, National Emergency Risk Assessment Guidelines (NERAG) have been developed to enable consistent and rigorous emergency-related risk assessments, increase the quality and comparability of risk assessments, and improve the national evidence base

on emergency-related risks. NERAG includes a scalable methodology to assess the impacts of natural disasters on the community and the economy. The publication of this information helps communities improve their disaster resilience by providing the information needed to make informed decisions and take appropriate protective action.

In **China**, disaster risk assessment currently mainly focuses on natural disasters that are liable to occur in a local administrative area within the coming year, with a view to understanding their potential scope of impact and damage. Key indicators include annual natural disaster occurrence trends and the requirements for ensuring the basic livelihoods of those affected. Every April, the Office of the People's Republic of China National Committee for Disaster Reduction organises a disaster trend forecasting consultation conference that brings together earthquake, weather, water, land and other relevant specialist bodies, where a trend analysis of disasters throughout the year is performed. The Ministry of Civil Affairs organises a comprehensive disaster risk assessment and performs an assessment of potential risk and damage in key areas on the basis of departmental forecasts. The Ministry of Civil Affairs also carries out damage forecast assessments and disaster trend forecasts for major disasters. These exercises have already begun covering flooding, typhoons and other sudden-onset weather disasters; providing policy-level support for the launch of early warning and emergency response initiatives.

In **Chile**, in the aftermath of the devastating magnitude 8.8 M_w earthquake and ensuing tsunami that struck on 27 February 2010 ("27F"), the Ministry of Housing and Urban Development (*Ministerio de Vivienda y Urbanismo* or MINVU) took proactive steps in disaster risk modelling for the purpose of improving urban planning. To guarantee a comprehensive approach, the MINVU, in collaboration with a series of public and private entities, carried out 25 master plans for the main urban centres located in the coastal area that was affected by the tsunami. Each master plan integrated risk assessment reports and modelling of tsunami propagation and inundation for several scenarios with strategies for project and mitigation works, evacuation routes, zoning and incentives for the construction of tsunami resilient housing projects. The risk studies and models recognised the importance and specificity of local risk patterns and local geographic conditions, in order to implement a precise strategy to reduce future damages and losses. The risk modelling used in this experience allowed MINVU to promote urban planning and housing policies with the proper risk outlooks (Government of Mexico (G20 Presidency) and World Bank: Chapter 5).

Another interesting approach is the creation of the Africa RiskView (ARV). ARV is an IT platform providing a transparent system to estimate drought-related crop losses and the resulting impact on populations' food security – providing an example of how vulnerability assessment can be used to target assistance (see Box 2.6).

Box 2.6. **Africa RiskView (ARV)**

Developed by the World Food Programme (WFP), ARV is an IT platform providing a system to estimate drought-related crop losses and the impact on populations' food security in sub-Saharan African economies. This tool also converts the anticipated adverse impacts into monetary and financial terms, with a view to providing accurate estimates of the required response costs. Several tasks can be performed by the software application, including: **early warning, risk mapping, vulnerability assessment and financial planning**. Rainfall and crop monitoring data are provided by reliable sources[1] to anticipate high-level food security needs of affected populations and budget for response costs.

Box 2.6. **Africa RiskView (ARV)** *(cont.)*

Using ARV, participating economies[2] can determine how changes in rainfall would affect crop performance – measured by the reference water stress indicator called "Water Requirement Satisfaction Index" (WRSI) – and, ultimately, vulnerable populations. Water stress indicators measure crop performance based on the availability of water to the crop during a growing season. They assume that crop yields are proportional to the satisfaction of crop needs for water resource. The WRSI, developed by the Food and Agriculture Organisation (FAO) (Frére and Popov, 1979, 1986; Doorenbos and Pruitt, 1977) and currently used in different parametric insurance schemes across the world, is defined as the ratio of actual evapotranspiration (ETa) to maximum evapotranspiration (ETc). In simple terms, this index captures the impact of timing, quantity, and distribution of rainfall, comparing the amount of water available throughout the season to how much a plant needs in its different stages of growth.[3]

A second component of ARV aims to **estimate the population affected** by overlaying drought index information with sub-national data on vulnerable populations. This component tries to identify how drought may impact the needs of individuals and households. Exposure and resiliency are employed as basic variables in the exercise. Exposure to drought risk is defined by the weight of agricultural activities in the household's total annual income. Resiliency is measured in terms of household's distance from the poverty line. The percentage of the population vulnerable to droughts of various degrees of severity can be modified by the user at different administrative levels.

As a third step, ARV seeks to determine a **monetary approximation of response costs**, based on the index-based estimate of seasonal crop performance and the impact of such performance on affected populations vulnerable to food insecurity.

Using ARV, response costs can be estimated at **different aggregation levels, including the local and regional levels,** by multiplying the population affected by a fixed cost per beneficiary. Such cost can be adjusted by the user to reflect the cost of various types of responses to food insecure populations (e.g. food aid, cash vouchers), assessing financial needs for drought events of varying magnitudes. The tool can also be used to study historical data and learn from past events, with a view to improving contingency planning and emergency preparedness for future shocks.

The ARV also provides the technical foundation and basic infrastructure for Africa Risk Capacity (ARC), an African-owned, continental index-based weather risk insurance pool and early response mechanism. As a flexible tool that can be used to select accurate proxies for drought related losses and response cost needs, ARV allows ARC participating members to quantify critical financial components of their drought risk and, consequently, to determine the desired retention level beyond which drought risks are transferred to the risk pool, the ceding percentage (or co-insurance proportion), as well as the coverage limits to be purchased. These parameters determine the cost of risk transfer.

1. The data sources include: FAO, WFP, Famine Early Warning Systems Network, and the National Oceanic and Atmospheric Administration (NOAA).
2. ARC participating economies are: Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Republic of Congo, Côte d'Ivoire, Djibouti, Gambia, Guinea, Kenya, Liberia, Libya, Malawi, Mauritania, Mozambique, Niger, Rwanda, Western Sahara, Senegal, Togo and Zimbabwe.
3. "ETa corresponds to an estimation of the quantity of water actually evaporated while ETc corresponds to the quantity of water that would evaporate if the water requirements of the plant were fully satisfied (…). Since crop sensibility to water stress depends on its growth phase, most of the insurance contracts consider those phases and take in account different references values of WRSI as triggers, depending on the phase considered (…). Rainfall level of each (phase) is compared to the crop requirement for this particular growth stage and included in the weighted sum in order to compute the index corresponding for the whole period" (Leblois and Quirion, 2013).

Source: African Risk Capacity (*www.africanriskcapacity.org/africa-risk-view//introduction*).

In order to support the availability of – and public access to – flood risk information, the Australian Government has invested funds through the National Flood Risk Information Project to collate existing flood risk mapping and associated flood studies into the Australian Flood Risk Information Portal, which is intended to increase the public's awareness of their own risk. This information is being sourced from all three tiers of government, though the major custodian is local government. The Australian Government is also funding the completion of a revision to the Australian Rainfall and Runoff national guideline, which will improve the quality of future flood studies and estimates of flood risk.

In **Switzerland**, Swiss federal law obliges the Swiss cantons to set up hazard maps for flood, avalanche, landslide and rockfall. These hazard maps show hypothetical natural events in terms of intensity and annual probability; however, they do not predict their financial impacts. Their goal is to identify areas in which infrastructure would suffer damage if hit by such events.

In **Indonesia**, in the aftermath of the 2009 earthquake in West Sumatra, the Australia-Indonesia Facility for Disaster Reduction supported an international team of engineers and scientists to collect and analyse building damage information, including relevant structural characteristics. The survey was co-led by Geoscience Australia and the Institute of Technology, Bandung, and resulted in a comprehensive study of the building stock in Padang. This information provided the basis for the broad categorisation of the Indonesian building stock, which has in turn been used to inform the development of a full national suite of models defining the vulnerability of structure types to earthquake ground motion.

In **Russia**, following a Presidential decree, subnational governments are developing ways to assess local disaster risks in order to support emergency planning. Many subnational governments have already completed lists of risk zones. These risk zones provide rough estimates of exposed populations and assets in each area. They are classified by types of disaster risks, and help in identifying vulnerable segments of the population. In the process of assessing these risks, both natural disasters and man-made disasters are taken into consideration, including for example, potential hazards due to dangerous facilities such as the Kursk Nuclear Power Plant.

Research institutions have been established to ***strengthen research capabilities relating to natural perils***, specifically to collect and analyse data on hazards, vulnerabilities and losses. In **Argentina**, for instance, the importance of agriculture within the economy and its susceptibility to disaster impacts led to the creation of a number of institutions focusing on the management of disaster risks in agriculture. These include the Agricultural Risk Bureau (*Oficina de Riesgo Agropecuario*) and the National Institute of Agricultural Technology (*Instituto Nacional de Tecnologia Agropecuaria*) which work collaboratively to gather information and develop models for disasters that generate losses to agriculture. Their research and modelling extend beyond natural catastrophes to encompass risks linked to climate change (World Bank, 2010a).

In **Australia**, a nationally-funded Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) has been established, focussed on improving the understanding of natural hazards in Australia. In addition to research into specific natural hazards such as fire, flood, storm, cyclone, earthquake and tsunami, research is being undertaken in the areas of economics, policy and decision making, and the resilience of people, infrastructure and institutions. Understanding disaster risk and impacts, and enabling an adaptive and empowered community that acts on this understanding, is central to

Australia's *National Strategy for Disaster Resilience*, with a range of initiatives undertaken such as the formation of the BNHCRC, development of NERAG (see above), and development and publication of state-wide risk assessments.

In the **Czech Republic**, the T.G. Masaryk Water Research Institute plays an important role in regard to flood risks. This public research institution focuses both on basic and applied research, and provides research solutions in water management and waste management. It gathers detailed and interdisciplinary information on past flood events and provides flood risk maps on its website. In **Singapore**, the Nanyang Technological University's Institute of Catastrophe Risk Management (ICRM), established in 2010, focuses on catastrophe-related reinsurance risk, sovereign risk, societal risk and other non-traditional risks in Asia. With support from the industry and the government, ICRM embarked on two key projects on flood and seismic risk assessments. ICRM is also part of the Global Earthquake Model (GEM) Project, a collaborative effort aimed at developing and deploying tools and resources for earthquake risk assessment worldwide.

In **Sweden**, the government commissioned Uppsala University, Karlstad University and the National Defence College to create a Centre for Natural Disaster Science. The Centre gathers around 40 senior researchers and is active in interdisciplinary projects covering fields such as communication of risks, effective collaboration, information gathering, early warning, and protection of critical infrastructure. In the **United Kingdom**, a Natural Hazards Partnership has been established to bring together expertise from lead public sector scientific agencies in order to support research and analysis related to hazards and contribute to the national Hazard Impact Model and National Risk Assessment process.

In Japan and Turkey, two economies prone to seismic hazards, specific research programmes have been established to improve the understanding of earthquake risks. **Japan** has a long-standing "Basic Plan for Research and Development in Disaster Reduction" and a policy for earthquake research ("Towards Promotion of Innovative Research Study – the Comprehensive and Basic Policy on Promotion of Observation, Monitoring, Survey and Research on Earthquake") which establishes a co-ordination mechanism among various government agencies and research institutes to encourage collaboration on the study of specific technical issues such as the development of new technologies for earthquake forecasting. In **Turkey**, a National Earthquake Investigation Programme has been established to support research into earthquake risks.

Private insurance and reinsurance sectors have made important contributions to risk assessment. In **Chile**, for example, the Chilean Insurance Industry Association (AACH) is developing a map to identify all risky areas susceptible to earthquakes and tsunamis within the economy. This map is expected to be a publicly-available tool that will contribute to future methodologies for disaster risk management. The AACH is also developing an earthquake and tsunami risk model, in co-operation with the Insurance Regulatory and Supervisory Authority (*Superintendencia de Valores y Seguros* [SVS]), that will be shared with government authorities for their use in risk assessment and when developing policies for public and private infrastructure investment. In **Germany** and **Austria**, the insurance industries have played key roles in the development of comprehensive flood risk maps (Zürs in Germany and Hora in Austria) and in making those risk maps readily available to the public as a means to promote public understanding of risk maps. The Austrian mapping initiative was also extended to storm and earthquake

risks. The insurance industry associations in **France** (Fédération française des sociétés d'assurances and Groupement des entreprises mutuelles d'assurance) have collaborated on the establishment of an association (Mission Risques Naturels) that supports government efforts to improve public awareness of disaster risks and undertakes assessments of hazards and exposures.

Assessment of financial vulnerabilities within the population and economy

As outlined in the Framework, a key objective of risk assessment should be to identify those that are exposed to potential losses from disaster risks and assess their capacity to absorb and recover from those losses, with the aim of identifying risk financing gaps or financial vulnerabilities. **Australia** is undertaking targeted work on improving the resilience of vulnerable sections of the population. This work includes an initial analysis of the strategic issues and range of factors that underpin vulnerability, moving away from labelling whole groups of people as vulnerable based purely on demographic characteristics or assumptions. A national stocktake of initiatives aimed at addressing vulnerability will identify existing work at the national, state and territory and local levels by governments, the not-for-profit, and private sectors to help identify gaps and focus areas for future work to achieve national outcomes that do not duplicate or overlap with existing activities.

In **South Africa**, the Annual Risk and Vulnerability profile, compiled by the National Disaster Management Centre (NDMC), focusses on three separate components: i) quantification of the hazard; ii) quantification of capacity (institutional etc.); and iii) quantification of vulnerability (social, economic, political and technological). The three components are then used in a weighted scoring model to determine a risk score per area of South Africa. Data for this risk profile is adjusted annually to understand the changing dynamic of the county's capacity and vulnerability. In different areas of South Africa, risk is often related to the lack of capacity and to a large presence of vulnerabilities, rather than the nature of the hazard. The economic component within the vulnerability index plays a role in identifying areas of high and low economic impact for disaster incidents. For example, the Gauteng Province features heavily in this category as it is the hub of economic activity. Using the Risk and Vulnerability Profile as an indicative assessment for economic losses, the profiles generated are able to determine sensitive areas based on exposure to disaster risk and capacity to manage that exposure.

Chile has established a capacity to identify vulnerable populations by leveraging the results of a National Socioeconomic Characterisation (CASEN) survey that takes place every 2-3 years. This survey, generally used for the purpose of evaluating the impact of social policies, helps estimate the extent of poverty and income distribution, identify the needs and demands of people in risk areas, and assess the gaps separating different social groups and geographical areas. Following the 27F earthquake, the government made use of the survey to conduct a post-disaster assessment of vulnerabilities in order to identify changes in the standard of living of the population affected by the earthquake and tsunami. The Post-Earthquake Survey covered the affected regions and used panel data, which permitted an evaluation of the evolution of the quality of life of populations affected by the earthquake and tsunami.[6]

In the **Philippines**, in order to improve the targeting of government resources, a survey to map out the poorest communities in the Philippines is being undertaken by the

Department of Social Welfare and Development. This will enable the Department to calibrate the package of social welfare support that it provides to individual communities, including assistance related to disaster risk. The Philippines has noted that disaster impacts are typically borne by families, with various levels of support from government and non-government organisations.

Post-disaster damage and impact assessments

As outlined in the Framework, comprehensive post-disaster loss assessments can provide key qualitative and quantitative information to help identify the strengths and weaknesses of risk assessment and possible areas for enhancement (OECD, 2012: Section I.4). Many economies have systems, tools, and databases in place to track disaster impacts and losses. These may be in place in the public sector or private sector, particularly the insurance sector. This information provides important input for future disaster risk assessment and is also critical for disaster response and recovery, including the provision of compensation to meet disaster losses.

The ***public sector plays an important role in damage assessment and the collection of data*** on costs in order to obtain a view of the scale of disaster losses and respond rapidly and in a targeted manner to those affected by disasters, be it in terms of emergency response and relief or financial compensation. For a number of economies, the completion of post-event assessments is required by legislation or is otherwise completed as a standard practice. In **Slovenia,** the *Act on the Recovery from the Consequences of Natural Disasters* requires that damage assessments are performed by special damage assessment committees at local, regional and national levels. Similarly, in **Sweden**, the *Civil Protection Act* requires that investigations are conducted after emergencies in order to provide data about the types and causes of accidents and emergencies as well as how they can be handled. In **Switzerland**, the federal authorities usually carry out in-depth event analysis after major disasters in order to support preparation for future events.

In the **Czech Republic**, the Ministry of Finance collects data on the impact of disaster events. As the Ministry of Finance provides aid for recovery and reconstruction to state and municipalities for damage to government property and private dwellings, it gathers information from regions and municipalities on the amount of damages incurred and the funds needed for recovery and reconstruction (funding is usually provided if municipal and regional budgets are not sufficient). Estimates must be given within seven days after the declaration of the end of the emergency situation. This information is then processed, in co-operation with the Ministry of Regional Development, and forwarded no later than 20 days after the end of the emergency situation to the government for approval and decision on the amount to be released from the state budget for recovery and reconstruction. The data collected does not distinguish between insured and uninsured losses.

In **Mexico**, the Ministry of Finance has developed a Hazard Tracking System for Tropical Cyclones, known as R-AVISA that tracks cyclones and estimates material and human losses at potentially affected areas. The information to update hazard characteristics – obtained from the US National Hurricane Centre – is automatically processed to estimate losses for exposed infrastructure in the potentially affected areas. This in turn allows for a quick mobilisation of disaster response and prevention resources.

FONDEN of Mexico has also developed a Funding Control, Request and Validation System, known as "*FONDEN en Línea*", which is a web tool that automates the reporting of

damages by affected government agencies from the moment when a disaster happens. Government officials capture the basic information and loss verification evidence necessary to request federal reconstruction funds. The system facilitates the reporting of losses through standardised templates, requiring the attachment of geocoding and photos from the damaged assets by using global positioning system (GPS) equipment. As a result, FONDEN funds can be duly processed and transmitted in a timely manner for the reconstruction of key infrastructure.

Following the 2010-11 Canterbury earthquake sequence, the **New Zealand** Treasury started tracking all the costs incurred by central government entities in the relief, recovery and rebuilding of Christchurch. The New Zealand *Public Finance Act* allows for expenses or capital expenditures to be incurred in emergencies without further authority from Parliament when certain conditions are met. This requires immediate response costs to be recorded so that these can be retrospectively approved in accordance with the legislation. Treasury collects information on public expenditure for relief, recovery and reconstruction from government agencies formally three times a year – once, as part of its annual year-end audit process, and twice as part of its six monthly budget and forecasting processes. This information is held centrally by Treasury and updated regularly. The information can then be regularly accessed for use in the Government's annual financial statements and forecast documents as well as for updates to Ministers. The annual process collects information about the costs that government departments, state-owned entities and Crown entities have actually incurred in the year to date in relation to earthquake recovery efforts in Christchurch. In **Chile**, the Ministry of Finance's 27F earthquake aftermath assessment was executed with other ministries and public entities. Specifically, each ministry calculated the losses incurred in their sector and provided input to the Ministry of Finance for verification and aggregation, streamlining the financial assessment of the disaster.

Damage and loss assessment reports from recent major disasters have also been prepared in **Indonesia**. These reports show a ranking of reconstruction needs, with housing accounting for the largest expenditures followed by public infrastructure (primarily roads, schools and health facilities). In **Malaysia**, whilst there is no systematic mechanism to analyse the impact of a disaster, each agency is responsible for completing this analysis for damages within the purview of its responsibility. Therefore, in the aftermath of a disaster, the response and recovery procedures would be localised and targeted to particular communities.

In the **Philippines**, the Office of Civil Defence, which is the Secretariat of the National Disaster Risk Reduction and Management Council, is tasked with collecting information related to damages and losses in the aftermath of a disaster. Reporting mechanisms are in place to transfer information from the field to the central level in order to report to the President the full extent of disaster impacts. Seismic hazard simulation software called the Rapid Earthquake Damage Assessment System (REDAS) has been developed to produce hazard and risk maps immediately after the occurrence of a strong and potentially damaging earthquake (see Box 2.7).

In **Chinese Taipei**, in order to monitor disaster losses and provide the basis for future government financial planning, 31 types of "Statistical Forms for Large-Scale Disaster Losses" were issued in 2010. The authorities responsible for various aspects of disaster management (e.g. the Ministry of the Interior is responsible for handling the effects of typhoons and earthquakes, the Ministry of Economic Affairs is responsible for handling the

Box 2.7. **Philippines: Rapid Earthquake Damage Assessment System (REDAS)**

Developed by the Philippine Institute of Volcanology and Seismology (PHIVOLCS) of the Department of Science and Technology, in collaboration with Geoscience Australia and supported by AusAID, REDAS is a seismic hazard simulation software that aims to produce hazard and risk maps immediately after the occurrence of a strong and potentially damaging earthquake.

REDAS aims to provide quick and near real-time simulated earthquake hazard information to disaster managers which helps them in assessing the distribution and extent of the impacts of a strong earthquake and prioritising the deployment of rescue and relief operations. The second objective is for the software to serve as a tool to inform land use planners, policy makers, city and town development planners and local governments, with a view to mainstreaming disaster risk reduction into the local development planning process and thus ensuring long-term mitigation of seismic risks.

The software can model four seismic hazards (ground shaking, liquefaction, landslides and tsunami) and, since it hosts exposure data, risk elements can also be plotted. Inputs required to produce hazard maps are basic earthquake and fault parameters. To make it multi-hazard in approach, static hazard maps such as volcanic and hydro-meteorological maps are built-in to the software. Its potential to be a risk assessment tool is being enhanced by improving the exposure database, the inclusion of a building inventory module, incorporation of vulnerability curves and by enhancing its modelling capability to address other natural hazards.

Risk databases can be built using GPS and maps from Google Earth™. The latest version of REDAS, which allows users to estimate earthquake impacts, was introduced for the first time in 2013 to 17 state universities and colleges.

Source: Philippine Institute of Volcanology and Seismology – Department of Science and Technology *www.phivolcs.dost.gov.ph/*.

effects of flooding, etc.) are required to fill out these forms within 60 days of the occurrence of a large-scale disaster and send them to the Office of Disaster Management. The Office gathers and analyses the data on disaster losses methodically and reports them in the *White Paper of Disaster Prevention and Rescues*, which is published annually.

In **China**, in order to assess actual losses caused by disasters and loss development trends, the Ministry of Civil Affairs and the National Statistics Bureau have developed a natural disaster statistical system. The system, which is revised every two years, defines the scope of disaster statistics, their key content, disaster reporting time frames and other aspects of data collection, compiled into nine tables, ledgers and other forms. The main assessment indicators include regions, persons, real estate and crops affected by the disaster. Disaster loss assessments are based on model assessments, on-site investigation and assessment, remote monitoring and assessment, and other approaches. If a major natural disaster occurs, the Ministry of Civil Affairs is required to organise and complete a major disaster loss assessment within 15 working days of receiving a provincial-level disaster loss assessment. Damage tracking assessments are performed annually at the national level on approximately 30-40 major disasters that trigger a national aid and emergency response, and a comprehensive assessment is performed on more than ten major disasters. Currently, the natural disaster loss statistical system, which comprises more than 20 statistical tables and over 500 statistical assessment indicators, has already

entered the approval stage, and a range of assessment techniques have been initially established which make use of grass-roots statistics, on-site investigation and assessment, remote monitoring and assessment, model assessment and various other methods to perform scope assessments, physical asset damage assessments and comprehensive damage assessments. For earthquakes, flooding and typhoons, housing vulnerability assessments in the event of a disaster are mainly performed on the basis of historical housing loss rates and the overall severity of the disaster (curve equation or matrix).

In **South Africa**, the NDMC collects comprehensive disaster damage and loss information through various sources including from Municipal and Provincial Disaster Management Centres (PDMC) which establish committees among various stakeholders and sector departments after the occurrence of a disaster in order to co-ordinate the relevant assistance from national government entities that have made expenditures on disaster losses. The NDMC and PDMCs, as well as the responsible sector departments, have a responsibility to report on disaster expenditure in line with the relevant funding frameworks. In **Spain**, the General Direction for Civil Protection and Emergencies collects information from different institutions (including the CCS) on the impacts of flood events and publishes that data in a publicly-accessible database. The creation of a similar database covering seismic events is underway.

In 2011, the government of **Thailand**, led by the Ministry of Finance and in collaboration with the World Bank and other development partners, undertook a rapid assessment of the impact of the floods in 26 of the 66 affected provinces. The assessment focused on the economic and social impacts of the major flooding on 18 main sectors and was aimed at preparing recovery and reconstruction plans. The results of the assessment were presented in a report establishing the economy's needs for post-disaster recovery and reconstruction and proposed short, medium, and long-term measures in each of the sectors to improve the sustainability of post-disaster reconstruction programs (World Bank, 2012).

In economies where compensation for disaster losses is provided to other levels of government or individuals and businesses, damage assessments are undertaken to support and record the provision of compensation. In **Mexico**, the Ministry of Finance, the CENAPRED and FONDEN collect, store and publish data on government spending to cover uninsured economic losses related to natural and man-made catastrophes.

To assist in the estimation of damages and post-disaster needs, ***methodologies have been developed to ensure coherence and consistency in estimations***. The methodologies may also be used to guide disaster risk assessment. In the **Philippines**, the Office of Civil Defence has recently attempted to draft instructions and methodologies in order to standardise reporting of disaster impacts in the economy based on a customised version of the Post-Disaster Needs Assessment methodology developed by the United Nations, the European Union and the World Bank. In **Russia**, a standard official methodology for estimating disaster impacts has been developed covering both direct and indirect losses, as well as disaster prevention expenses and forecasts. GIS technology is also employed to monitor and track damages in this economy. Systemic estimation methods are described and several official methods for classification of disasters have also been established.

In **Australia**, the federal government is currently working with state and territory governments to develop a National Impact Assessment Model (NIAM). When complete, the NIAM will enable governments to collect information and assess the severity of the impacts of a natural disaster against the social, economic, built and environment recovery domains in a nationally consistent way. The information will assist all governments in

better understanding where, and what type of, relief and recovery assistance is needed. The federal government, in addition, has provided funds to the Royal Melbourne Institute of Technology to revise and update its report entitled *Economic Costs of Natural Disasters in Australia*. The report was developed in 2001 to establish the costs of natural disasters in Australia, to examine the trends in these costs and to develop a model for costing future disasters. The report is being revised and updated with data covering the last thirteen years of natural disaster events in Australia and to incorporate the latest approaches and techniques for assessing disaster losses. The government has also developed a specific database (Damage Assessment and Reconstruction Monitoring system [DARMsys™]) to undertake structural assessment of the damage and monitor the rebuilding process after the Queensland flooding and Cyclone Yasi. Data is collected by assessors using a hand-held Trimble GPS device and transmitted wirelessly to a cloud-based server to allow access to real-time data. This has allowed the development of an accurate picture of the scale and location of damage very quickly after a disaster event. The technology has, following cyclones, been used to promptly assess damage to homes and flooding from a street perspective, and then to generate a database.

In **China**, in order to promote the standardisation of natural disaster risk and disaster impact assessment and other associated tasks, the Ministry of Civil Affairs issued a series of guidelines for disaster risk assessment and disaster loss assessment in 2012. The guidelines divide natural disaster risk into four major categories and 12 types of disaster assessment principles, factors, processes, indices and time frames, covering both risk assessment and loss assessment.

The ***private sector, primarily the insurance sector, is also engaged in the collection of data on losses.*** The insurance sector in many economies such as Australia, Canada, Czech Republic, Germany, Hungary, Malaysia, Mexico, New Zealand, Thailand, South Africa, Switzerland and the United States, amongst others, collects data on insured losses from disasters. In some economies, this data is kept in a central database maintained by the industry. In **Australia**, for instance, the Insurance Council of Australia has a catastrophe claims dataset to track the insured losses arising from natural disasters where the insured losses exceed AUD (Australian dollars) 10 million. In **Germany**, the insurance industry is constantly monitoring and tracking disaster losses. Long-lasting timelines exist for perils such as storm and flood. In **Switzerland**, private insurers record insured losses from natural catastrophes; this loss data base is not public, however, as it is used only for supervisory purposes. As insurance deductibles are standardised in Switzerland, non-insured loss can also be reconstructed. Losses are also monitored and tracked by the reinsurance industry and by large commercial data providers such as Perils in Germany, and Property Claim Service in the United States.

In other economies, data may be maintained by a disaster insurance scheme or collected by the supervisory authority from insurance companies on an *ad hoc* or systematic basis. In **Japan**, the Financial Services Agency has been keeping track of insured losses arising from large disasters such as the Great East Japan Earthquake based on data collected from each individual insurer. In **Thailand**, when a disaster occurs, the Office of Insurance Commission (OIC) collects data directly from all insurance companies. The OIC regularly updates this data and follows up on the process of submitted claims. Since the National Catastrophe Insurance Fund (NCIF) was established in 2012 (see chapter 3), the NCIF collects data and this data can be requested subject to certain conditions. In the **Czech Republic,** the Czech National Bank has the authority to collect data from insurance companies on the

number and volume of claims related to property as defined in the relevant law on state aid for recovery after a catastrophic event. In **Indonesia**, the government is seeking to track insured disaster losses with the support of the private insurance sector.

In **Mexico**, quantified risks and insured losses are collected annually, with the supervisory authority (*Comisión Nacional de Seguros y Fianzas* or CNSF) regularly reviewing information on the calculation of the probable maximum loss. This reporting helps to ensure that premiums charged by insurers are adequate to cover their risk exposure. In **Poland**, the financial supervisory authority (*Komisja Nadzoru Finansowego* or KNF) has, since 2010, been asking insurance undertakings annually for information on natural and man-made disasters that have occurred during the year. Undertakings provide the KNF with information about the number of loss events, value of losses and the extent to which they were covered by reinsurance contracts. The KNF analyses this information, in particular from the perspective of the impact of losses on the solvency position of (re)insurance companies. In **Portugal**, insurance undertakings inform the supervisory authority, on a quarterly basis, about their aggregate insured losses, which implicitly includes the total amount of losses that resulted from catastrophic events.

Databases, public or private, provide a key tool for tracking disaster impacts and losses over time and promoting consistency in data collection methods. This data can then be used to develop risk assessments and, when public, can contribute to raising public awareness about disaster risks. In **Canada**, the Canadian Disaster Database (CDD) – a publicly accessible web-based repository of historical information about natural and man-made disasters – contains information on over 1 000 past disaster events (see Box 2.8).

Box 2.8. **The Canadian Disaster Database (CDD)**

The CDD contains detailed disaster information on natural, technological and conflict events (excluding war) that have happened since 1900 in Canada or abroad and that have directly affected Canadians. The CDD tracks "significant disaster events" which conform to the *Emergency Management Framework for Canada* definition of a "disaster" and meet one or more of the following criteria:

- 10 or more people killed
- 100 or more people affected/injured/infected/evacuated or homeless
- An appeal for national/international assistance
- Historical significance
- Significant damage/interruption of normal processes such that the community affected cannot recover on its own.

The database describes where and when a disaster occurred, the number of injuries, evacuations, and fatalities, as well as a rough estimate of the costs (insured and uninsured). As much as possible, the CDD contains primary data that is valid, current and supported by reliable and traceable sources, including federal institutions, provincial/territorial governments, non-governmental organisations and media sources. Data is updated and reviewed on a semi-annual basis. A geospatial mapping component has been added to the CDD, which enables users to refine their search of the disaster database to a spatially-defined area. It also displays query results charted across a map.

The CDD displays cost data in the dollar amount of the year that the event took place or the year a specific payment was made. Users may also convert this "raw", data into the dollar

Box 2.8. **The Canadian Disaster Database (CDD)** *(cont.)*

amount in effect for the year of their choosing to assist with analysis concerning whether costs have increased or decreased over time or whether preventative/mitigating measures have helped to lower the cost of disasters.

Housed and maintained by Public Safety Canada, the CDD data is updated as new information about past disasters becomes available and as new disasters occur.

The CDD consultation process involves a network of participating disaster experts from academia, non-governmental organisations, and various provincial, territorial and federal governments. This network of experts is consulted in order to either provide raw data, or verify and enhance disaster information proposed for inclusion in the CDD. Conceived as an idea to better inform the public, as well as government policy and program officials on disasters in Canada, the CDD is now accessed internationally and used for awareness, risk assessment and as a tool to support decision-making.

Source: Public Safety Canada – *www.publicsafety.gc.ca/cdd*.

In **Australia**, governments, communities and businesses have access to a number of databases that track the economic and other impacts of natural disasters. One of these databases is the Australian Emergency Management Knowledge Hub,[7] which provides research, resources and news relevant to emergency management and includes statistics, information, photos, video and media about past disaster events. The Knowledge Hub includes a database of historical disaster information which can be searched by disaster type, location, date, number of injuries and fatalities, and insurance cost.

In **Switzerland**, there are a number of government databases tracking natural disasters and their physical impacts. The Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) runs a database with information on floods and mudslides dating back to 1972. WSL and the Federal Office for the Environment collect data on the number of forest fires and the extent of the affected areas. At the level of Swiss cantons, there is an obligation under the *Forest Act* and *Water Construction Act* to maintain a disaster register (*cadastre des événements*). In **Brunei Darussalam**, the National Disaster Management Centre has acknowledged the importance of disaster risk and loss assessment, as well as the need to monitor financial impacts and track disaster costs and is planning for the establishment of a centralised disaster loss database.

In some economies, there has been a specific effort by the private and public sectors to ***collaborate on the collection and sharing of data*** related to disaster losses. In **France**, following the devastating effects of windstorm Xynthia in 2010, causing storm surges in the Bay of Biscay and in Brittany, the French government, the *Caisse centrale de réassurance* (CCR, the state-owned reinsurance company), and a group of insurance companies (*Mission des sociétés d'assurances pour la connaissance et la prévention des risques naturels*), established a National Observatory of Natural Hazards (*Observatoire national des risques naturels*, or ONRN) as a non-profit, public-private collaboration in disaster risk assessment. The establishment of the ONRN allows for the sharing of information and data collected and elaborated by different stakeholders, at central and local levels, including confidential data, and for the presentation of such information and data in a reliable, harmonised, updated and consistent manner. The ONRN provides consistent and harmonised data on natural hazards for a full range of different applications, including risk assessment, risk mitigation, emergency

preparedness and financial planning.[8] End users of the data have a role in the governance of the ONRN, and can thus provide comments and input into ONRN work.

Given the growing interconnectedness of economies, which can create spill-over effects from disasters elsewhere, ***private businesses have a genuine interest in learning about disaster impacts in other economies***. For instance, in **Hong Kong, China**, in order to assist its manufacturing industries (which have important supply linkages with Japan), the government conveyed to the Japanese Government its industries' request for more information on the supply situation in Japan following the Great East Japan Earthquake. Information provided by the Japanese Government was then disseminated to the affected industries in Hong Kong, China. Thus, economies with relatively low exposure to extreme hazards may have a strong interest in proper damage assessments being conducted by those parts of the world prone to disasters.

Implementation challenges

Economies that participated in the survey reported a number of challenges to undertaking comprehensive *ex ante* risk and vulnerability assessments and *ex post* damage and loss assessments, mostly related to a lack of assessment capacity (including limited expertise, resources, defined processes, and technologies) as well as a lack of buy-in from government departments that can impede co-ordination.

A lack of assessment capacity for *ex ante* risk and vulnerability assessment and *ex post* damage and loss assessment was identified as a challenge, attributed to a number of factors, including: i) a lack of resources for collecting data, modelling impacts, and quantifying exposures across levels of government (and particularly at sub-national levels); ii) a lack of data for assessing financial, economic, and social impacts, partly as a result of limited resources; iii) a lack of technical expertise in specific areas; iv) a lack of clear processes for undertaking assessments, measuring exposures, and calculating losses; v) and a lack of supporting technology to facilitate damage assessment.

Resourcing the development of risk assessments is a challenge at all levels of government as most existing national disaster funding models are weighted towards response and recovery, with a focus on immediate humanitarian and economic relief and restoration of infrastructure to its previous standard – rather than risk assessment and mitigation. A lack of stable funding for developing data collection and processing as well as modelling capacity can also create particular challenges. The development of these capacities requires a combination of research, application, improvements and fine-tuning, which is a long-term process requiring stable funding to guarantee sustainability in technical capacities – the lack of stable funding means that it is impossible to overcome key technical issues and modelling methods in disaster assessment.

A lack of resources for data collection and processing creates specific challenges for risk assessment. Data may be unavailable, there may be a lack of sufficient granularity, the data may not be geo-referenced or may be unavailable in the required format. As revealed in a survey conducted by the OECD (see Box 2.9), many governments do not systematically collect data on disaster losses. Some economies prefer, moreover, to maintain localised loss databases, leaving the responsibility for data collection to local governments or individual ministries. This contrasts with, and may in some instances possibly be explained by, the existence of several long-standing domestic, regional, or global initiatives in the field of collection and dissemination of data on disaster losses or risk coverage/risk

Box 2.9. **OECD Survey on challenges in the quantification of losses**

In 2011 the OECD conducted a survey on data collection and procedures to quantify disaster risks, difficulties encountered by members and other selected economies, as well as relevant national initiatives in this field. While nearly all respondents see themselves as prone to disasters, the outcome shows that:

Quantification of insured and uninsured losses

- More than half of the respondents find it difficult to provide aggregate amounts of insured losses resulting from disasters in recent years, and many of them do not collect such data at the national or sub-national level.
- In more than half of the responding economies, information is collected by the private sector and in about half of them by the public sector as well. Several respondents refer to private sources only. These data collection activities are conducted on a voluntary basis in some members.
- Aggregate data on uninsured losses, which are difficult to estimate as they affect many different populations, communities, goods, buildings or infrastructure, are computed at the national level in only about one fourth of the responding economies.

Quantification of insurance coverage

- Data on insured exposures to natural and man-made disasters is collected/disseminated at a national (or sub-national), regional, or international level in only a few economies.

Quantification of government spending after a disaster

- In only about one third of the respondents reviewed, aggregate data on government spending incurred to cover uninsured economic losses after a disaster (e.g. emergency response costs, temporary housing, payments to households for physical damage, reconstruction) are collected.
- The production of spending data requires in-depth co-operation between different governmental agencies that is often time-consuming. To overcome this difficulty, some governments have established a special entity to co-ordinate data collection at the national level.

In several responding economies, the process of data gathering/dissemination on insured losses and/or level of risk coverage is attracting rising interest and is currently being reviewed and improved in a number of them.

Note: The UNISDR Global Assessment Report 2013 also identified the inadequate availability of disaster data, due to the fact that disaster losses are often not systematically accounted for, as one of the key obstacles to risk assessment and planning at the national level. As a result, the lack of visibility of disaster risk and the uncertainties around risk ownership pose major challenge for the implementation of effective DRM strategies (UNISDR, 2013: Chapter 15).

Source: OECD, Policy Options for Disaster Risk Financing and Transfer, Quantification of Disaster Losses and Exposures: An OECD Perspective in Government of Mexico (G20 Presidency) and World Bank, 2012: Chapter 17.

exposures, such as ISO's Property Claim Services (PCS) in the United States, PERILS AG in Europe, Swiss Re sigma, Munich Re GEO risks research, the Centre for Research on the Epidemiology of Disasters (CRED) EM-DAT, the DesInventar methodology and Asian Disaster Reduction Center's Global Disaster Identifier Number (GLIDE). Comparability of information across these initiatives is, however, problematic given non-homogeneous parameters in the choice of definitions, classifications, adjustments, geographic areas, and other features. Efforts to harmonise classification criteria have been undertaken, such

as the implementation of a common disaster category classification and peril terminology, although significant variation in approach remains across economies (CRED and Munich Re, 2009).

These challenges remain and were identified by a number of economies. In some cases, traditional disaster relief decision-making is mainly based on local statistical reporting on local disasters and experience, with disaster loss assessments rarely performed. A lack of experts who can estimate the impact of damage to assets and the extent of disaster-damaged areas is also an impediment.

Specific types of risks and data posed particular estimation challenges. For example, while it is possible to track and estimate some costs fairly easily (e.g. costs of search and rescue, and other immediate response costs), other costs, such as the cost of fixing local infrastructure (e.g. water pipes and roads), are much more difficult to estimate at the national level. Where costs cannot be reliably estimated, these present a challenge and on-going fiscal risk. There is also limited understanding of the costs of cyber-attacks, a man-made threat that may have systemic impacts within the economy. The value of information and equipment and the costs related to re-securing networks have not been adequately assessed and it was suggested that this could be an avenue for future research.

As noted above, a number of economies, such as **Mexico** and **Australia**, have developed specific technologies to support the timeliness and quality of risk and damage assessment information. However, a lack of supporting technology remains a key challenge in other economies. For example, the lack of a real-time integrated information management system for risk assessment may be a key obstacle to the development of pre-disaster impact analysis. There may also be challenges in terms of operating a disaster reporting system based on fixed computer terminals, which restricts the timeliness of disaster reporting and creates concerns related to a lack of reliable protection for its network and hardware environment (the destruction of which would have an impact on reporting). In some cases, a lack of equipment for grass-roots disaster reporting such as dedicated computers, cameras, video cameras and other disaster recording and reporting equipment may present a significant challenge.

Another key challenge relates to a lack of co-ordination among government departments involved in risk and exposure assessment and disaster response. For example, in one economy, specific risk assessments are undertaken by different ministries in the context of particular risk prevention projects, although there is no mechanism for consolidating the findings of those assessments. Another economy highlighted challenges in regard to the systematic collection of financial impacts due to fragmented financial reporting responsibilities (budget office, agency responsible for disaster risk management, civil defence agency, and the presidential office) which has made it difficult to implement consistent and standardised methodologies for data collection. Another economy noted that there may be problems with information flows as some agencies may view their data as proprietary and not make the data readily available to other government departments. Another economy noted that, while the government monitors disaster losses for the public sector, there is a lack of a proper systematic methodology and estimation model for private sector losses, inhibiting the government's ability to understand the cumulative social and economic impacts of disasters on the economy.

In some economies, processes for reporting may be in place although reporting across government agencies is lacking, impeding an assessment of the full range of disaster

impacts. One economy highlighted the importance of emphasising the objectives and nature of risk assessment throughout relevant government agencies in order to make them aware of the relevance of complete and accurate information and encourage co-operation from those who are responsible for, and manage, the necessary information. In particular, agencies must be made aware of the benefit of sharing their information as a means to build financial risk management strategies that may improve their own risk transfer options while enhancing the benefits to be derived from such schemes. This economy suggests that it may be helpful if requests involving numerous departments are sponsored by one or more top ministries in order to ensure prioritisation and support timely information gathering.

One economy reported that very strict laws surrounding the gathering and utilisation of data due to privacy reasons is an important challenge for assessing disaster risk on its territory. It noted that due to these laws, information which is essential for completing an accurate assessment of risk is blurred, tiled or coarsened to meet data protection objectives. As a result, the risk picture is incomplete.

Notes

1. Anticipated government interventions may be relevant in this respect; for instance, more timely availability of funding can reduce the indirect impacts and secondary consequences of a disaster.
2. A more recent version of the DaLA methodology is the multi-sectorial post-disaster needs assessment (PDNA) methodology that takes into account recovery and reconstruction priorities over a short, medium and long term time frame.
3. Although initial efforts focussed on these three natural hazards, the goal is to have estimations for all hazards relevant for Mexico. Mexico currently uses models for up to ten natural hazards.
4. The other participating economies are: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Republic of the Marshall Islands, Nauru, Niue, Palau, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, and Vanuatu
5. PCRAFI (*http://pcrafi.sopac.org/*) is a joint initiative between the Secretariat of the Pacific Community (SPC) – its Applied Geoscience & Technology Division (SPC – SOPAC) – the World Bank and the ADB, with financial support from the government of Japan and the Global Facility for Disaster Risk Reduction (GFDRR) and technical support from AIR Worldwide, New Zealand GNS Science, Geoscience Australia, Pacific Disaster Center (PDC), OpenGeo and GFDRR Labs.
6. The survey data was provided by the Social Observatory of the Universidad Alberto Hurtado, and was conducted between the months of May and June of 2010 through the implementation of a face to face questionnaire of a subsample of 22 456 households interviewed in the 2009 CASEN survey. For more information, see *http://observatorio.ministeriodesarrollosocial.gob.cl/*.
7. The Australian Emergency Management Knowledge Hub is available at: *www.emknowledge.gov.au*.
8. For instance, the French Ministry of Sustainable Development had started a preliminary evaluation of flood risks for the purposes of implementing the EU Flood Directive to its full extent. This exercise, now to be carried forward under the auspices of the ONRN, is expected to lead to a comprehensive assessment of flood risks in France, as well as to the design and adoption of targeted flood risk mitigation measures.

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Chapter 3

Private disaster risk financing tools and markets and the need for financial preparedness

This chapter provides an overview of the disaster risk financing tools available to households and businesses in surveyed economies and approaches to improving disaster insurance coverage, including public awareness initiatives and efforts to ensure the resilience of the financial system. An overview of the disaster risk financing tools available and the contribution of such tools to the financial management of disaster risks is provided along with an overview of public support for disaster insurance, including regulatory measures, subsidies, investments in risk reduction, public (re)insurance facilities and guarantees as well as targeted approaches to supporting financial protection among vulnerable populations. Efforts to ensure the resilience of the financial sector to disaster risks, including the capacity to efficiently settle claims in the event of a disaster, and to improve public awareness of disaster risk and the need for financial protection are described. The chapter concludes with a discussion of common implementation challenges to ensuring comprehensive financial protection against disaster risk.

Private insurance and mitigating the cost of disasters

As emphasised by the G20/OECD Methodological Framework, a comprehensive and integrated approach is required for disaster risk financing strategies, including an assessment of the availability, adequacy and efficiency of different types of financial tools available to the population and within the economy, as well as their costs and benefits relative to other types of possible risk reduction measures.

Private insurance is one of the main risk financing tools for businesses and households (as well as governments, see chapter 4) to strengthen their financial resilience against disasters, complementing investments in risk reduction. Risk transfer instruments, such as insurance, allow for the shifting of a portion of disaster risks to others, in exchange for a price, and for the spreading of such risks. Within insurance markets, reinsurance plays an essential role in managing the financial impacts of disasters, given its ability to distribute risk and losses internationally. The financial sector and, in particular the insurance sector, can be called upon to play important roles in this field, depending on the stage of development of these markets, the robustness of their infrastructures, the level of capitalisation, solvency and soundness of insurance undertakings, the degree of market openness as well as the financial depth of the economy. A stable and well-functioning financial sector enables continued economic activity following a disaster and supports the provision of DRF. As witnessed by recent experience in **New Zealand**, where there is a high penetration of (government-provided) earthquake insurance coverage, disaster insurance can facilitate rapid economic recovery in the aftermath of a major earthquake by providing the necessary resources to fund reconstruction in a timely manner and reduce interruption to economic activity.[1]

In addition to traditional insurance and reinsurance contracts, risk financing can also be accessed by large corporations, insurers, and governments through innovative financial products developed in the capital markets. The availability and cost of these capital market instruments are influenced by uncertainties characterising the risk assessment process: supplying reliable and consistent data on hazards, exposures and vulnerabilities, or at least facilitating the collection, recording, storage and dissemination of such data, can greatly enhance the capacity of markets. The development of private market risk transfer solutions may also be influenced by the level of post-disaster assistance offered by the government; specifically, the willingness of individuals and businesses to obtain private disaster insurance may diminish should there be an expectation that the government will compensate those affected by the disaster for any losses incurred, regardless of whether private insurance coverage was available.

When assessing the availability, breadth, and depth of private market risk transfer solutions for disasters, and in particular in regard to disaster insurance, the following main elements can be considered (see also Table 3.1):

1. The *hazards covered* (natural and/or man-made, depending on the disaster risk profile of the economy) against which coverage is available

2. The *scope of losses covered* (e.g. property damage, business interruption, life, accident, liability) by insurance
3. The *segments of the population and the economy* for which coverage is available (e.g. households in urban areas, households in rural areas, farmers and herders, small business enterprises, large commercial and industrial corporations, local governments)
4. The *contractual mechanism* by which disaster coverage is made available on the market (e.g. stand-alone policies, optional endorsements to other policies)
5. The *pricing mechanism* of insurance coverage.

Table 3.1. **Key aspects of disaster insurance**

1) Hazards covered	• Single • Selected group • All
2) Scope of losses covered	• Damage to property, e.g.: ❖ Residential/commercial ❖ Private/public (buildings and infrastructures) • Damage to motor and transport vehicles • Business interruption • Life, accident • Liability
3) Segments of the population and economy covered *(policyholders)*	• Households (e.g. urban, rural) • Corporate (e.g. large commercial, small and medium-sized enterprises (SMEs), agriculture) • Financial sector • Government (e.g. central, local)
4) Contractual mechanism	• Stand-alone policy • Extension/endorsement
	Linked to separate contract, financial or non-financial
	• Credit-linked insurance (e.g. mortgage, loan) • Insurance linked to an infrastructure concession, engineering contract
5) Pricing	• Flat • Risk-based
6) Other policy features	• Deductibles • Co-insurance • Basis of claim (indemnity-based or parametric-based)

Source: Adapted from G20/OECD Methodological Framework for Disaster Risk Assessment and Risk Financing, *www.oecd.org/daf/fin/insurance/OECD_APEC_DisasterRiskFinancing.pdf*.

In some economies, the ***availability and affordability of disaster insurance is not considered problematic***, due to a ***relatively low level of risk***. In **Hong Kong, China,** for instance, insurance for disaster losses is provided by the private insurance sector and covers all segments (individuals, households, small businesses, large corporations). Earthquake coverage is included in the basic fire or all-risks rate without specific charge. Almost all policies cover earthquake, either as a specified peril (earthquake shock and fire, volcanic eruption and tsunami) or as part of an all risks wording. Cover is normally provided for the full sum insured. The typhoon season in Hong Kong, China, is in the summer time but over the last two decades typhoon losses have been minor. Despite the exposure, there is no specific windstorm rate – the peril is included within the overall fire or all-risks rate and almost all policies include windstorm for the full sum insured. Most domestic and commercial policies, moreover, automatically include flood for the full sum insured.

In **Malaysia**, disaster insurance on a stand-alone basis is not available as there is little demand for such products, reflecting the low level of disaster risk (except for occasional floods). Household property insurance available from the private sector covers hurricane,

cyclone, typhoon, windstorm, earthquake, landslides and floods. For commercial properties, such protection can be obtained at an additional premium. Fire and motor insurance with protection against additional perils (such as floods, hurricanes, landslides), can also be obtained at an additional premium. Catastrophe perils may also be extended to contractor's all-risk and engineering-type policies and to industrial all-risk insurance policies. At an additional premium agricultural insurance can be extended to cover natural disasters including floods and windstorms.

In **Singapore**, insurance products covering disaster perils are available to individuals, corporate entities, and government. Most of the perils are covered under property insurance policies. For example, most mandatory fire insurance policies are acquired together with a mortgage loan or as a Management Corporation Strata Title (MCST) property and offer basic coverage against damage to the building structure or common areas by fire, lightning, bursting or overflow of water tanks and apparatus, malicious intent and floods. In **Brunei Darussalam**, while there is no specific disaster insurance available (i.e. no standalone products), coverage for certain types of disasters are included in property cover, such as floods and landslides.

While in other economies disaster risks may be more material, ***private disaster insurance provides varying levels of risk coverage and penetration***. In **Germany,** insurance coverage for natural catastrophes (*Elementarschadenversicherung*) which includes flood coverage, can currently be obtained for more than 99% of areas. Coverage is generally provided at the building's sliding replacement value (i.e. automatically adjusted to the price trend, thereby reducing the possibility of underinsurance). However, market penetration remains low (approximately 33%). In addition, natural catastrophe cover and especially flood insurance is not available in certain high risk areas (like river valleys); however, there have been recent discussions on how to make coverage available in those areas.

In the **Czech Republic**, coverage for the full range of natural hazard risks is available within the insurance market, which is regarded as well-developed and able to provide coverage for households, companies, agricultural producers and the government. Risks may be bundled; that is, sold together in one policy, or the policy could be designed only for one peril/damage (however, insurers will generally prefer to bundle the risks so as to diversify them). Disaster insurance coverage is not compulsory. The only persistent problem reported by the government regarding insurance coverage is the existence of buildings or properties in flood zones that are not insurable. The treatment of citizens living in flood zones where insurance is not available remains a sensitive social and political issue. However, this problem concerns only dwellings that have been built in the past as, according to current legislation, the authorities may not issue a building permit in the flood zones. Also, the government bans any activities that could worsen drainage functions within the flood zones.

In **Hungary**, there is a well-developed system of insurance coverage, with household insurance products covering all disaster risks (for natural hazards – flood, storm, hail, earthquake, and landslide). Household insurance has a relatively high penetration rate at approximately 75%, ensuring wide coverage of disaster insurance. However, some insurance policies exclude flood in high risk localities. To address this issue, households which cannot obtain insurance for flooding have access to the state fund *Wesselenyi Miklos Ar-es Belvizvedelmi*.

Australia has a well-established private insurance market that offers products that insure against losses from a wide variety of risks. In principle, its existence allows the economy to manage risks more effectively, reducing financial uncertainty in the event of a disaster and allowing for a more efficient use of capital by individuals, businesses, and government. However, a series of natural disasters in Australia in recent years, including the Queensland floods of 2010-11 and Cyclone Yasi in 2011, resulted in insured losses running into the billions of dollars.[2]

Insurers responded to these disasters by investing in their understanding of the risk of, and therefore potential losses from, natural disasters. A better understanding of the idiosyncratic risks faced by particular areas and particular properties, including detailed flood risk data on individual properties, has resulted in a widespread risk re-rating of properties for natural disasters. Premiums have been increased, in large part reflecting this new understanding of idiosyncratic risk, and in some cases, insurers stopped offering flood cover to consumers in certain high-risk areas. Insurance prices for home contents, and in particular for home buildings, has outstripped the growth in consumer prices. Some particular geographical regions such as North Queensland (which is vulnerable to floods and tropical cyclones) have experienced larger than average increases. The significant changes in the insurance market in Australia (and New Zealand, following the Canterbury earthquake sequence) prompted government reviews of natural disaster insurance arrangements in 2011 (see Box 3.1).

Box 3.1. **Disaster Insurance Reviews in Australia and New Zealand**

In **Australia**, following major floods in Queensland during the period from December 2010-January 2011,[1] the Natural Disaster Insurance Review (NDIR) was launched to consider issues related to the availability and affordability of insurance offered by the private insurance market.

The Review was stimulated by the absence of flood insurance for many policyholders, as well as by evidence of under-insurance for bushfires, cyclones and floods more generally. A significant proportion of homeowners who suffered property damage had policies that did not cover flood damage. The fact that home insurance policies covered storm damage, including related water damage, but many policies did not cover flood damage created frustration and confusion among policyholders. Some individuals had opted not to take flood coverage where it was available or were unaware that their insurance did not cover flood or only covered it partially. The lack of flood coverage in many home insurance policies led to a community backlash against insurers during 2011 and considerable distress, financial loss and disillusionment for many insured homeowners.

The NDIR was set up primarily to explore options for the most preferable risk sharing arrangements, with the overarching premise that there was no desire to interfere with the private market whilst it was functioning satisfactorily. There was a particular emphasis on examining the extent of non-insurance and underinsurance and ways of remedying this outcome. The biggest problem was in relation to the operation of exclusion clauses.

In relation to public assets, the Terms of Reference of the NDIR specifically asked the Review Panel to consider whether the existing Commonwealth and state arrangements for dealing with natural disaster recovery and resilience required supplementation. The relationship between private market solutions and public funding mechanisms was, therefore, touched on in the course of the review.

Box 3.1. **Disaster Insurance Reviews in Australia and New Zealand** *(cont.)*

The Australian Government was concerned with ensuring that the appropriate measures are in place to foster more complete sharing of risk and equitable sharing of the cost of damage and loss resulting from floods and other natural disasters throughout the nation. The NDIR was aimed at identifying possible strategies to achieve a number of key results, including:

i) Improving the ability of individuals and communities affected by the floods and other natural disasters to recover and rebuild as quickly as possible.

ii) Giving people the opportunity to choose where they live in an informed way.

iii) Giving individuals and communities at risk the opportunity to obtain suitable protection against those risks, both in terms of having access to insurance and benefiting from appropriate mitigation strategies.

The NDIR was comprised of a Review Panel and a Working Group with representation from Treasury and various government departments. Consultation was undertaken with communities, businesses, members of the public, state and territory governments and international experts. The final report was published in September 2011 and included a number of recommendations for improving the management of flood risks in Australia. This includes measures to ensure comprehensive coverage of flood risks by offering premium support and reinsurance for flood insurance coverage in flood-prone areas. The Australian Government launched a set of consultations to explore the implications of those recommendations. A number of measures have also been implemented to improve the consumer understanding of flood coverage and to improve the claims management process (see below).

Similarly, in **New Zealand**, a review of the Earthquake Commission (EQC), the Crown entity that provides insurance coverage for earthquakes and other disaster, is pending. EQC was put under scrutiny after the 2010-11 Canterbury earthquake sequence which represented the first major test of the EQC model since its inception. Through the review, the government of New Zealand is seeking to achieve a series of objectives, including to: i) support the contribution of a well-functioning insurance industry to economic growth opportunities; ii) minimise the fiscal risk to the Crown associated with private property damage in natural disasters (a contingent liability); iii) support an efficient approach to the overall management of disaster risk and recovery; and iv) minimise the potential for property-owners to experience socially unacceptable distress and loss in the event of a disaster. Matters covered by the review include the structure and extent of EQC cover, the pricing of insurance coverage, the institutional design, and the financial management strategy. A consultation document was published in July 2015.

1. The flooding, which occurred in a La Nina year, was the result of a series of heavy rainfall events and several cyclones, including Tasha and Yasi that "were historically unique due to their causes and wide-ranging impact" (in past La Nina years, parts of Queensland had also experienced severe rainfall and flooding) (World Bank and Queensland Reconstruction Authority, 2011).

Source: Australia Natural Disaster Insurance Review (*www.ndir.gov.au*); New Zealand Review of the Earthquake Commission Act (*www.treasury.govt.nz/publications/reviews-consultation/eqc*).

The increased inclusion of flood cover in home and contents insurance policies in Australia has also been a factor that has led to an increase in the prices of insurance policies. At the time of the 2010-11 Queensland floods, only about 54% of policies for home buildings included coverage for flood – as of May 2013 that figure stood at 83%.

In several economies, ***disaster coverage may be limited due to the limited scope of insurance markets more generally***. In these markets, efforts are being made to enhance the availability and penetration of disaster insurance. In **Mexico**, insurance policies are sold in packages with earthquake, volcanic eruption, and hydro meteorological perils as an add-on if fire insurance is purchased. General household insurance policies have less than a 5% penetration rate for voluntary policies, while the penetration rate for loan-linked insurance is approximately 36%. The commercial and industry penetration rates are 5% for small enterprises, increasing to 30%-40% for medium-sized industries and approximately 95% for large industries. Similarly, in **Chile**, earthquake and tsunami risks can be covered by way of optional endorsements to residential property policies. There is widespread coverage for natural disasters in insurance policies purchased by large industries (e.g. mining, electric and industrial sectors), to protect against both property damage and business interruption. The Chilean government also requires that infrastructure investments awarded in concessions be covered by natural disaster insurance.[3]

In **China**, property insurance provided on a purely commercial basis and targeted at corporate clients includes disaster coverage, although the insurance penetration rate is low. Rural housing insurance, which aims to provide disaster coverage for rural village residents' homes, is integrated into a regional product, with premiums generally supported by local financial subsidies. There is considerable variation in coverage of rural housing insurance across regions. The regulatory agencies in China encourage insurance companies to pro-actively develop innovative products, increase the quality of insurance services, and satisfy the disaster coverage needs of individual and corporate clients. Over the longer term, the government plans to provide major financial support to disaster risk financing. In **Russia**, insurance against natural hazards comprises a minor proportion of the level of total insurance premiums. With disaster insurance having a low penetration rate, post-disaster government financing dominates. For instance, only 15% of houses destroyed by fires in 2010 were insured. While the introduction of mandatory insurance schemes for extreme events has been considered, no consensus has been reached to date, and legal and constitutional issues exist.

Public support for disaster insurance

Disaster risks may, however, be uninsurable or hard to insure due to the expected high frequency and/or high level of severity of hazard events. Risk reduction has the potential to increase insurability by reducing risks facing the insurance sector, although some peak risks, due to their extreme nature, may never become insurable on reasonable economic terms. Furthermore, in economies where insurance markets are not well developed (but also in more developed markets), insurance products may be unavailable or unaffordable, for instance due to very low income levels, poorly developed or inefficient distribution systems, and lack of proper data and supporting institutions to record and collect the data necessary for efficient pricing, among other factors.

Measures to make risk transfer mechanisms available and affordable, such as broad state-sponsored disaster insurance programmes as well as more narrow approaches targeting specific sectors or segments of society could be taken. Specific incentives aimed at improving the availability and affordability of disaster insurance through subsidies and tax incentives can also be effective. Disaster risk awareness also plays an important role in generating demand for disaster insurance by promoting awareness of the financial

impacts of disasters and the need to plan for – and mitigate – these impacts through the development of financial strategies.

As outlined in the G20/OECD Methodological Framework, careful consideration needs to be given to any intervention in insurance markets, including an assessment of expected costs and adverse impacts and possible effects on incentives and market functioning as well as on the likely distribution of expected direct costs which may be passed on or directly charged to households, businesses and other end users of insurance. How these direct costs are distributed among stakeholders may prove to be a sensitive issue, particularly as any institutional arrangement mandating the purchase of insurance may be viewed as an implicit tax.

Regulatory measures, subsidies and collaboration in risk reduction

In a number of economies, governments have sought to promote greater coverage against disaster risks through legislative and regulatory measures, as well as through subsidies and other financial incentives. For instance, in some economies, the provision of disaster insurance coverage by the private sector is required by statute as an add-on to voluntary fire insurance policies. In other economies, the insurability of disaster risks has been promoted through public-private collaboration on risk reduction.

In **Belgium**, all home insurance policies offered by private insurers must cover most natural disasters, including flood, earthquake, landslide, and storm risk (including damage caused by hurricanes and other bursts of wind as well as by hail, snow and ice pressure) where a fire policy has been purchased. While the coverage of disaster risks is not compulsory, insurance policies including such coverage are very popular and a great part of the population is covered by such insurance. The framework imposes limitations on the extent of cover, namely that the total sum insured: i) for a building and its contents must not exceed EUR (euros) 1.466 million; and ii) for goods that are used for trade or industry does not exceed EUR 471 million. The scope of coverage includes homes, farms, horticulture, wine, fruit and livestock, and covers damages to buildings and furniture but does not include business interruption or corporal damages. If the limits are breached, the *Caisse nationale des Calamités* (National Disaster Fund) may intervene to expand on the coverage provided by private insurers. It is sometimes difficult for a consumer to insure certain risks (e.g. a frequently flooded home) as the private insurers refuse to cover the risk or accept the risk but only at a very high premium. A public institution (*Bureau de tarification – Catastrophes naturelles* [Office of pricing – natural disasters]) was established to arrange tariff conditions (premium rates) and contractual conditions for natural disaster risk policies that insurers refuse to cover under their own terms. The results of the management (benefits or losses) and operating costs of the Office are divided between insurers offering simple risks and fire insurance in Belgium and the members of the National Disaster Fund.

In **Switzerland**, there is a dual system for the provision of natural disaster insurance. Private insurers are obliged to offer natural catastrophe coverage for flood, storm, hail, snow, avalanche, snow pressure, rock fall, rockslide and landslide[4] as part of fire insurance for buildings[5] in the seven cantons that do not have a cantonal monopole insurer, and for home contents in 23 of 26 cantons. The owners of buildings are obliged to insure buildings against natural catastrophes in most (22 of 26) of the Swiss cantons although the purchase of coverage for contents is not mandatory. The penetration rate for natural disaster coverage is high with almost all buildings being insured against natural catastrophes and

most households (estimated at 90%) covered for contents as well. The premiums and deductibles for this coverage are uniform at rates proposed by the insurers (based on expected losses, expenses, and the risk of unexpected losses) and approved by the supervisory authority. Since it is uniform, it is also affordable for building owners with higher than average exposure to natural catastrophes. This uniformity is politically motivated; it implies a solidarity of less exposed to more exposed regions as well as a compensation between different perils (some regions are more exposed to flood, others more to avalanches). Insurers pool their natural catastrophe claims in a claims pool from which insurers pay for their share of losses according to their market share, which ensures there is no economic disadvantage for individual insurers in providing coverage in riskier locations (given that they are under no obligation to offer the fire insurance that the natural catastrophe coverage is attached to in all regions).

In some economies, the government has established ***a statutory approach to create a reinsurance pool owned and operated by the private insurance industry***. In **Indonesia**, *PT. Asuransi MAIPARK*, a specialist reinsurance company, was established in 2003 to support the management of earthquake risks. The governing legislation provides that all non-life insurance and reinsurance companies operating in Indonesia are shareholders of the company and the company is operated by the insurance sector. Premiums are charged at a set rate based upon the type of property (commercial/industrial or residential dwelling); the materials used in the building's construction (wood, steel, reinforced concrete frame); and a fixed component based upon the region in which the property is located. The commercial properties category is also divided between properties which exceed nine stories high and those with less than nine stories. Insurance cover is an extension of standard fire policies and is regulated by the Indonesian Standard Earthquake Policy which encompasses cover for damage from earthquake, fire and explosion following an earthquake, volcanic eruption, and tsunami as well as related business interruption.

A number of state governments in the **United States** have established insurance pools for storm (and sometimes hail) risk, often limited to residential and commercial customers that have difficulty accessing private insurance markets, and sometimes with the explicit financial backing of the state government (see Table 3.2). Such pools exist in a number of hurricane-prone states, including North and South Carolina, Georgia, Texas, Alabama, Mississippi, and Louisiana. In California, the California Earthquake Authority (CEA) provides catastrophic residential earthquake insurance in light of severe restrictions to earthquake insurance coverage offered by the private sector in the wake of a 6.7-magnitude earthquake that struck California's San Fernando Valley in January 1994. Companies that sell residential property insurance in California can choose to offer their own earthquake insurance product or they can become a participating insurance company of the CEA and offer a CEA policy. Similarly, in Florida, the Citizens Property Insurance Corporation (CPIC) is a not-for-profit, tax-exempt, government entity created in 2002 to provide insurance protection against storms (hurricanes) to Florida policyholders that are unable to find property insurance coverage in the private market. The scheme is funded by policyholder premiums and can assess levies against policyholders in the case of any deficit. The CEA and CPIC have made use of capital markets to transfer some of the risks they face through the issuance of catastrophe bonds.

A number of economies have put in place specific ***subsidies and tax incentives as a means to promote the affordability of disaster insurance*** and expand the coverage of disaster risks. Such subsidies are particularly prevalent in the case of agriculture insurance and other

Table 3.2. **US State disaster insurance schemes**

Name of Programme	Coverage			Residential limit	Commercial limit	Reinsurance	Conditions to access programme
	Wind	Hail	EQ				
North Carolina Wind Pool	•	•		Building: USD 750 000 Contents: 40% of home's value	USD 3 million	Yes	
South Carolina Wind and Hail Underwriting Association (wind pool)	•	•		USD 1.3 million	USD 2.5 million	Yes	Only available if individuals cannot get cover from private market.
Georgia Underwriting Association	•	•		USD 2 million	USD 2 million	Yes – (reinsurance for USD 150 million after losses exceed USD 50 million)	Buildings must comply with hurricane standards.
Citizens Property Insurance Corporation (Florida)	•			USD 2 million	USD 1 million	Yes – can obtain USD 10 billion from Florida state reinsurance	
Alabama (wind pool)	•			USD 500 000	USD 1 million	Yes	
Mississippi Windstorm Underwriting Association	•	•		Building: USD 1 million for 1 to 4 family dwellings Contents: USD 250 000	USD 1 million	Yes	Discounts are available to property holders for strengthening resilience.
Louisiana Citizens Property Insurance Corporation	•			Building: USD 750 000 Personal property: USD 375 000	Building: USD 5 million Contents: USD 2 million		An individual can only have access if denied access from the private insurance markets. If assets are insufficient, all insured individuals can be forced to pay a 10% surcharge on their insurance cover.
Texas Windstorm Insurance Association	•	•		USD 1.8 million	USD 4.4 million		Mandatory compliance with building codes. If a dwelling does not comply, special permission to be covered is possible subject to a 15% surcharge and no discounts. If losses exceed USD 2.5 billion, parliament will decide on the allocation of losses.
California Earthquake Authority			•	Building: Limitation imposed in homeowners policy	USD 100 000	Yes	Insurers can underwrite compulsory earthquake cover themselves or distribute policies on behalf of CEA.

programmes targeting vulnerable populations (as described below) although a few economies have established incentives to support the penetration of broader disaster insurance.

In **Korea**, partial premium subsidies are offered by central and local governments to support the special insurance scheme for storms and flooding. Government support for premiums (50%) is also provided for crop and fisheries disaster insurance programmes operated by the Ministry of Agriculture, Food and Rural Affairs and the Ministry of Oceans and Fisheries, respectively. In **Japan** income tax deductions for earthquake insurance premiums have been introduced, in order to incentivise the purchase of coverage.

In addition, some governments provide incentives to insurers to offer certain products which may not have been offered or which may have been offered on different terms in the absence of the subsidy. In **Mexico**, as a means to support the availability of disaster insurance coverage, legal frameworks for insurance (*Ley General de Instituciones y Sociedades Mutualistas de Seguros*) and income tax (*Ley de Impuesto Sobre la Renta*) provide private insurers with tax incentives to facilitate their offering of catastrophic insurance cover.

In other economies, ***public-private partnerships have been established to promote the insurability of specific risks***. In **Australia**, a range of specific mitigation investments have been made by the Government to reduce the potential for loss and support effective private insurance coverage in areas severely affected by the 2010-11 Queensland floods. In the

United Kingdom, the government has negotiated a number of agreements with the insurance industry whereby the latter would insure properties at risk, so long as the Environment Agency announced plans to defend the property against flooding. However, the most recent agreement expired in 2013 and will be replaced by a not-for-profit reinsurance scheme (Flood Re) to support the insurability of property in flood-prone zones. In **Germany**, a programme has been established to allow households in flood exposed areas to obtain a flood resilience certificate that is based on extensive risk assessment by authorised experts (including recommendations for individual prevention measures) as a means to improve the insurability of those properties.

Disaster insurance schemes

In some economies, disaster risks are judged as material, potentially raising issues of insurability. This has led governments to provide support for disaster insurance through broad or targeted disaster insurance schemes.

State-sponsored direct insurance programs

In some economies where private insurance markets are unwilling or unable to provide sufficient levels of direct coverage for some or all natural or man-made hazards, due to local conditions or the particular risk profile of the territory, primary insurance to cover certain disaster losses is provided by a special purpose entity set up by the government to act as direct insurer. In such cases, the government provides insurance and responds to claims (completely or up to a certain limit). The private insurance sector often contributes its operational capabilities, such as marketing of the policies, collection of the premiums, and/or adjustment of the claims.

In some economies, direct insurance is provided by governments to cover ***substantially all (or most) disaster risks***. In **Spain**, the CCS was set up in 1941 after the Spanish Civil War and is the oldest example of a natural disaster insurance regime created by a government to insure catastrophic risks directly. The CCS, a state-owned institution with its own assets, provides coverage for natural catastrophe and man-made events (including terrorism). The events covered under the natural disaster category include flooding, earthquake, seaquake, volcanic eruption, cyclonic storms, and falling of astronomic bodies or meteorites. The private insurance industry cooperates with the CCS in the operation of the system by issuing policies, collecting the compulsory surcharge and handling claims, an arrangement that significantly lowers the operational costs of the CCS. The greatest challenge to the operation of the CCS occurred during Windstorm Klaus which occurred in January 2009. The cumulative losses, both in terms of the number of claims and the total value of losses, tested the operational aspects of the CCS. The insurance and reinsurance association of Spain (*Unión Española de Entidades Aseguradoras y Reaseguradoras* or UNESPA) reported that this was the biggest extraordinary event Spain had experienced. Despite this, claims were handled relatively quickly with minimal delays. After this event, the CCS remained financially viable despite the massive losses endured.

In **Iceland,** ICI was established in 1992 as a state institution to provide direct natural disaster insurance coverage. ICI was established in response to a market failure as the private insurance market in Iceland is not willing or interested in accepting natural disaster risks. All residential property owners who voluntarily buy fire insurance for buildings and contents from private insurance companies automatically acquire ICI cover. Perils insured by ICI include direct damage caused by volcanic eruption, earthquake, floods and landslides. The

scheme also covers assets which are publicly owned. ICI is the sole provider of natural disaster cover in Iceland and has sufficient financial capacity to cover ISK 43 billion in insured losses (as of August 2013). Losses beyond this are covered through reinsurance arrangements.

Under the dual system in **Switzerland**, there is a local public monopole insurer in 19 of the 26 Swiss cantons that is the sole provider of natural disaster coverage. In those cantons, disaster insurance products are provided as a compulsory addition to fire insurance cover with a uniform premium rate to ensure the affordability of natural disaster insurance. In order to diversify risk exposure amongst cantons (given that individual monopole insurers face concentrated risk exposures), the cantonal monopole insurers cede part of their insured risk at market prices to a dedicated supra-cantonal insurer which then cedes part of the risk to the reinsurance market.

The monopole insurers provide better coverage (with lower deductibles and no limitation of damages recoverable per event), generally have lower premiums and are more active in carrying out prevention initiatives than the private insurers. Earthquake risks are not covered by the monopole insurers and thus this risk is generally not insured. Consequently, some of the cantonal monopole insurers have set up a fund of limited size to pay for earthquake damages. Given that the establishment of this fund is voluntary, any compensation for losses from the fund would be provided on a voluntary basis. The mechanism is a temporary measure to overcome the problem with earthquake insurance cover not being incorporated into cover for natural catastrophes. In line with the development of the fund, there are initiatives to extend the current system and ensure that widespread earthquake insurance cover is available in the long term.

In other economies, government direct insurance coverage is targeted at a ***smaller sub-set of perils or an individual peril***. In **New Zealand**, for instance, EQC is the primary provider of disaster insurance to residential property owners for most risks. EQC is a Crown entity, wholly owned by the Government of New Zealand and controlled by a board of commissioners. EQC administers the Natural Disaster Fund which benefits from a government guarantee that ensures the fund will meet all of its obligations. EQC provides disaster insurance automatically to residential property owners who insure against fire and helps in organising repair and replacement after disaster events. The EQC scheme covers residential buildings (with coverage capped at NZD (New Zealand dollars) 100 000 + Goods and Services Tax (GST) per dwelling) and contents (with coverage capped at NZD 20 000 + GST per dwelling) against damage by earthquake, volcanic eruption, natural landslip, hydrothermal activity, and tsunami, including losses due to fire caused by any of these perils. The EQC scheme also covers residential land against damage by these five perils, storm and flood (i.e. the storm and flood cover only applies to residential land and not to buildings and contents). Private earthquake insurance is available to supplement coverage provided under the EQC scheme. A review of the EQC is pending in New Zealand, where the crown entity was put under scrutiny after the 2010-11 Canterbury earthquake sequence (see Box 3.1 above).

In **Turkey**, following the 1999 earthquakes in the Marmara and Duzce regions, the government, with the support of the World Bank, established the Turkish Catastrophe Insurance Pool (TCIP) to provide earthquake insurance on a mandatory basis for dwellings in municipal areas (see Box 3.4 below). The aim of the TCIP is to provide an adequate level of protection with affordable premiums. Therefore, the coverage limit of compulsory insurance is currently TRY (Turkish liras) 150 000 (since 2012). This limit is reassessed annually according to changes in the construction price index, which is also taken into

account when assessing claims. Policyholders are free to buy additional coverage in excess of this limit from private insurance companies if the value of their dwelling is more than this amount. Industrial and commercial risks as well as residential buildings in small villages (with no municipality established) can be insured on a voluntary basis.

The compulsory earthquake insurance is a stand-alone product sold separately from fire (or homeowner's) insurance. It covers building damages for earthquake, fire related to earthquake, explosion related to earthquake, and landslide related to earthquake. Premiums vary depending upon seismicity, local soil conditions, and the type and quality of construction. Prices range from 0.4 per mille at the lowest to 5.5 per mille at the highest. Although the scheme is compulsory, and proof of a policy is needed to connect a property to water or electricity services, there is no specific penalty imposed on those without insurance cover. A reform enacted in 2012 (*Law No. 6305 – Catastrophe Insurance Law*) introduced additional checks for compliance with the mandatory insurance requirement in order to increase penetration.[6]

Earthquake insurance premiums are ceded to the TCIP, which is managed by the Natural Disasters Insurance Council. The TCIP has significant reinsurance backing, benefits from government support in terms of reinsurance (since the 2012 reforms) and is exempt from taxes, duties and charges. Some of the surplus funds are restricted and can only be spent on specific purposes. Since the establishment of the scheme, there have not been any large scale disasters to test the capacity of the scheme; which has enabled the scheme to collect a surplus amount.

In **Korea**, while private insurance coverage is available for most risks, the government has established insurance programs for storm and flood (typhoon, flood, heavy rain, strong wind, winds and waves, tsunami, heavy snow) and earthquake damage to residential properties and greenhouses as well as for agriculture and fisheries. The program covering residential properties is overseen by NEMA but is operated by a private insurance company.

In the **United States**, residential flood insurance has been provided mainly by the federally-run National Flood Insurance Program (NFIP) since its creation in 1968. The NFIP was developed due to the position by private insurance companies following the Mississippi floods of 1927, and maintained through the 1960s, that this peril was uninsurable. Following severe financial problems caused by the insufficient collection of premiums, a reform was passed in 2012 calling on FEMA, and other agencies, to make a number of changes to the way the NFIP is run. Key provisions of the legislation require the NFIP to raise rates for many policyholders to reflect true flood risk, make the program more financially stable, and change how Flood Insurance Rate Map updates impact policyholders. However, price increases have led to affordability challenges for some homeowners prompting further legislation aimed at limiting price increases and improving affordability.[7]

In the **Philippines**, with support from the ADB, the Insurance Commission is leading an effort to design an earthquake insurance scheme for households and small and medium-sized enterprises, which seeks to complement existing products independently offered by the private sector. An approach involving the creation of a public-private partnership to establish an Earthquake Protection Insurance Corporation of the Philippines (EPIC) was agreed in 2013. EPIC would provide earthquake insurance coverage on a mandatory basis. Work is underway to collect the data necessary for the modelling of earthquake risk and to draft the necessary legislation with the aim of EPIC becoming operational in late 2015 (Varkay, 2013).

In **South Africa**, public support for disaster insurance is focused on man-made risks. The government established Sasria in 1979 as a direct result of the South African insurance industry's reluctance to provide insurance cover for politically-motivated risks, including terrorism risk. Sasria provides insurance cover to residential and corporate clients, distributed through the private insurance industry, covering politically-motivated acts, political riots and terrorism, and since 1998, non-political perils such as strikes and labour disturbances. The company is self-funding and generates income from premiums which is used to pay all claims and expenses.

State-sponsored reinsurance programs

In some economies, the government provides reinsurance protection to private insurance companies writing disaster risk for all perils or for specific perils that may be more difficult to insure. In such cases, the government supports the private insurance sector by offering special reinsurance arrangements (proportional and non-proportional), limiting private exposure to peak risks and therefore encouraging private coverage of those risks. Government-sponsored reinsurance programs may be mandatory or optional for primary carriers.

This approach may be suitable where primary insurance carriers are financially able to retain a portion of the risk, but there is not enough reinsurance capacity on the private market to provide the required excess of loss arrangements. Limiting the private sector's exposure through reinsurance may also be part of an institutional arrangement in which mandatory offer, purchase, or extension of disaster risk coverage is introduced by law. In this respect, this option is aimed at protecting the insurers' solvency and, therefore, the stability of the whole system.

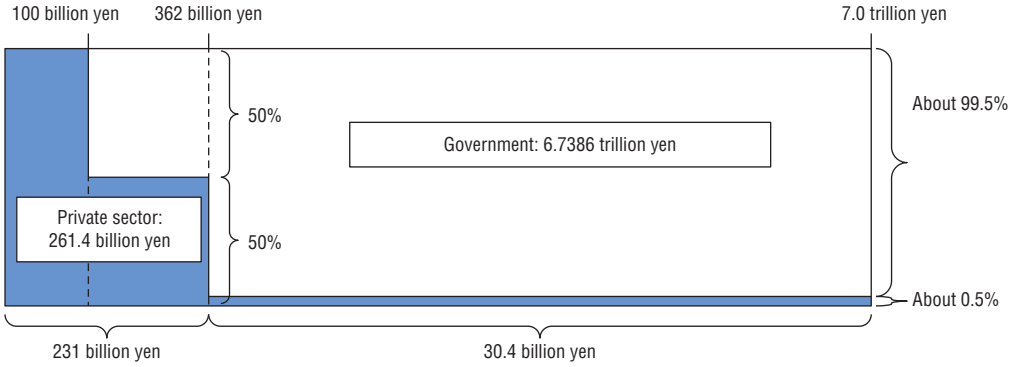
In some economies, the state-sponsored reinsurance coverage is offered for ***substantially all (or most) disaster risks***. In **France**, property (including motor vehicle) and business interruption insurance is automatically extended to cover against the effects of natural disasters. Coverage is provided on a flat-rate basis, established by law as a percentage of the underlying basic premium. The state-owned reinsurer, CCR, offers reinsurance cover (with the benefit of a government guarantee) to primary insurers for the cover they extend for natural disaster risks. CCR does not have a monopoly in natural disaster reinsurance: primary carriers, therefore, are free to seek coverage from the reinsurer of their choice, and may even take the risk of not purchasing reinsurance. However, CCR remains the only company within its sector of activity that offers a whole range of reinsurance solutions with unlimited cover. A draft bill aimed at introducing, among other changes, the ability to impose risk-based pricing for large businesses and local authorities as a means for providing incentives to implement risk reduction measures, is under consideration.

In other economies, the state-sponsored reinsurance coverage is offered only for a ***smaller sub-set of perils or an individual peril***. In **Japan**, a state-sponsored reinsurance program for earthquake damage to residential dwellings was introduced by a law on earthquake insurance in 1966 (shortly after the Niigata earthquake in 1964). The law established the Japan Earthquake Reinsurance Co., Ltd. (JER) which acts as the sole earthquake reinsurer for the private insurance market. The JER can be seen as an earthquake reinsurance pool, retaining a portion of the liability and ceding the rest back to private insurers (based on their market share) and to the Japanese government through reinsurance treaties. The reinsurance program is designed such that the liability of private insurers and the JER itself does not exceed the accumulated reserves from earthquake insurance premiums.

Under this scheme, earthquake insurance is arranged as an optional rider to fire insurance which covers buildings for residential use and/or personal property. Private insurers must then fully insure their risk with the JER. The scope of earthquake insurance coverage includes loss or damage of buildings for residential use and personal property through fire, destruction, burial or flooding caused directly or indirectly by an earthquake, volcanic eruption or resulting tsunami. Earthquake insurance for commercial business is provided solely by private insurers.

At present, the aggregate limit of indemnity for a single event (JPY 7.0 trillion) is shared by the private and public sectors as follows: for earthquake insurance liabilities up to JPY 100 billion, the JER is liable for 100% of insurance claims; over JPY 100 billion and up to JPY 362 billion, the government is liable for 50% while the JER and private insurers (due to retroceded risk from the JER) are liable for 50%; and from JPY 362 billion to JPY 7.0 trillion, the government is liable for approximately 99.5% and private insurers (including the JER) are liable for approximately 0.5% (see Figure 3.1 below). Under the law, where earthquake insurance liabilities for one event exceeds an indemnity cap of JPY 7.0 trillion, residential policyholders' claims can be reduced proportionately.

Figure 3.1. **Risk Allocation under Japan's Earthquake Insurance Scheme**

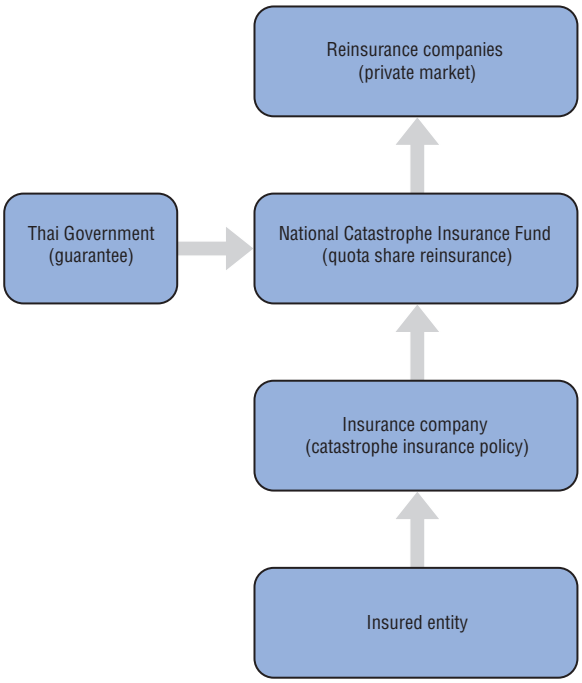


Source: Ministry of Finance, Japan.

In **Thailand**, the insurance sector offers property insurance for fire and business interruption to cover against losses arising from natural disasters. It also offers natural disaster coverage under automobile insurance, life and personal accident insurance and crop insurance. However, following the devastating floods in 2011, many business operators and individuals were no longer able to obtain affordable insurance policies to cover flooding and other natural hazards. As a response, and as a measure to restore public confidence, the government established a National Catastrophe Insurance Fund (NCIF) in January 2012 with a view to making disaster insurance coverage broadly available to businesses and individuals alike. The NCIF is employed as a reinsurance reserve. Local insurance companies that issue policies retain part of the risk underwritten and transfer the rest to the NCIF, which in turns retrocedes a portion to international carriers operating on the global reinsurance market (see Figure 3.2).

The "Catastrophe Insurance Policy" offers coverage for damages caused by three perils: flood, earthquake and windstorm. Coverage is triggered by a "catastrophe", according to specific conditions.[8] Catastrophe coverage can be purchased by business entities, including SMEs, only on top of a fire insurance policy or an industrial all-risk

Figure 3.2. **Thailand's National Catastrophe Insurance Fund**



policy. The policy cover is on a "first loss" basis and is limited to property damage, with no coverage for business interruption. Coverage does not apply to the loss of properties located in the floodway (where damage is otherwise compensated by the Thai government). For earthquake and windstorm damage, indemnity payments are made based on an evaluation of the actual loss sustained (within established limits). For flood events, a simplified sliding-scale Water Level Criterion for compensation has been established to expedite the claim process for residential properties.[9] To complement the support provided for insurance coverage, the Thai government has also developed strategies for preventing future flooding. Under the short-term risk management program, the topography along Chao Phraya River was studied and floodgates were constructed to retain or direct flood water to designated zones. Under the long-term risk management program, the government plans to expand forests in the northern mountain area of the territory. Water management and continued involvement of the government in the NCIF are key components of the sustainability of the scheme.

As part of the implementation of a comprehensive disaster prevention and risk management program, the government of **Chinese Taipei** introduced the Residential Earthquake Insurance Program (TREIP). The program is managed by the TREIF, a governmental entity established in 2002. TREIP's policies are written by domestic and foreign insurers in Chinese Taipei and cover earthquake shock, fire or explosion caused by earthquake, landslide, land subsidence, earth movement and rupture caused by earthquake and, since 2006, tsunami, sea surge and flood caused by earthquake. The program was designed to share earthquake risk between private insurance companies and the government and to diversify such risk through a combination of local co-insurance, TREIF, international reinsurance, capital markets and government funds. Private insurers retain the first tier of risk (up to TWD 3 billion), TREIF shares the 2nd tier of risk (up to TWD 53 billion) with domestic and international reinsurance and capital markets, and the

government retains the top level of risks of up to a total limit of TWD 70 billion (raised from TWD 60 billion in 2009 and TWD 50 billion in 2007). In the event that losses exceed the capped amount, the losses paid to policyholders will be proportionally reduced (proration).

Prior to the creation of the TREIP, earthquake insurance was provided as an endorsement to long-term residential fire policies. However, since 1 April 2002, new residential fire policies have been issued on an annual (rather than long-term) basis, and have been amended to cover earthquake risk automatically. Existing long-term policies can also be voluntarily endorsed at any time to provide annual cover for earthquake. As of 30 June 2013, the penetration rate was about 30% of the total estimated 8.37 million households in Chinese Taipei. The new policies provide indemnity on a replacement cost basis for buildings of up to a maximum insured amount of TWD 1.5 million (with a further TWD 0.2 million of reimbursement available per household for Contingent Living Expenses). No deductible is applied. TREIP premiums are established at a flat rate for all households although premiums are prorated for the small number of households in properties valued at less than TWD 1.2 million. Insurers will pay the indemnity to insured parties only for total loss.[10]

In **Portugal,** where the earthquake insurance penetration rate remains very low (only 16% of the insured households were protected against earthquake risk in 2007), state support for the coverage of earthquake risk is being considered. To improve coverage, the Portuguese insurance and pension funds supervisory authority (*Autoridade de Supervisão de Seguros e Fundos de Pensões* or ASF) has in recent years performed studies supporting the development of a national system to cover earthquake risk. The program would include the establishment of a public fund designed to accumulate financial resources to cover earthquake-related losses. This cover would be made mandatory for all insured households. According to the latest legislative proposal, the government would act as a guarantor of last resort, i.e. it would be responsible for the highest severity/lowest probability events.

In a number of economies state sponsored reinsurance programs have also been established to manage ***man-made risks*** such as the risk of terrorism. In **Germany**, in the aftermath of September 11th, 2001, German insurers collaborated on the establishment of Extremus Insurance AG ("Extremus"), a specialist reinsurer for terrorism risk coverage, to address a market failure that impeded the ability to obtain terrorism risk insurance. Coverage by Extremus is optional. The private insurance and reinsurance market provides the first EUR 2 billion in coverage with the German government providing the second layer of coverage of up to EUR 8 billion. Although the German government had only envisioned providing assistance on a short-term basis, the government guarantee was renewed for a further two years in 2013.

In **Hong Kong, China,** since January 2002 the government has provided direct workers compensation insurers with a facility of up to HKD (Hong Kong dollars) 10 billion in aggregate to cover claims arising out of terrorism under their workers' compensation insurance policies, in order to address the problem arising out of the withdrawal of reinsurance coverage for terrorism risks in workers' compensation business following the September 11th attacks in the United States. Participation in the facility is voluntary. Participating insurers are required to pay a monthly charge of 3% on the gross premiums written for the month to the government. With this facility, insurers can continue to provide cover for employment-related claims for death and bodily injury caused by terrorist acts and protection for both employers and employees can be maintained.

Lastly, an innovative regional initiative has been designed in South-Eastern Europe through the Europa Reinsurance Facility Ltd ("Europa Re"), a private reinsurance company owned by participating governments that provides catastrophe reinsurance as well as technical assistance to insurance companies active in the region (see Box 3.2).

Box 3.2. **Europa Reinsurance Facility (Europa Re)**

To address very low levels of catastrophe and weather risk insurance penetration in Southeast Europe, Europa Re was established with financial and technical support from the World Bank (under the Southeast Europe and Caucasus Catastrophe Risk Insurance Facility (SEEC CRIF) project), the Global Environment Facility (GEF), the Swiss Secretariat for Economic Affairs (SECO) and UNISDR Europe. Europa Re is owned by the participating economies in Southeast Europe, including the Republic of Albania (since 2010), Republic of Serbia (since 2012) and the former Yugoslav Republic of Macedonia (since 2012). Bosnia and Herzegovina and Montenegro have expressed an interest in joining.

The program is aimed at jump-starting the development of local catastrophe insurance markets in Southeast Europe by equipping the insurance companies with adequate reinsurance, know-how and insurance technology to enter or expand their presence in catastrophe and weather risk insurance product lines, which include earthquake and flood insurance and multi-peril agricultural insurance products. This objective is pursued through the creation of economy specific risk models, regulations, pricing and actuarial guidelines and new products. Improving risk management standards at local, national and regional levels as well as educating the public on natural hazard risks and disaster risk mitigation are also among the core objectives of the program.

Europa Re provides reinsurance support to insurance companies in the economies of Southeast Europe to enable them to supply affordable insurance products against weather risk and geo-related perils with a view to protecting homeowners, farmers, enterprises and government organisations. Working together with partner company Europa Re Management Ltd. (a Swiss-based specialty insurance services provider), Europa Re offers a comprehensive market development package (reinsurance capacity, insurance market infrastructure services and technology solutions) to insurance companies in support of innovative catastrophe and weather risk products.

Property catastrophe reinsurance contracts offered by Europa Re will typically be for losses covered under the primary catastrophe insurance policies protecting against losses from earthquake, flood as well as other natural events.

Envisaged products include:

- Catastrophe insurance coverage for damages caused to property and contents by earthquake (and fire following an earthquake) and flood.
- Agriculture yield index insurance coverage, designed to protect farmers from the loss of crop yields due to adverse weather events and biological risks. Tailored for specific crops, this insurance product provides protection to farmers against extreme weather events that affect crop yields.

Local direct insurers who will become part of the program will benefit from:

- Access to a sophisticated web-based production platform with integrated insurance technology applications that include automated pricing and underwriting, innovative claims management services, financial and regulatory reporting, interactive consumer information portal (CATMonitor) and risk management.

Box 3.2. **Europa Reinsurance Facility (Europa Re)** *(cont.)*

- Dedicated reinsurance capacity for the risk arising out of sales of insurance products endorsed by Europa Re.

Up to 95% of Europa Re's risk exposure will be reinsured with "A" and above rated reinsurers. The company relies on the customised risk pricing models developed exclusively for the markets in Southeast Europe (Albania, Serbia and former Yugoslav Republic of Macedonia) by a private modelling firm. Operating as a regional aggregator of catastrophe risk and being well equipped with the modern risk modelling tools, Europa Re intends to offer highly competitive reinsurance terms to its partner insurance companies, on a proportional or an excess of loss basis.

Table 3.3 provides an overview of the different possible roles of government in disaster insurance schemes. Table 3.4 outlines the scope of coverage of disaster insurance schemes.

Table 3.3. **Roles of government in disaster insurance schemes in selected economies**

Reinsurer
Australia (*Australian Reinsurance Pool Corporation*)
Chinese Taipei *(Residential Earthquake Insurance Fund)*
Denmark (participation in *Terrorism Insurance Pool for Non-Life Insurance*)
France (*Caisse Centrale de Réassurance*)
Germany (participation in *Extremus AG*)
Hong Kong, China *(fund in support of Workers' Compensation coverage)*
Japan (*Japan Earthquake Reinsurance Co., Ltd.*)
Netherlands (participation in *Nederlandse Herverzekeringsmaatschappij voor Terrorismeschaden or NHT*)
Thailand *(National Catastrophe Insurance Fund)*
United Kingdom *(Pool Re and Flood Re (April 2016))*
United States (participation in *Terrorism Risk Insurance Program*)
Direct insurer
Iceland *(Iceland Catastrophe Insurance)*
Denmark *(Danish Storm Council)*
Korea *(Residential storm and flood coverage)*
New Zealand (*Earthquake Commission*)
South Africa (*Sasria Limited*)
Spain (*Consorcio de compensación de seguros*)
Switzerland *(Cantonal monopoles, e.g. Assurance immobilière Berne, Gebäudeversicherung Kanton Zürich)*
Turkey *(Turkish Catastrophe Insurance Pool)*
United States (*California Earthquake Authority, Citizens Property Insurance (Florida), National Flood Insurance Program*)

Targeted disaster insurance

In economies where private insurance markets are not as well developed, where government resources are severely constrained, or where the paying capacity of the most vulnerable layers of the population is extremely low, the promotion of risk financing and transfer tools requires the introduction of innovative approaches targeting the most pressing needs in the particular economy.

Several innovative insurance and micro-insurance solutions have been developed, often with the support of the international donor community, focused on specific sectors

Table 3.4. **Scope of coverage under disaster insurance schemes in selected economies**

Residential property damage	Commercial property damage	Infrastructure	Business interruption
Chinese Taipei (earthquake – TREIF) **Denmark** (storm surge – Danish Storm Council) **France** (natural perils, technological accidents – *under two different insurance programs*) **Iceland** (natural perils – *Iceland Catastrophe Insurance*) **Japan** (earthquakes, volcanic eruptions and resulting tsunami – *JER*) **Korea** (typhoon, flood, heavy rain, strong wind, winds and waves, tsunami, heavy snow, earthquake) **Netherlands** (terrorism – *NHT*) **New Zealand** (earthquake, volcanic eruption, natural landslip, hydrothermal activity, tsunami & fire associated with any of the listed perils – *Earthquake Commission*) **South Africa** (political riots, terrorism, strikes, labour disturbances – *Sasria*) **Spain** (all extraordinary risks – *CCS*) **Swiss cantons** (all natural perils except earthquake) **Turkey** (earthquake – *Turkish Catastrophe Insurance Pool)* **United States** (flood – *National Flood Insurance Program;* earthquake – *California Earthquake Authority;* wind – *Citizens Property Insurance Corporation*)	**Australia** (terrorism – *Australian Reinsurance Pool Corporation)* **Denmark** (storm surge – *Danish Storm Council* – and terrorism – *Terrorism Insurance Pool for Non-Life Insurance*) **France** (natural perils, terrorism – *under two different insurance programs*) **Germany** (terrorism – *Extremus AG*) **Iceland** (natural perils – *Iceland Catastrophe Insurance*) **Netherlands** (terrorism – *NHT*) **South Africa** (political riots, terrorism, strikes, labour disturbances – *Sasria*) **Spain** (all extraordinary risks – *CCS*) **Thailand** (flood, earthquake, windstorm – *NCIF*) **United Kingdom** (terrorism – *Pool Re*) **United States** (terrorism – *Terrorism Risk Insurance Program*)	**Iceland** (natural perils – *Iceland Catastrophe Insurance*) **Spain** (all extraordinary risks – *CCS*)	**Australia** (terrorism – *Australian Reinsurance Pool Corporation*) **Denmark** (terrorism – *Terrorism Insurance Pool for Non-Life Insurance*) **France** (natural perils, terrorism – *under two different insurance programs*) **Germany** (terrorism – *Extremus AG*) **Netherlands** (terrorism – *NHT*) **South Africa** (political riots, terrorism, strikes, labour disturbances – *Sasria*) **Spain** (all extraordinary risks – *CCS*) **United Kingdom** (terrorism – *Pool Re*) **United States** (terrorism – *Terrorism Risk Insurance Program*)

(e.g. agriculture) or segments (e.g. the most vulnerable) of the economy, including weather index-based parametric products (see Box 3.3) as well as portfolio protection tools aimed at strengthening the resilience of rural banks, credit cooperatives, microfinance lenders and other financial institutions against disaster risk. Some of these tools have been introduced only recently; as such, it may be too early for an assessment. Yet, a presentation of their

Box 3.3. **Parametric-based insurance products**

The pay-outs of risk transfer instruments may be quantified on the basis of actual losses sustained by the protection buyer (indemnity based), or the amount of such payment may be agreed upon by the parties irrespectively of actual losses and triggered by a physical parameter measuring the intensity of the hazard at given locations (parametric) or by an index comprising multiple measurements of such parameters for each event (parametric index) (OECD, 2012: Section II). A parametric insurance product can be defined as an insurance contract where the ultimate payment or contract settlement is determined by a weather or geological observation or index, such as average temperature or rainfall over a given period or the intensity of an earthquake or wind storm. Parametric insurance pay-outs are not based on individual loss adjustments, but are determined according to the measurement of a highly correlated index. Therefore, there is the potential for a mismatch between parametric insurance claims settlement and the actual losses of the insured, which is generally referred to as basis risk (Ibarra, n.d.). Basis risk occurs where the amount of the pay-out triggered by the defined parameter or index varies substantially from the actual amount of damages, potentially leaving the insured with large uncovered exposures (or the insurer with payments exceeding the level of damage).

structure and basic features may provide useful guidance for the identification of possible solutions targeted to economies where financial and insurance markets are still in the initial stages of development.

Insurance schemes for agricultural risks

A number of developed and developing economies have established state-sponsored agricultural or crop insurance schemes that cover agricultural losses, including losses from natural disasters.[11] For example, in **Spain**, the CCS plays an important role in agricultural risk coverage through a co-insurance plan (10%) with the private insurers and as the main reinsurer for the system. In **Korea**, insurance products are available to cover crops against disaster. The crop disaster insurance scheme is governed by the Ministry of Agriculture, Food and Rural Affairs and is offered for named perils and as multi-peril crop insurance. The named peril coverage is for crops including apple, pear, peach, grape, sweet persimmon and tangerine for damage arising from hail and typhoon. Farmers who utilise this insurance can also utilise insurance coverage for freezing and torrential rain. As premium support is available to farmers to assist them in obtaining insurance coverage, the insurance penetration rate is reasonable. The Ministry of Oceans and Fisheries offers an optional fisheries disaster insurance which provides coverage to the fisheries industry for losses arising from natural disasters.

In many developing economies, the agricultural sector is responsible for substantial shares of employment and economic output. It also stands out as one of the economic sectors most affected by natural hazards, especially climate-related perils such as droughts, floods, excessive rain, cold waves, and hail. Unlike disaster insurance for property where the infrequent nature of losses allows insurers to manage large events, insurers expect losses related to agricultural insurance every year making significant events more difficult to manage (Munich Re, 2009). Therefore, the economic viability of agriculture insurance is often more challenging. As a result, a number of economies have put in place or are considering the implementation of state-supported agricultural insurance schemes, even where broader state-sponsored schemes for property disaster insurance have not been established (see Table 3.5).

Table 3.5. **Key elements of agricultural insurance schemes (selected economies)**

	Micro Insurance Scheme (Agriculture)	Features of the Scheme
Chile	Micro insurance products for small to medium sized farmers	• Available for small to medium-sized farmers • Government subsidisation of premiums • **Covers:** wheat, potatoes, tomatoes, rice, among others • **Perils covered:** drought, floods and other natural disasters
Kenya	Kilimo Salama Index Based Crop Insurance	• Premium sharing arrangement with agri-businesses whereby if a farmer buys seed from the agri-business, it will cover 50% of the premium • **Covers:** farm inputs (seed, fertilizer) • **Perils:** drought and excess rain
Thailand	Thailand Rice Disaster Relief Top-up Crop Insurance Scheme	• Designed to top-up the amount which a farmer may already receive as compensation from the Thai government's Disaster Relief Program • **Covers:** rice • **Perils covered:** floods, drought, pest, disease
Vietnam	Pilot Agricultural Insurance Programme 2011-13	• Pilot programme subsidised by the Vietnamese government • **Covers:** rice, livestock, aquaculture • **Perils covered:** storm, drought, cold, frost, tsunami, diseases and epidemics

The current disaster insurance system arrangements in **China** are mainly focused on agriculture insurance and mainly protect agricultural products from damage caused by natural disasters, accidents, pests, and disease. China is an agricultural nation and is also prone to agricultural disasters, incurring massive agricultural losses every year. The establishment and development of agriculture insurance, designed to facilitate the distribution and transfer of agricultural risk, is considered to be of vital significance to improving agricultural risk resistance capacity, the stabilisation of agricultural production, and the protection of farmers' interests. Penetration rates are high and have been increasing, with penetration rates reaching 64.9%, 67.3% and 61.8% of farmers and operating bodies for the three major crops of rice paddy, corn and wheat, respectively.

The agriculture insurance system in China is advancing, using a system of initial trials followed by wider promotion. Lessons learned include: i) government departments must make use of subsidy, tax and other policies to guide and encourage insurance agencies and agricultural household participation in agricultural insurance, and thus gradually cultivate insurance awareness in agricultural households; ii) insurance companies must operate in agriculture insurance on a wholly independent basis, bearing their own risk and generating their own financing in accordance with market principles; iii) all parties should voluntarily take out insurance coverage and provide underwriting in accordance with their respective risk bearing capacity and resistance capacity; and iv) provision of agriculture insurance must be carried out so as to ensure the proper promotion and management of the tasks relevant to agriculture insurance.

A number of policy measures have been implemented to strengthen agriculture insurance, including: i) regulations for agriculture insurance have been promulgated, providing a legal foundation for the management of agriculture insurance operations; ii) the state has a policy of providing premium subsidies for certain crops covered by insurance; iii) agriculture insurance operators receive tax benefits; iv) initiatives are underway to promote the establishment of a catastrophe insurance system, and it is hoped that this will result in a more mature, sophisticated catastrophe insurance framework and implementation plan; and v) in order to guard against the risk of major agricultural disaster, China has established an agriculture insurance disaster risk reserve system, whereby insurance companies are required to set aside reserves at a set ratio to the agriculture insurance premium and accrued underwriting profit, thus gradually establishing a long-term mechanism for dealing with agricultural disaster shocks. Obstacles remain, including: i) while coverage is expected to expand, the level of agricultural insurance coverage is relatively low; ii) service levels are sub-par; and iii) major disaster risk distribution mechanisms are inadequate.

In addition, the Beijing municipal government has entered into an agreement with global reinsurers to promote the access of farmers in the Beijing area to insurance protection for any agricultural losses arising from catastrophic events. The Beijing municipal government will retain risk for the first 160% of the annual premium and reinsurance coverage provided by the reinsurance market will cover losses between 160% and 300% of the original premium. If there are losses which exceed 300% of the premium paid, these will be covered by the Beijing municipal government's Agricultural Catastrophe Risk Reserve. The utilisation of the reinsurance market limits the risk exposure of the insurers and thus makes offering such products more attractive (Swiss Re, 2010, 2013b).

In **Viet Nam**, approximately 20% of economic output is generated by the agricultural sector, which is highly exposed to natural hazards, including tropical cyclones (typhoons),

tornadoes, landslides and droughts. Having heavily invested in improving irrigation, pest and disease control, and flood defences, the government of Viet Nam decided in 2011 to implement an agriculture insurance scheme starting with a subsidised pilot programme. The programme provides insurance cover for rice, livestock and aquaculture farming against storm, flood, drought, cold, frost, tsunami and other perils. It also provides cover against named pests and diseases and epidemics specific to rice, livestock and aquaculture. During the pilot, the programme is being implemented in 20 provinces throughout Viet Nam. The rice insurance scheme is index based; the livestock and aquaculture schemes are indemnity based. The Ministry of Finance and the Ministry of Agriculture and Rural Development provide guidance and support for programme implementation. The Viet Nam National Reinsurance Corporation, Vina Re, and Viet Nam's two largest insurers, Bao Viet and Bao Minh, were appointed by the Ministry of Finance to participate in the design and implementation of the pilot programme. Swiss Re was asked to provide actuarial services in calculating insurance premium rates as well as reinsurance capacity (Swiss Re, 2013a).

In **Thailand**, the Rice Disaster Relief Top-up Crop Insurance Scheme is a government-based micro-insurance product provided by eight local insurance companies and nine reinsurance companies. Each insurance and reinsurance company covers a portion of the risk based upon a quota share arrangement. The scheme was set up to provide additional compensation to top-up the amount which a farmer may already receive as compensation from the Thai government's Disaster Relief Program. Coverage is provided for damage that occurs to rice in the growing or harvest stage where it is affected by flood, drought, windstorm, frost, hail or bushfire. In order to assist farmers with the financial cost of obtaining coverage, the Thai government pays 50% of the premium and the farmer pays the remaining cost. The system is index based. If damage does occur, there is a simple process for recovery which involves the farmer showing that their farm was located in the affected area and that a loss occurred to the rice being grown. The significance of this micro-insurance product derives from the importance of rice as a staple agricultural product in Thailand. In **Turkey**, the agriculture sector is very important for the economy and impacts all sectors of the economy directly or indirectly. To address disaster risks in the agriculture sector, the government has established the Turkish Agriculture Insurance Pool (TAIP) (see Box 3.4) (Munich Re, 2013).

Box 3.4. **Turkey: PPP Model in Turkish Insurance Sector: TCIP and TAIP**

Public Private Partnership is a vital tool for the insurance sector in Turkey. Lack of insurance awareness and low income levels hinder growth in the insurance sector. For this reason, the Turkish government has supported the establishment of insurance schemes for earthquakes and agriculture risks.

The TCIP was established in 2000. TCIP is the legal entity which is responsible for the provision, implementation and management of compulsory earthquake insurance in Turkey. Due to high earthquake risk and potential economic losses, earthquake insurance is compulsory in Turkey. The TCIP insurance provides indemnification for monetary losses caused by earthquake to dwelling houses for up to a maximum compensation limit that is reviewed annually. Compulsory earthquake insurance is only available for residential buildings within municipals borders. Buildings which belong to public institutions and organisations and buildings which are fully used for commercial and industrial purposes cannot obtain insurance cover under the compulsory earthquake insurance system.

Box 3.4. **Turkey: PPP Model in Turkish Insurance Sector: TCIP and TAIP** *(cont.)*

The TAIP, founded in 2005, aims to introduce standard provisions in insurance contracts for providing coverage of risks, including the conditions for transferring risk, ensuring centralised payment of the indemnification upon occurrence of the risks, and improving and popularising agricultural insurance. TAIP provides only product guarantees in the agriculture branches such as crop insurance, livestock insurance, aquaculture insurance and greenhouse insurance and covers both disasters and standard contingencies. A special exception applies specifically for greenhouse insurance as greenhouse structures and products that are cultivated in the greenhouse are insured by TAIP against earthquake risk. In both the TCIP and the TAIP, the Turkish government and insurance sector work together. Insurance companies are an important part of the pools and participate on the Management Boards of these pools. Insurance companies are the main distributors of TCIP and TAIP policies and also have the option of participating in the reinsurance phase.

To promote compulsory earthquake insurance and agriculture insurance, the Turkish government provides some support to the pools. This financial support is in the provision of reinsurance, premium subsidies, technical support and organisational support. To ensure affordability of insurance for Compulsory Earthquake Insurance, there is a cap for maximum indemnities. Beyond this cap, individuals have the option of buying additional property insurance coverage from non-life insurance companies. The penetration of agriculture insurance is low despite the support given to individuals to assist them with the premiums for agricultural insurance. The premium support provided to individuals is at least 50%, up to a maximum amount of 66.6% of the policy cost; nevertheless, agricultural insurance premiums remain very expensive, even taking into account the subsidy. Premium support payments are made directly to TAIP on behalf of farmers who bought agriculture insurance policies. In order to enhance the penetration rate, the TAIP is working to reduce the cost of the premium. The compulsory nature of earthquake insurance also has broader implications for the development of other insurance markets in Turkey, where non-life insurance has a low insurance penetration rate. Experience with earthquake insurance has had the positive benefits of increasing risk awareness in society and familiarity with insurance policies. The penetration rate is approximately 35%.

TCIP and TAIP try to generate reserve funds for future contingencies. In generating surplus funds for future contingencies, they endeavour to calculate the risks in order to promote fiscal stability. Moving forward, the short term objectives of the TCIP and TAIP is to secure reinsurance contracts from the international commercial reinsurance market as well as generate additional capital through new risk transfer mechanism such as catastrophe bonds. The reinsurance support provided by government is extremely important for these pools because of the difficulty in securing sufficient and economical reinsurance offers from the reinsurance market, especially after significant global disasters.

In **Brazil**, the private insurance market (as well as an insurer related to the *Banco do Brasil*, a state-owned bank) offers crop insurance covering specific risks as well as on a multi-peril basis, although the federal government supports the market through subsidies ranging from 30%-60% of the premium depending upon the crop and location. In **Chile**, agricultural micro-insurance policies are made available to small and medium-sized domestic farmers. The government supports farmers for a total of 50% of the cost of insurance as well as an additional amount of 1.5 UF (Unidades de Fomento, approximately

USD 60). Some small farmers may be able to qualify for subsidies amounting to 90% of the premium. Products such as wheat, potatoes, tomatoes and rice, among others, are insured against droughts, floods and other natural disasters.

In **Malaysia**, agricultural insurance can be extended to cover natural disasters, including floods and windstorms for an additional premium. Initially proposed to be funded by the government, the greatest challenge in designing the scheme has been the availability of good and comprehensive data in addition to the limited funding available relative to the expectation that the scheme would provide the best and maximum benefits. There is also an on-going effort to explore the development of a paddy takaful[12] scheme to provide protection to small-scale paddy farmers against natural disasters such as floods, droughts, pests and diseases. In **India**, a large proportion of rural households are dependent on agriculture for their livelihoods. Due to limited irrigation infrastructures, yields are strongly affected by climatic events (monsoon in particular), leading to significant financial vulnerability to weather risks. The protection of farmers from harvest variability is, therefore, a key concern for Indian governmental authorities (see Box 3.5).

Box 3.5. **Crop insurance in India**

Traditional crop insurance in India is provided by the Agriculture Insurance Corporation of India Ltd. (AIC) under the National Agricultural Insurance Scheme (NAIS). Insurance coverage is normally bundled with crop financing and it is subsidised by central and state governments. The NAIS operates on an area-yield indexed basis, whereby claim payments to farmers depend on the average yield of the insured crop measured across the insurance unit, typically an administrative block, in which they live. NAIS financing is based on *ex post* funding by the government.

As soon as the Indian insurance market was opened, at least in part, to private and foreign insurers, the Insurance Regulatory and Development Authority (IRDA) required all private insurers to reserve a certain portion of their portfolios for the rural and social sectors. In response to this requirement, private insurance companies – but also AIC – started offering Weather Based Crop Insurance Schemes (WBCIS), as a substitute or complement to crop insurance supplied by the government.

Similar to other weather-index insurance products, WBCIS pay-outs are triggered by excess or shortfall from a predetermined threshold level of rainfall, temperature or humidity. Coverage provided by the WBCIS is "area based", assuming average risk and average loss characteristics for an entire cultivation area. In this context, basis risk may arise because the trigger value is the average yield calculated for a larger area, which may not represent the actual yield of a smaller unit. Basis risk may also arise on account of distance of the village from the automated weather station, as data generated may not represent that of the localities which are far away from the station. On the other hand, the individual farm level approach (indemnity-based) requires *ex ante* and *ex post* assessments, which are costly and may be affected by moral hazard.

The minimisation of basis risk through a well-planned network of automated weather stations has been identified as a key priority in India. The location of weather stations, in fact, has the greatest bearing on the extent of basis risk in a weather insurance contract once the key parameters of the contract have been set. Aimed at providing a more accurate basis for calculating the threshold yield for triggering pay-outs, the Modified National Agricultural Insurance Scheme (MNAIS) was introduced in 2010-11. A hybrid of the area-yield and weather-index schemes, it is being tested by the Indian government across 34 districts in 12 states.

Box 3.5. **Crop insurance in India** *(cont.)*

India is a global leader in micro-insurance innovation. This is due, in part, to the huge number of rural households, offering the potential for achieving economies of scale. Another factor is the interplay between roles of different stakeholders: the public sector has a clear mandate to assist the poor and it dominates a significant portion of the insurance market, while the private sector contributes technological solutions and innovations in product design and distribution channels.

Another interesting micro-insurance scheme is offered by the Kilimo Salama Index-Based Crop Insurance programme developed in **Kenya**. Kilimo Salama, meaning "safe agriculture" in Swahili, is a crop index-based micro-insurance product launched in 2008 to protect investments in farm inputs by wheat growers against drought and excess rain. Under the auspices of the Agricultural Index Insurance Initiative,[13] it is reportedly the largest program of its kind in Africa. In addition to the investment in farm inputs (e.g. seed, fertilizer), farm output value (i.e. an estimate of the expected harvest value) can also be covered by a second parametric micro-insurance product offered under the scheme. Pay-outs are determined based on the actual amount and distribution of rainfall over the crop season, measured at the weather station nearest to the insured farm.

Existing index insurance contracts have been adapted to the Kenyan climatic characteristics and planting practices: reference is made, in particular, to historical data sets, consisting of between 20 to 30 years of weather data, combined with agronomical data on crop development. Pricing of the risk is then made on this basis by international reinsurers. Complex agronomical models, relying on weather data, are used to simulate crop growth at various locations. The FAO's Water Requirement Satisfaction Index (also used in the Africa RiskView program, see Box 2.6), which captures the impact of timing, quantity, and distribution of rainfall and allows for the comparison of the amount of water available throughout the season to how much a plant needs in its different stages of growth, is employed as an agronomical model to quantify rainfall deficiency.

Distribution channels for the micro-insurance product include local agro-dealers and mobile phone networks. A mobile money platform is used to process premiums and claims payments: the success and growth of this product is largely due to technical innovation, particularly in using mobile technology. An increased understanding of the need for micro-insurance and trust amongst farmers that the insurance product will deliver on its promises have also been important factors in supporting the penetration of this product (Burke, de Janvry and Quintero, 2010).[14]

Another factor behind the scheme's success is that assessments are based upon criteria and are not made at an individual farm level. This is achieved through the use of weather stations which are employed to prevent the need to visit each affected farm. The use of electronic weather stations and automatic measurement, therefore, greatly reduces the costs of operations (Syngenta Foundation for Sustainable Agriculture, 2012). A significant investment was required to upgrade and renovate weather stations in co-operation with the Kenya Meteorological Department. The use of this technology is very open and transparent so that farmers can be fully aware when they are (or are not) covered.

Affordability of the product is achieved through an innovative "premium sharing arrangement" with agri-businesses, who sponsor 50% of the premium. The distributors of

the agricultural inputs have a commercial interest in paying a portion of the premium, as the insurance payments provide farmers with the financial means to buy new agricultural inputs for the next season from the agricultural input distributors (financial means which they may not otherwise have following an adverse weather event). Evidence that the manner in which Kilimo Salama operates is successful can be seen in the upward trend in premium revenue that has been collected over the past few years.

In **Mongolia**, due to severe livestock loss and ensuing economic damages arising from catastrophic weather events during the years 1999-2002, the government of Mongolia, with the support of international organisations and donors, launched the Index Based Livestock Insurance Project (IBLIP) in 2005. The project aims to support agricultural sector development as part of the government's objective to foster economic diversification and to enhance food security. With the specific purpose of reducing vulnerabilities caused by a climate risk called dzud,[15] the IBLIP scheme was piloted in three selected provinces (*aimags*) from 2005 to 2008 and then scaled-up to the national level by adding 5-6 provinces each year until 2012. Under the IBLIP, the trigger for coverage is based on an index capturing livestock mortality at district (*soum*) level rather than on individual herders' livestock mortality. In other words, indemnity payments are provided to herders based on the mortality rate of each livestock species at *soum* level.[16] The IBLIP is not mandatory, so herders have the right to choose the livestock species, if any, to be insured.[17]

The financing structure of the program was designed by establishing different risk layers: while the lower portion of the risk is retained by individual insurance companies, the remainder is partially pooled among participating carriers in the Livestock Insurance Indemnity Pool (LIIP), a reserve fund established under the Ministry of Finance to guarantee indemnity payments. The LIIP is partially reinsured with the government, whose exposure is, in turn, protected by a contingent credit facility with the World Bank (Luxbacher and Goodland, 2011). A Project Steering Committee, made up of representatives from various government entities and based at the Ministry of Finance, oversees the IBLIP. Under the project, capacity has been built within the various entities involved in its implementation including local governments, insurance companies, insurance agents, the Financial Regulatory Commission, the National Statistical Office, and banking and financial institutions. The project also involved a comprehensive risk awareness and education campaign to promote the purchase of the insurance product. As a result of this initiative, the financial capacity of the private insurance sector has been enhanced in rural areas, local administrations have improved their risk management strategies, and Mongolian herders have learned to transfer some of their climate risks and benefit from the scheme thanks to the implementation of this project. The main challenge faced in this project was to design a sustainable legal, institutional, and financial framework so that the government-backed project could transition into a market-based solution.

In **Ethiopia** (later extended to **Senegal**), a program has been established that provides farmers with a means to afford agricultural insurance premiums while contributing to adaptation initiatives in their community (see Box 3.6).

Micro insurance programs targeting other vulnerable segments

Other programs, not directly related to agricultural risks, have been established to target vulnerable segments of society, such as rural households or small entrepreneurs. In **China**, a rural, double trigger earthquake micro-insurance program has been developed to provide small payments to individuals after the occurrence of a small earthquake,

Box 3.6. **Horn of Africa Risk Transfer for Adaptation (HARITA) and R4 Rural Resilience Initiative**

Farmers in Ethiopia are among the poorest and most vulnerable in the world. Extending insurance coverage to the vast majority of those who do not have it is the key objective of the HARITA project, a joint initiative led by Swiss Re, Oxfam America and several other partners.[1]

HARITA consists of a comprehensive risk management package for the poor, including a risk transfer component. With donor support, it gives people the initial option to pay for their premiums with their labour, engaging them in community-led and locally designed climate adaptation initiatives in return for insurance cover.

Building on the success of the HARITA project in Ethiopia, which constituted a first step towards educating local farmers about the benefits of insurance and developing the mechanisms of a future insurance market, Oxfam America and the WFP launched the R4 Rural Resilience Initiative. The initiative offers households access to drought insurance and credit, facilitates their work on environmental projects that strengthen their communities, and encourages families to save.

This innovative public-private partnership is expanding from Ethiopia and Senegal to Malawi and Zambia over the next four years and will enable poor farmers to strengthen their food and income security by managing risks through a four-pronged approach: i) improving natural resource management (community risk reduction); ii) accessing microcredit ("prudent" risk taking); iii) obtaining insurance coverage (risk transfer); and iv) increasing savings (risk reserves).

HARITA and R4 are new models for sustainable development founded on the principles of collaboration and mutual support by public and private sector organisations, communities, and governmental ministries. The long-term goal of HARITA and R4 is to achieve rural resiliency through an effective public-private partnership and a market-based collaborative mechanism.

1. The network of partners includes the Rockefeller Foundation, Ethiopian farmers, the Relief Society of Tigray (REST), Nyala Insurance Share Company, Africa Insurance Company, Dedebit Credit and Savings Institution (DECSI), Mekelle University, the government of Ethiopia and the International Research Institute for Climate and Society (IRI).

allowing those affected to build up cash flows. The program also provides coverage against a secondary trigger event which is a catastrophic event expected to generate significant damage. For earthquakes with a magnitude of 6.5, the payment is a fixed amount of CNY (Yuan renminbi) 500. For earthquakes with a magnitude of 8 or higher, the fixed-amount payment is CNY 1 000 (Stojanovski, 2011). The program also offers an alternative approach which provides a non-indemnity catastrophic coverage of CNY 16 000 which would be payable if the property has collapsed or is uninhabitable (Shah, 2010). Insurance companies, reinsurers, and the Chinese government each provide a layer of coverage for the program. The private insurers cover the first layer up to CNY 2 billion and the reinsurers cover the next CNY 4 billion in losses. If these losses are exceeded, the final layer is covered by the Chinese government, up to a maximum contribution of CNY 12 billion (Shah, 2010). The additional costs factored into this micro-insurance product includes a fixed cost of 2.5% for the premium collection mechanism, a loss adjustment layer of 5%, a brokerage fee of 25% per premium sold for reinsurance coverage and a brokerage fee of 11% of the premium for the risk retention levels maintained by the government (Shah, 2010).

As noted, in **India**, the regulatory framework requires insurers to reserve a certain portion of their portfolios for the rural and social sectors. This has increased the number and diversity of micro-insurance products for disaster risk targeting low-income segments of society. For example, *Afat Vimo* provides protection for property (household building and contents), stock in trade, personal accident and death from 19 natural disaster risks, including earthquake, fire and flood. A fixed premium of INR (Indian rupees) 133 is charged annually to policyholders (a cost of approximately 0.5% of income for a typical policyholder). The scheme is underwritten by public insurers Oriental Insurance Company and the Life Insurance Corporation of India. Another example is the *Swayamkrushi* initiative which provides micro-finance and micro-insurance for women in informal employment. In order for women to be covered, an annual premium of INR 100 is payable. In return women will receive INR 30 000 for accidental death as well as the write-off of existing loans pertaining to working tools if a natural disaster causes death to a family member or creates property loss.

In **Nepal,** a specialised disaster micro-insurance and micro-financing product is offered to women. The product is offered through the Centre for Self Help Development at an annual cost of NPR (Nepalese rupees) 100. In return for the premium payment, the family of a female policyholder receives NPR 5 000-6 500 should the policyholder be killed by disaster, NPR 2 500-3 250 should her husband be killed in a disaster, and payments of up to NPR 6 500 for the repair or rebuilding of dwellings which collapsed during a natural disaster. In the **Philippines,** a number of micro-insurance programs exist to provide protection to vulnerable populations against natural disaster and other risks. For example, *Buhay-Buhay-Kabuhayan* was created with the assistance of German development co-operation agency *Gesellschaft für Internationale Zusammenarbeit* (GIZ) and covers personal accident, permanent disability, fire, typhoon, flood, earthquake and lightning. The scheme provides a set pay-out of PHP (Philippine pesos) 10 000 per unit if the dwelling or livelihood of an insured is lost or damaged.

In **Malaysia**, the penetration rate for disaster insurance is disproportionately low among financially vulnerable groups. With the support of Bank Negara Malaysia (central bank), a micro-insurance product has been launched (1Malaysia micro-protection plan) with the aim of providing affordable life and non-life insurance coverage against a variety of risks, including natural disaster risks. The product establishes a set premium based on age (for life products) and sum insured (for property coverage) and provides indemnity based coverage for property up to MYR (Malaysian ringgit) 50 000 and lump-sum payments for death. In **Indonesia,** micro-insurance schemes have been developed to address specific risks, including *Asuransi Wahana Tata*, a micro-insurance pilot to cover flood risks in Jakarta, and *PT. Asuransi MAIPARK* – Parametric Earthquake micro-insurance product for homeowners to protect against earthquake risk.

Haiti is considered one of the most disaster-prone economies in the world and is extremely vulnerable to natural hazards - especially tropical cyclones, floods and earthquakes. Following the devastating earthquake of 2010, a natural catastrophe micro-insurance scheme ("Kore W") was launched by a group including: MiCRO (Microinsurance Catastrophic Risk Organization), a specialty licensed (re)insurance company domiciled in Barbados;[18] Fonkoze, the largest Haitian micro-finance institution which offers a full range of financial services to the rural-based poor; the international relief organization Mercy Corps; and a number of other partners.[19]

With an infrastructure of 46 branch offices that provide the institution with a presence in all ten departments of Haiti, Fonkoze has almost 300 000 clients. Reportedly, some

65 000 female entrepreneurs are enrolled in their micro-loans program, borrowing anywhere between USD 25 and USD 1 200 for six-month loan cycles. The risk transfer program was rolled out officially in 2011 and all of Fonkoze's group-lending clients across the economy are now automatically enrolled in the Kore W insurance scheme. Kore W is purchased through a partially subsidised premium at the onset of each loan cycle – borrowers pay 3% of their loan value per cycle to be covered under the micro insurance scheme, which covers approximately 55% of the premium cost to Fokonze.

Upon the occurrence of an extreme natural hazard that ruins their home or livelihood, Kore W provides policyholders with USD 125 pay-outs, allows cancellation of outstanding loan balances, and offers new loans when members are ready. The Kore W purchasers are largely women, many of whom earn less than USD 2 per day selling small goods at local markets. The first component of the product is a commercially reinsured parametric contract where payments are automatically triggered if objective thresholds are exceeded for rainfall, wind speed, or seismic activity at any Fonkoze location throughout Haiti. To mitigate its own risk, Fonkoze has secured coverage for its basis risk, the differential between the coverage provided by the parametric reinsurance pay-out and the actual benefits payable to borrowers under the Kore W program criteria.[20]

In **Saint Lucia**, a Weather Index-Based Livelihood Protection Policy has been developed to protect the livelihoods of individuals by providing pay-outs based on the occurrence of extreme weather events measured on a parametric basis (See Box 3.7).

Box 3.7. **Saint Lucia: Weather Index-Based Livelihood Protection Policy**

In October 2012, a weather index-based micro-insurance product known as the Livelihood Protection Policy (LPP) was launched in Saint Lucia. The product was developed by a consortium of partners involved in the Climate Risk Adaption and Insurance in the Caribbean Programme (CRAICP).[1]

The aim of the LPP is to provide livelihood protection for low-income populations against adverse weather risks, offering a safety net for those whose incomes are affected by severe climatic events, such as strong winds and heavy rainfall during hurricanes and tropical storms. A wide range of beneficiaries is envisaged: from fishers whose core activity may be negatively affected by storms to farmers whose harvest depends on rain levels.

The territory of the island of Saint Lucia was divided into 39 grid cells and each insured person is assigned to the cell in which he or she is domiciled. Pricing of coverage is based on a fixed rate of 8% on the sum insured across the entire island, without any differentiation from cell to cell. The maximum sum that can be insured is approximately USD 3 700 and customers may decide the amount of coverage required in 10 segments of equal value.

Rainfall levels and wind-speed at the centre point of each grid cell are monitored on a daily basis by satellite technology and insured persons receive early warnings and emergency advice via mobile phone SMS, allowing them to anticipate a storm and take precautionary measures. If coverage is triggered by the severity of a weather event, there is no need for the beneficiaries to lodge a claim with the insurer as pay-outs are directly credited to the insured persons' bank account.[2]

1. CRAICP is financed by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and implemented by the Munich Climate Insurance Initiative (MCII) through a partnership with MicroEnsure and CCRIF and Munich RE.
2. The policy is underwritten by EC Global Insurance Company Limited and distributed via several local distribution channels, including the Saint Lucia Development Bank and the Credit Union League.

In **Peru**, an approach has been developed to provide *ex ante* pay-out for an expected extreme weather event, allowing beneficiaries to prepare in advance. "Forecast Insurance," developed in the context of an international co-operation project launched by Germany in 2010 within the scope of the International Climate Initiative,[21] makes innovative weather insurance products available to producer associations, agro-export companies, fisheries,[22] and financial and governmental institutions along Peru's northern coast.[23]

The Extreme El Niño Insurance Product (EENIP) is an index "forecast" insurance product, designed to provide a wide range of stakeholders with the financial means to prepare for the consequences of imminent extreme natural events, such as the extra costs and losses associated with catastrophic rainfall and flooding that follow a build-up of extreme levels of sea surface temperatures (SSTs) in the Pacific.

Pay-outs of the EENIP are triggered by extreme increases in Pacific SST that occur during an El Niño year.[24] The SST indicator is observed months before the onset of heavy rainfall on land, triggering pay-outs that enable the insured persons to finance the implementation of loss prevention and risk management strategies well before the catastrophic flooding reaches full force. For example, the EENIP for the Piura region makes payments based on average November-December Niño 1+2 SST measurements, thus enabling rapid pay-outs in January before the onset of flooding. Based on a series of studies, a relationship between such values and precipitation levels in the region was established (Khalil et al., 2007; Lagos et al., 2008). The analysis was then refined to determine an appropriate SST value for triggering payment under the insurance contract. Reportedly, logistic regression was used to identify Nino 1 + 2 values that correspond to rainfall events with return periods of 10 and 20 years respectively, representative of a strong El Niño event.[25] Limiting insurance coverage to the less frequent yet strongest El Niño events allowed for affordable pricing of the product, while providing protection against more severe losses. Because the weather index is based on predictions for determining the pay-out, the insurance must be purchased one year in advance before any index confirms the occurrence of an extreme El Niño phenomenon.

The EENIP can reduce exposure to unexpected losses and costs for vulnerable households, enterprises, and public sector entities, while facilitating disaster mitigation and planning. As such, the EENIP appears to be an innovative insurance product that could facilitate risk mitigation through pay-outs based on forecasting, thereby allowing for *ex ante* loss prevention.

Disaster insurance for credit institutions

In a number of economies, micro-finance and other local credit institutions play an important role in ensuring access to credit for small entrepreneurs and business owners. In economies highly exposed to extreme weather events like torrential rain or strong wind, these institutions face significant financial risks related to natural hazards. Disaster insurance coverage for financial institutions enables these institutions to continue to provide financing in the aftermath of a disaster event and support the financial resilience of the broader economy.

The cash flow of credit cooperatives in the **Philippines**, for instance, can be suddenly interrupted if member borrowers lose their livelihoods and assets in a storm and become unable to fulfil their debt obligations. Starting from the end of 2010, a group of partners (including Munich Re and GIZ), working in support of the Cooperative Life Insurance and

Mutual Benefit Services (CLIMBS),[26] have been implementing a weather-index-based micro-insurance product in the Philippines. This product is employed as a hedge for credit portfolios, enabling the cooperatives to manage their loan defaults and meet their social commitments in the event of a catastrophe. This extreme weather event insurance tool is based upon a parametric index for each municipality, developed by private sector partners, categorising wind speed and rainfall into 10-, 15-, and 20-year recurrence events. Using these benchmarks as pay-out triggers, CLIMBS compensates local cooperatives based on a pre-determined percentage of the value of their portfolios of loans, depending on the event intensity and corresponding category class. Shortly after a trigger event, the institution concerned receives an insurance payment which is then disbursed to its members in the form of emergency loans granted on favourable terms, according to specific needs (the insured cooperatives must make a commitment to pass on the insurance benefits to their members). The micro-insurance product, CLIMBS Catastrophe Protection Policy, appears to be beneficial to the cooperatives in helping manage their exposure to default risk as well as to the member borrowers or shareholders of these cooperatives by protecting their equity and investments in the cooperatives and by enabling them to rebuild their livelihoods after an extreme weather event.

Similarly, the banking and financial sectors in **Indonesia** face severe earthquake exposures, especially those firms that have limited capacity to diversify geographically.[27] Local credit institutions, such as rural banks and microfinance lenders, dominate the financial landscape in this economy and have the most comprehensive outreach to small and medium-sized enterprises, which in turn represent the backbone of Indonesia's growing economy. Liquidity issues, capital base erosion, poor loan performance, limited access to second-tier financing and extra-costs are some of the key areas of concern for these financial institutions facing earthquake risk; supporting them in the management of their exposures, therefore, has important social and economic implications.

A group of partners, in collaboration with *PT. Asuransi MAIPARK*, is developing index-based earthquake insurance to strengthen the resiliency of the financial sector that serves lower income households and SMEs. The "Earthquake Index Insurance" product (EQII) is designed to transfer portfolio risks of financial institutions, such as banks, financial services firms and credit unions, enabling them to expand access to financial services in vulnerable, under-served areas and to aid in local recovery through continued lending after an earthquake event. An intensity index of geographically-mapped earthquake-induced ground motion is used as a trigger for EQII with the level of pay-out calibrated to the insured entity's expectation of loan non-performance across its portfolio. Payment rates increase with the event intensity, and are weighted to reflect the geographic spread of the portfolio as well as population density. Using EQII to protect financial institutions and increasing their resilience to earthquake risk may have positive effects, including lower interest rates on loans and increased access to credit in the aftermath of a disaster event.

Financial sector resilience and claims management

In order to ensure the provision of disaster risk financing, the financial sector must be sound and resilient, capable of delivering promised payments and financing in the event of a disaster. Financial sector resilience to disasters depends on an adequate solvency regime and liquidity rules; stress testing for solvency and liquidity; and adequate business continuity planning within the financial sector, at the level of financial institutions and financial market infrastructures. Insurance regulation and supervision address the various facets of disaster

risk, such as catastrophe risk models, specific capital charges or reserves, reinsurance arrangements, liquidity, and claims management. In addition, while insurance and reinsurance companies may have important risk exposures, other financial sector participants such as banks, credit institutions, and financial market infrastructures may also be exposed to disaster risk. There should also be efficient and fair claims-handling procedures so that policyholders are promptly paid for insured losses, thus fulfilling the conditions of their insurance contract and ensuring that funds are available for reconstruction.

Financial sector resilience and business continuity

In many economies, financial sector resilience, including capital adequacy, liquidity, and business continuity, is recognised as a key priority, with relevant measures and initiatives in place to ensure operational and financial resilience against disasters. In most economies, particular attention is given to ensuring the continuity of critical financial market infrastructures, such as payment clearing and settlement systems, which have the potential to transmit disruptions across the financial sector given their central role in most financial systems.

The supervision of operational risks, including risks that arise from disruptions to operations, is an important element of supervisory frameworks in most economies and international principles related to the supervision of banking, insurance, market intermediaries, and financial market infrastructure all include principles related to the supervision of operational risk.[28] A number of economies have established ***specific requirements for business continuity management*** in order to mitigate the operational risks related to natural disasters and other disruptive events and support the resilience of the financial sector. In its guidelines for the supervision of banks, financial instruments business operators, and insurance companies, the Financial Services Agency of **Japan** requires the establishment of business continuity management strategies to cope with emergencies, as well as the development of a crisis management manual and a business continuity plan.

In **Malaysia**, guidelines have been issued for all financial institutions which outline business continuity management principles and specific requirements with regard to the formulation, implementation, testing, and maintenance of a Business Continuity Plan (BCP) and Disaster Recovery Plan (DRP). In the event of a disaster, the central bank also issues additional guidelines on necessary precautionary measures to support continuous provision of critical business services and operations. For instance, during the monsoon season in 2011, a circular was issued to all financial institutions in order to emphasise the criticality of flood preparedness scenarios under the BCP and requiring financial institutions to report on affected branches/premises immediately. In **Italy,** a special working group called *Continuità di Servizio* (CODISE) was established in 2003 to help ensure business continuity in the Italian financial market in the event of operational difficulties, including a severe or catastrophic crisis (see Box 3.8).

In **New Zealand**, the Reserve Bank of New Zealand (RBNZ) has taken a number of steps in recent years to improve the financial sector's resilience to disasters. For instance, for banks this has involved a review of the outsourcing policy that requires the New Zealand board of a bank to have the legal and practical ability to have control of core functions after failure as well as periodic reviews of banks' business continuity plans. Systemically important payments systems are required to self-assess against relevant international

Box 3.8. **Ensuring business continuity in the Italian financial market**

CODISE is a working group co-ordinated by the Bank of Italy in agreement with the Italian securities and exchange commission (*Commissione Nazionale per le Società e la Borsa* or CONSOB), consisting of representatives of the leading banking groups and the companies that manage infrastructures essential to the orderly working of the financial system. CODISE is the co-ordinating committee for all activities, both within and outside the Bank of Italy, relating to the handling of operational crises in the national financial system.

In the event of a crisis affecting domestic operators, the CODISE co-ordinator must provide the necessary liaison with the Bank of Italy's crisis management units, other domestic financial operators and the European Central Bank. CODISE currently performs a number of functions:

- Co-ordinating the handling of operational crises involving the infrastructure and/or participants in the Italian financial system.
- Representing the Italian financial market in Eurosystem co-ordination activities.
- Interacting with other sectorial authorities (Civil Protection and the CONSOB).
- Serving as contact point for Italian operators in an emergency.
- Developing risk scenarios.
- Drafting business continuity rules and standards.
- Running simulations, including those co-ordinated by the Eurosystem, and evaluating the results and impact on emergency management plans in terms of business continuity.

CODISE identified the financial services that were vital to the orderly functioning of the system, laid out risk levels, and evaluated the interdependence among the main participants in the domestic financial marketplace. When a crisis is declared, CODISE establishes a direct link with the Civil Protection Department.

Source: Bank of Italy – *www.bancaditalia.it/sispaga/codise.*

standards that include business continuity and to publish these self-assessments. **Portugal** is also actively involved in the assessment of its financial sector resilience. The national insurance and pension funds supervisory authority is conducting a survey in order to assess insurance and pension fund managing entities' business continuity plans and processes. This survey aims to provide a global view on the resilience of the market, as well as to identify best practices and potential vulnerabilities. Furthermore, as part of the survey, entities reviewed are encouraged to conduct a self-assessment of the effectiveness of their operating processes in the event of a disaster that would interrupt the normal course of their activities.

In **Singapore**, the Monetary Authority of Singapore (MAS) prepares the industry for disasters by issuing guidelines on business continuity management and conducting supervisory inspections based on these guidelines. MAS also regularly organises industry-wide exercises (IWE) involving banks, insurers, capital market firms and financial market infrastructure. The objectives of these exercises are to enhance the resilience of the financial sector and provide an opportunity for financial institutions and infrastructures to test their business continuity and communication processes, as well as enhance co-ordination with key industry players and civil authorities. The scenarios developed for these exercises take into account prevailing risks and concerns of MAS and the financial

industry. For example, IWE I (2006) focused on terrorist attacks in the Central Business District, while IWE II (2008) was based on the outbreak of a flu pandemic. The IWE held in 2011, featured combined physical attacks (i.e. roving terrorist attacks across the financial sector, similar to the events in Mumbai in 2008) and targeted cyber-attacks. In **Brunei Darussalam**, the *Autoriti Monetari Brunei Darussalam*, the central bank and financial regulator, has established its own crisis management plan with dedicated responsibility assigned to the offsite officers of banks for the co-ordination of bank-specific crisis management plans with those of the authority.

In **Hong Kong, China**, the Hong Kong Monetary Authority (HKMA) expects Authorized Institutions (AIs) in the banking sector to have business continuity planning (BCP) processes in place. The HKMA has published a Supervisory Policy Manual on BCP setting out the HKMA's supervisory approach to the business continuity planning of AIs and the sound practices which the HKMA expects AIs to put in place in order to ensure continuity of business operations in times of emergency or disaster. This is supplemented by further guidance through circulars issued from time to time, as well as self-assessments and on-site examinations of selected AIs to ensure their readiness and effectiveness in triggering BCPs. As required under the Supervisory Policy Manual on BCP, AIs should conduct business impact analysis to identify different kinds of risks on business continuity and to quantify the impact of disruptions to their operations. This helps AIs identify critical services that must be maintained and continued in the event of a disaster. In addition, AIs should also have usable and functional alternate sites for business continuity (e.g. in case the AIs' main offices are inaccessible due to a disaster or other scenario) and such alternate sites should be sufficiently distanced from the main office to avoid being affected by the same contingent event. AIs are also required to test their BCPs at least annually to ensure that they are operable. In addition, to safeguard the stability of the Hong Kong, China financial market, there are a number of risk management measures adopted by the Hong Kong Exchange (HKEx) to ensure resilience of its operations, including a Market Contingency Plan (MCP), which sets out the procedures that HKEx will take in contingency events, Default Procedures, and Liquidity Support through arranged credit facilities with commercial banks.

In **Chile**, ensuring adequate business continuity planning within the financial sector at the level of financial institutions and financial infrastructures (e.g. payments systems, equities and futures markets, central clearing counterparties) is contained within the regulations of the *Superintendencia de Bancos e Instituciones Financieras* (SBIF). The Superintendent uses the operational risk definition proposed by the Basel Committee on Banking Supervision for the management of operational risks, covering the risk of losses resulting from inadequate or failure of processes, people and systems or from external events. In **Chinese Taipei**, the financial authority has been encouraging financial institutions to develop a well-designed reaction system or implementation plan to help reduce the potential for economic disruptions when natural disasters occur and to enable the continued operation of the financial system.

In **Russia**, the business continuity plans of the nation's central bank are considered to be of great importance. The main measures taken by the Bank of Russia for any unforeseen circumstances include the creation of a committee on the management of the continuity of activity of the Bank, the formation of a long-term programme of providing for the continuity of activity of the Bank, and the creation of a control system for business continuity which is integrated into the broader system of internal controls at the Bank.

Work under the long-term programme involves the preparation of all divisions within the Bank for continuous functioning, including ensuring high fault tolerance and availability of information and telecommunications infrastructure in the event of natural disasters, techno-genic accidents and large-scale emergency situations involving interruptions in power supply and work of engineering systems, transport collapses, breaks in communications, failures in processing of financial documents and payment systems, or when employees might for various reasons be subject to significant stress.

Capital adequacy requirements to account for insured losses related to disaster events (for both the life and non-life sectors) are generally part of capital standards in most economies and are included in the Solvency II framework in the European Union. A number of economies also ***undertake regular reviews and stress testing*** on the impact of natural disasters on insurer solvency. In **Australia**, the Australian Prudential Regulatory Authority (APRA) closely monitors the financial system, periodically examining the adequacy of the capital requirements applicable to general and life insurers. In the 2012 Life and General Insurance Capital Review, APRA noted that the financial strength of insurers may be adversely impacted by the occurrence of multiple large losses in any one year. As a result, APRA made changes to the prudential regime by setting the level of required capital for insurers to correspond to a 99.5% probability of sufficiency over a one-year period (that is, a 0.5% probability of insurer failure over a one-year period).

In **New Zealand**, the RBNZ has established a new regulatory and supervisory regime and is in the process of licensing insurers, including revised capital requirements for insurers that incorporate a catastrophe risk charge. The RBNZ has also been examining operational risk within the largest four banks' capital models. In **Switzerland**, the solvency requirements (Swiss Solvency Test) for insurers take natural catastrophe risks fully into account by means of a probabilistic model. In **Mexico**, CNSF undertakes stress testing every six months (Dynamic Solvency Test). Insurers are also required to undertake stress testing in line with international standards at least on an annual basis. The outcome of the stress testing is utilised by the CNSF to identify potential future trends and address possible disaster scenarios where the system may be compromised.

In **Poland**, the KNF has, as part of its supervisory process, required Polish insurance undertakings to carry out stress tests since 2009. For non-life insurance undertakings, these stress tests include a specific requirement for the inclusion of catastrophe scenarios where each participant should consider two scenarios: natural catastrophe (flood with damage at a level of 0.16% of sum insured) and man-made disaster (the biggest insured potential loss). Insurance undertakings can also develop their own scenario and submit the results. The KNF checks if an insurance undertaking meets solvency requirements after application of the stress tests. The KNF also assesses natural catastrophe models used by insurers as part of the pre-application process for internal model approvals under the Solvency II requirements. In addition, the KNF, together with industry experts, established the NatCat Forum initiative which aims to create flood risk management and data quality guidelines for the Polish insurance sector, with particular emphasis on Solvency II requirements. The results of this work stream will be published as KNF guidelines.

In **Chile**, the SVS and the insurance industry association (AACH) are planning to develop a project that establishes an earthquake and tsunami risk assessment model which would replace the current basis for calculation of the catastrophic earthquake reserve. This project aims to assess the risk of earthquake and tsunami, based on a more scientific risk mapping of the territory and a specific definition of vulnerabilities, including the characteristics of

insured properties, through a mathematical model. The resulting information is expected to enhance the insurance industry's risk management practices. In **Thailand**, after the flood in 2011, the OIC reviewed the capital adequacy of all companies to ensure that companies remained financially strong. As the flood caused an unexpectedly huge loss, some companies held less capital than required, although only for a short period. The OIC allowed a waiver for such cases for a limited time. Exposure to disaster risk will later be reviewed in order for it to be included sufficiently in the risk-based capital calculation.

Claims management

Fair and efficient claims management is a key element in disaster risk insurance as it serves to ensure that policyholders with insured losses are promptly compensated in accordance with the terms and conditions in the insurance contract, providing a source of funding for rehabilitation and reconstruction. Monitoring the performance of private sector insurance companies tasked with the payment of indemnities to victims of disasters can support speedy compensation and fairness in the treatment of claims, while minimising opportunistic conduct on the part of insurance companies.

In **Australia**, the Australian government and the Insurance Council of Australia strengthened, in 2012, the General Insurance Code of Practice to raise service standards, improve the way that claims and complaints are handled and help people better understand how general insurance works. Insurance companies are now required to resolve claims stemming from catastrophes in the same time frame as other claims (within four months of a claim being made). Previously, the categorisation of claims arising from catastrophes as extreme events allowed deviation from existing standards. Reports prepared on insurers' compliance with the provisions of the Code will also be publicly released for the first time to improve transparency. In addition, new regulatory requirements were imposed to ensure that a standard definition of "flood" is used in home building, home contents, small business and strata title insurance policies and requiring insurers to provide consumers with one-page fact sheets that set out key information about the coverage provided under home building and home contents insurance policies.

In **China**, the Insurance Law as well as the relevant industry management rules take the interests of policyholders into full consideration in establishing claims management standards. A stringent product approval process is in place which requires that the terms of all types of products must provide payments in a fair, timely and effective manner. All commercial insurance companies must have clear standards and processes in place for the processing of claims, in order to improve service quality and increase market competition. In addition, major companies have made systematic arrangements to establish a "green channel" to speed the resolution of disaster claims and provide advance payment of compensation amounts, among other initiatives. The Agricultural Insurance Regulations stipulate that: i) insurance agencies must pay the due compensation to the policyholder within 10 days of reaching a compensation agreement with said policyholder; ii) insurance agencies must pay the due compensation amount in line with the approved loss amount for the insurance subject in accordance with the stipulations of the agricultural insurance contract; iii) where relevant units collectively take out agricultural insurance, claim forms must be confirmed by the signature of the policyholder; and iv) the insurance agency is required to publish claim results.

In **Poland**, the Polish Financial Supervisory Authority ensures that funds are disbursed quickly through constant monitoring of insurers and reinsurers, including a focus on

ensuring transparency in the claims handling processes and tracking changes in the number of claims handling complaints relative to the insurance portfolio. Insurers in Poland are also held accountable through requirements to clearly document their procedures for claims handling and related complaints as well as instances of non-compliance with those procedures. Similarly, in **Portugal**, the supervisory authority regularly monitors the implementation of claims settlement policies and procedures and requires reporting on the settlement of claims.

In **Hong Kong, China**, the performance of insurers in claims management is monitored by the competent authority. Insurers are encouraged to establish a claims settlement committee to assist the Board of Directors' oversight of the claims settling policy and position of the company. Particular attention is also drawn to any significant claims cases or events which might give rise to a series of claims (e.g. typhoons, floods).

A number of economies have put in place arrangements to address some of ***the operational challenges related to disaster claims management***. In **Japan**, after the Great East Japan Earthquake, the Minister for Financial Services and the Governor of the Bank of Japan immediately made a request to financial institutions and the insurance industry to take appropriate measures to assist victims. As a result of this request, the insurance industry simplified insurance receipt procedures and organised industry wide loss adjustment mechanisms in order to promptly resolve insurance claims. Insurers completed 98% of insurance claims within 6 months after the occurrence of the earthquake. The earthquake resulted in the enactment of the *Disaster Countermeasures Basic Act* and the establishment of an emergency management scheme for serious disasters. The Financial Services Agency revised its Supervisory Guidelines to ensure that, in the aftermath of a disaster, insurers take appropriate measures, such as industry co-operation, to achieve efficient payment of insurance claims.

In the aftermath of the 2011 floods in **Thailand**, the OIC cooperated with the General Insurance Association, the surveyors and network organisations in order to facilitate the claims handling process. This included efforts to quicken claims payment by increasing the number of specialists and qualified personnel to assess losses, promote awareness among those affected on how to proceed with claims, provide assistance on completing claims, as well as other measures to ensure claims were efficiently and fairly addressed.

In **Chile**, the need to handle a massive amount of claims received in a short timeframe – more than 230 000 in just a few months – was one of the biggest operational challenges that the local insurers had to face in the aftermath of the 27F earthquake in February 2010. The insurers belonging to multinational groups had contingency plans in place and were able to successfully handle the claims with the aid of dedicated teams of experts promptly sent from abroad. By August 2010, almost all residential properties damaged by the earthquake and covered by insurance were inspected and by the end of December 2010 approximately 99.8% of the residential property insurance claims were settled. The SVS conducted its own review of the impact of 27F on the insurance industry including the performance of the private insurance sector and lessons learned (Superintendencia de Valores y Seguros, 2012).

Public awareness

Disaster risk awareness is a key element of DRM strategies. Human-induced factors greatly contribute to the costs of disasters. Changes in patterns of human behaviour, perception and decision-making at all levels of government and society, therefore, can lead

to a substantial reduction in disaster risk. Improving the level of risk awareness and the quality of disaster risk reduction education tools clearly stands out as an essential feature of effective DRM strategies.[29] Moreover, promoting awareness of the financial impacts of disasters and the need to plan for – and mitigate – these impacts through the development of financial management strategies, including investment in physical risk reduction and financial tools, can boost financial resilience.

Improving public awareness of financial protection options and the need for financial strategies to address disaster risks can also make an important contribution to increasing disaster insurance coverage. Enhancing awareness on the need for financial preparedness may include communication on the expected allocation of disaster costs and particularly who is responsible for those costs (through, for example, government policy statements and targeted messages), as well as information about the availability and main characteristics of DRF tools.

Many economies have launched campaigns seeking to raise public awareness about the importance of preparing for emergencies of all kinds, but only some of them focus specifically on the financial impacts of disasters and the need for financial preparedness. In **Australia**, several community- and non-government organisation-based initiatives have been developed to promote public awareness of the impacts of natural disasters, including the need for financial preparedness. One such initiative is the Australian Red Cross' emergency "REDiPlan" booklet, which is distributed to households to promote planning and preparation for natural disasters. The booklet includes information on developing a financial plan for managing the impacts of natural disasters and the importance of appropriate levels of insurance in helping households manage the financial impacts of natural disasters. More broadly, Australia's *National Strategy for Disaster Resilience* advances the notion of a disaster-resilient community being one where people understand their exposure to disaster risk, have taken steps to anticipate disasters and to protect themselves, and work together with local leaders to prepare for and deal with disasters.

In **China**, various levels of government, insurance regulatory bodies and commercial insurance companies are actively involved in disaster advocacy initiatives, by means of public service announcements, on-site discussions, and product promotions aimed at encouraging disaster loss prevention activities and the use of disaster risk financing tools by individuals to mitigate the potential impact of disasters. The **Korean** government has used websites, mass media, telecommunication mediums and promotional materials to enhance public awareness of the financial impacts of disasters and highlight the importance of financial preparedness. The OIC in **Thailand** regularly hosts seminars and joins events nationwide in order to promote insurance as a financial protection tool to the public with the hope of increasing penetration rates. The government of **Indonesia**, in collaboration with local authorities, the insurance industry and research institutes, has performed a variety of outreach activities and seminars to raise public awareness of disaster risks.

In the **Czech Republic**, the insurance of property against natural perils is one of the elements of the financial education programs conducted under the aegis of the Ministry of Finance. Individual ministries also organise a wide range of courses, seminars and conferences for the general public and specialists to spread information on risk mitigation and disaster (most often flood) management. In **Germany**, a number of state governments, consumer protection organisations and the insurance industry have sought to raise awareness of the financial impacts of disasters and encourage the purchase of insurance in lieu of reliance on state aid. Concerted efforts have been made to make it clear that, if

private insurance coverage is available, there would be no future state aid in the event of a disaster. Since then, it is reported that market penetration has continuously risen.

In **Switzerland** as part of the disaster prevention initiatives, the Federal Office of Environment and the National Platform for Natural Hazards disseminates publications and organises public seminars on the importance of natural disaster risks and how to cope with those risks. Part of the educational aspect aims to prevent building construction in high-risk areas by ensuring individuals have a greater awareness of hazard maps and that these are viewed prior to construction decisions. Recently, there has been a shift towards enhancing awareness of earthquake risk (due to the lack of broad insurance coverage for this peril).

In 2009, the government of **Mexico** launched a new initiative to improve states' understanding of disaster risks and to increase their involvement in the design of financial risk transfer schemes. This initiative was enhanced in 2011 through an increase in financial support. The initiative aims to assist state governments in developing inventories of public assets and low-income housing (including attributes such as type of construction, year of construction, replacement cost, location, and past damage) that are eligible for insurance and in conducting studies to identify and quantify these assets' vulnerability to natural hazards. FONDEN provides state entities with technical and/or financial support for the development of integrated risk management systems.

Implementation challenges

Economies that participated in the survey have reported a number of challenges related to developing disaster insurance markets that provide affordable insurance coverage for the full set of risks that the economy faces, citing constraints in terms of both the demand for insurance coverage and the ability of the market to provide insurance options that are economically viable.

On the demand side, limited financial awareness and low levels of financial literacy were key challenges in terms of building understanding of insurance as a tool for financial protection and therefore demand for insurance. This is exacerbated by the lack of an insurance culture and/or by a population that perceives insurance to be too expensive or is sceptical regarding the operations of insurance companies, including the certainty of claims payment (which hampers penetration even in some economies where disaster insurance is compulsory). Product complexity, for example in the case of innovative index-based or parametric insurance products, can also be an impediment to demand and highlights the need for knowledge transfer and communication. In addition, moral hazard, where individuals or business may be unwilling to pay for insurance given that they expect full compensation for losses from government, was identified by many economies as an important impediment to demand for insurance.

The lack of demand for insurance creates impediments to the economic viability of insurance coverage by the private sector given the limited potential for premium revenue and for pooling a broad spectrum of risks (which may be unevenly distributed across the economy). This is exacerbated by the potential for adverse selection, where only those likely to face losses will seek insurance, making it uneconomical for insurance companies to provide coverage. More than one economy noted the challenge related to insuring legacy structures in high-risk areas (i.e. those built prior to the existence of any legal framework to restrict building in those areas) as well as newer structures that do not comply with current building standards.

A number of structural impediments to the supply of affordable disaster insurance coverage were also identified. This includes the lack of information and data on natural disasters (particularly localised disasters) which affects the ability of insurance companies to underwrite disaster risks – especially in the case of small insurance companies. The insurance industry's limited underwriting capacity and ability to cope with severe disasters has led to the tendency to take a relatively cautious approach to assuming liability for disaster loss in some cases, which often leads to higher (and potentially unaffordable) premium levels.

The establishment of small-scale index-based insurance schemes, used for instance for the agricultural sector, requires significant investments in technology, as well as extensive and high-quality data sets to model the hazard and quantify loss probabilities. A significant challenge in designing a public agricultural insurance scheme can be the availability of good and comprehensive data.

It was also noted that insurance market infrastructures, including an effective legal and regulatory framework, efficient delivery channels, and stable reinsurance capacity, are critical for the establishment of viable disaster insurance options. For example, the inadequacy of major disaster insurance distribution mechanisms can be a significant barrier to expanding public agricultural insurance schemes.

In economies where public funding has been provided for disaster insurance, either as premium subsidies or reinsurance/guarantees, a key challenge has been removing that public support as insurance market capacity expands. This is a particular challenge in the case of agricultural insurance and other insurance schemes targeting vulnerable segments where it is often difficult to design an approach that is commercially viable. A significant challenge is to design the legal, institutional, and financial frameworks that will allow government-backed schemes to transition into a market-based solution.

As noted, agriculture insurance poses particular challenges due to the frequency of loss events (relative to natural disaster insurance, where events may be less frequent, allowing for the build-up of reserves in years with no disaster events). The frequency of losses in agriculture insurance leads to generally expensive premiums, particularly for multi-peril indemnity coverage (Munich Re, 2009). While single-peril and index-based products are more affordable, these products create risks for farmers as a result of uncovered perils and basis risk (Munich Re, 2010).

Another key challenge identified in the case of public disaster insurance schemes is that, given the uneven distribution of disaster risks across an economy, public schemes will face challenges in terms of establishing a reasonable/fair flat-rate premium system or alternatively, developing the infrastructure and capacity necessary to implement a risk-based system.

In terms of operational resilience, the main challenges cited include the need for effective and timely co-ordination and communication among authorities charged with surveillance, the level of uncertainty surrounding the occurrence and impacts of natural disasters (which creates challenges for business continuity management), and the tendency to ignore or underestimate the importance of backup systems or recovery planning in the units that manage and supervise the budget for recovery expenditures. Financial sector resilience depends in large part on the degree and adequacy of disaster preparedness within financial institutions and market infrastructures, which is a function of cost and prioritisation. It was also noted that banks' credit exposure to catastrophe risks are not specifically taken into account in solvency requirements.

In terms of claims management, the availability of sufficient loss adjustment capacity in the aftermath of a disaster is a key challenge that has been identified in economies that have suffered large-scale disasters, such as Chile and New Zealand (although the use of parametric insurance eliminates the need for loss adjustment). Related to this issue is the need to ensure quick access for loss adjusters to the affected areas in order to ensure the claims process can begin quickly. The lack of appropriate standards for assessing losses can increase the likelihood of claims disputes.

Notes

1. It is important to note that the ability of insurance companies to make efficient claims payments for indemnity-based insurance coverage will depend on their ability to access the affected area in order to complete loss adjustments (insurance coverage based on a physical parameter or index does not require loss adjustment).
2. Total insured losses from natural disasters from 2007 to 2013 averaged AUD 1.9 billion a year, compared to AUD 290 million a year from 2000 to 2006. The insured losses of the Queensland floods of 2010-11 and Cyclone Yasi in 2011 are together estimated to have totalled around AUD 3.8 billion.
3. Since 1993, the Chilean government started private sector bidding for concession of infrastructure such as highways, prisons, airports, ports, and hospitals. One of the requirements for the concessions is that the bidder who is awarded the contract must have insurance coverage for natural disasters.
4. Earthquake is not categorized as a natural catastrophe for the purposes of insurance and is thus not often covered – despite Switzerland's exposure to earthquake.
5. With exceptions such as pavilions, mobile homes, mountain railways, objects on construction areas, and greenhouses.
6. An English-language translation of this law is available on the website of the Turkish Catastrophe Insurance Pool at: *www.tcip.gov.tr/mevzuat-587Sayili-kanun.html*.
7. In January 2014 the US Senate passed the *Homeowner Flood Insurance Affordability Act, 2014* to curb price increases generated by the *Biggert-Waters Flood Insurance Act*. The *Biggert-Waters Flood Insurance Act* was passed on 6 July 2013 and is operational until 30 September 2017. The implementation of the *Biggert-Waters Flood Insurance Act* incorporated actuarially sound pricing mechanisms into calculations of NFIP premiums. The use of actuarially sound pricing mechanisms had the effect of increasing the cost of obtaining flood insurance significantly. The introduction of the *Homeowner Flood Insurance Affordability Act* created changes for single family homes to ensure affordability of flood insurance. The legislation also provides scope for affordability initiatives to be extended to situations where a family has more than one family home provided that neither home is rented out.
8. A "catastrophe" can be declared under the following conditions: i) upon the advice of the Department of Disaster Prevention and Mitigation, a declaration of the Cabinet of Ministers is issued, stating that a particular event has escalated to a 'catastrophe'; ii) the total claim for catastrophe damages exceeds THB (Thai Baht) 5 billion per event that is within a 60-day duration and with a minimum of two claimants; iii) earthquake with a magnitude of at least 7 on the Richter scale; or iv) windstorm with wind speeds of at least 120 kilometres per hour.
9. The compensation provided is: i) THB 30 000 if water level reaches the floor of the household, less than 50 cm; ii) THB 50 000 if the water level reaches 50 cm; iii) THB 75 000 if the water level reaches 75 cm; and iv) THB 100 000 if the water level reaches 100 cm.
10. The definition of "total loss" has also been revised and refers to any of the following conditions: i) the insured property is demolished upon order of a government agency; or ii) the insured property has been declared uninhabitable and in need of demolition and rebuilding by a qualified adjuster, or by an association of professional architects, structural engineers, civil engineers, or geotechnical engineers; or iii) the assessment establishes that the insured property could be inhabitable after repairing and the repair cost equals or exceeds 50% of the replacement cost at the time when the insured event occurred.
11. The OECD has examined the implications of risk management for policy in agriculture, including a quantitative analysis of risk and case studies on policy approaches in various countries (OECD, 2011).

12. Based on principles of mutuality and co-operation, takaful is an Islamic form of insurance characterized by elements of shared responsibility, joint indemnity, common interest and solidarity, in which each participant contributes into a fund that is used to cover expected claims.
13. The Agricultural Index Insurance Initiative is a partnership between UAP Insurance and the Syngenta Foundation for Sustainable Agriculture.
14. Kilimo Salama operates such that those selling the indexed crop insurance products would register a farmer for cover using a simple mobile phone application. Confirmation of the insurance policy will then be received by SMS message. Technology is used in the sale of the product, in claims processing and in assessing when damages are paid out. Pay-outs are transferred through a mobile payment system called "M-Pesa", developed by a local telecommunications service provider. In line with the use of technology and with a view to linking risk transfer to risk reduction, if farmers have any questions about their coverage or if they would like advice about how to make their farms more resilient, they have the option of calling a toll free number.
15. *Dzuds* are severe winter conditions that are characterized by extremely low temperatures, wind, snow, or ice that prevent livestock from accessing pastures or receiving sufficient food (Sayed, 2010).
16. Livestock mortality index is a methodology for calculating the livestock mortality rate of the insured herders' *soum*. For instance, the livestock mortality rate in 2012 winter and spring will be calculated by subtracting livestock mortality rate of the 2013 mid-year from final-year mortality rate for each livestock species in a *soum* where a herder was insured in 2012.
17. The product can insure a selected number of livestock species, including horses, sheep, cattle, and camels.
18. MiCRO's activities are supported locally by Haitian insurer Alternative Insurance Company S.A, along with Swiss Re.
19. Other partners in the program include Swiss Re, Guy Carpenter's subsidiary GC Micro Risk SolutionsSM (GC Micro), Caribbean Risk Managers Limited (CaribRM), the UK Department for International Development (DFID) and the Swiss Agency for Development and Cooperation (SDC).
20. Swiss Re reinsures the parametric policy, while MiCRO's risk-bearing cell for Haiti, further backed by a Multi-Donor Trust Fund managed by the Caribbean Development Bank, provides the financial resources to pay "basis risk" claims. Financial support was also provided by the UK Department for International Development (DFID) and the Swiss Agency for Development and Cooperation (SDC).
21. The initiative was commissioned by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and managed by GIZ.
22. The agricultural and fishery sectors constitute a significant component of Peru's economic activities.
23. The project specifically targets northern coastal regions that are most affected by the El Niño (Piura, Lambayeque, and La Libertad). "The project strategy is divided into four action lines. The first is performing a demand and risk analysis in order that the population and public and private institutions (target group) in the pilot region have a clear idea of the need and advantages of purchasing weather insurance as a means of lowering weather-related risks. The second is weather insurance product development tailored to the target group's needs. The third is institutionality and legal framework strengthening on the matter of weather insurance in both the government and private spheres. Furthermore, national institutions are supporting the respective adaptation of the legal framework so that weather insurance is endorsed. Finally, the fourth action line is knowledge management for spreading information on weather insurance products nationally and internationally, for promoting experience sharing, and for evaluating their reproducibility in other Peruvian regions and throughout Latin America" (GIZ, 2012).
24. "El Niño" is cyclical climate phenomenon characterised by complex interactions between the ocean and the atmosphere across the eastern and western tropical Pacific, caused by a disruption in El Niño Southern Oscillation (ENSO). Trade winds and ocean currents in the equatorial Pacific change course, thus causing SST to increase and convection to shift from the western to the central Pacific. El Niño (the warm phase) and La Niña (the cool phase) refer to the two extremes on this spectrum as indicated by changes in SSTs (GlobalAgRisk, 2012). The US NOAA maintains a public database of historic and current SST measurements from four regions in the Pacific. SSTs have become the standard scientific benchmark for monitoring changes in geophysical processes that signal an El Niño year. Sustained SST elevation occurring in specific regions of the Pacific Ocean is one of the primary indicators of El Niño, as monitored by meteorological institutions around the world. The time series of monthly average SST measurements maintained by NOAA spans from 1950. NOAA also synthesises a number of ENSO indices, using recorded and reconstructed SSTs, available at monthly resolution dating back to 1856. See: *www.cpc.ncep.noaa.gov/data/indexes/sstoi.indexes*.

25. The current version of the Niño 1+2 (November and December) insurance contract starts paying at 24°C with a maximum payment at 27°C. Studies are currently being conducted to anticipate the pay-outs using Niño 3 measurements.
26. CLIMBS is an umbrella organisation and a grassroots insurance cooperative owned by over 1 700 primary cooperatives and federations in the Philippines. It is registered with the Cooperative Development Authority and it was issued a licence to operate as a composite insurance cooperative by the Insurance Commission.
27. "Geographically concentrated FIs have limited institutional protection against earthquake risk and limited ability to access new capital following a disaster" (GlobalAgRisk, 2013).
28. The relevant international principles are the Basel Committee on Banking Supervision's Core Principles for Banking Supervision, the International Association of Insurance Supervisors' Insurance Core Principles, the International Organization of Securities Commissions' Objectives and Principles of Securities Regulation, and the Principles for Financial Market Infrastructures developed by the Committee on Payment and Settlement Systems and the International Organization of Securities Commissions.
29. Principles and good practices drawn from experiences within the OECD are presented in the OECD Policy Handbook on Natural Hazard Awareness and Disaster Risk Reduction Education issued in 2010 under the auspices of the OECD High-Level Advisory Board on the Financial Management of Large-Scale Catastrophes (OECD, 2010b). *www.oecd.org/pensions/insurance/42221773.pdf*.

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Chapter 4

Government compensation, financial assistance arrangements and sovereign risk financing strategies

This chapter provides an overview of government compensation and financial assistance arrangements as well as strategies for managing sovereign exposures to disaster risks. It begins by providing an overview of government compensation and financial assistance arrangements across surveyed economies. This is followed by an overview of efforts to put in place the necessary processes to ensure fair and efficient deployment of public funds. Potential approaches to managing sovereign exposures to disasters, including a discussion of ex ante approaches such as reserve funds, contingent credit arrangements and risk transfer tools and ex post approaches such as borrowing in financial markets, re-allocation of funding and taxation are described. The chapter concludes with a discussion of common implementation challenges to ensuring fair and efficient deployment of government compensation and financial assistance and to developing sovereign risk financing strategies and accessing risk transfer tools.

Government compensation and financial assistance arrangements and a fair and efficient deployment of funds

Government compensation and financial assistance arrangements can be established to address financial vulnerabilities where private coverage by DRF tools may be lacking or unobtainable at an affordable price. The schemes may cover basic living expenses and losses linked to disaster impacts (e.g. property damage, temporary relocation) and may aim to provide general financial assistance or more direct compensation for losses.

The existence of financial assistance and compensation schemes is particularly important in economies where insurance markets are less developed, or where income levels are low, as it may be unreasonable to expect individuals and businesses to make use of private markets such as insurance due to the lack of availability or unaffordability. In these contexts, financial vulnerabilities, which may be significant, might remain unaddressed, particularly for poorer segments of the population.

As outlined in the Framework (OECD, 2012: Section II.2), compensation arrangements that are explicit and well-defined *ex ante* have important advantages relative to financial assistance that is provided on an *ad hoc* basis after a disaster event. Well-defined rules and processes provide clarity on access to financial assistance, helping to ensure prompt assistance, reduce moral hazard and decrease the potential for unplanned post-disaster assistance. In the absence of well-defined parameters surrounding this assistance, individuals and businesses may come to develop strong expectations of *ad hoc* post-disaster aid, thereby affecting incentives for self-protection and reducing demand for other sources of financial coverage such as insurance. Therefore, there is a need for an integrated approach that ensures financial protection for the most affected and vulnerable segments of society, delivered in a manner that does not crowd out, but supports, private initiative in risk reduction.

Ex ante governmental schemes may, by restricting the scope of compensation (for instance by strictly defining eligible damages and placing a cap on the level of public assistance, with payments covering only essential or reasonable needs), serve to reduce expectations of full compensation of losses and at the same time provide greater certainty regarding compensation for severely affected individuals and businesses, thereby strengthening incentives for financial self-protection and promoting confidence in solidarity mechanisms while helping to clarify and limit the government's contingent liabilities. In order to avoid double payments, government schemes may exclude compensation of already insured property; moreover, to prevent moral hazard, such schemes may not offer compensation in the event that insurance coverage could ordinarily have been purchased. Well-designed governmental schemes may thus help to reduce moral hazard and avoid the crowding-out of private insurance markets, thus complementing these markets (OECD, 2012: Section II.2).

These schemes may be designed to ensure timely appropriations or release of funds within pre-specified parameters, thereby ensuring timely disbursement of disaster funds

for emergency assistance, social protection, recovery and reconstruction. The financing of such schemes may be *ex ante*, taking the form of a governmental reserve fund financed internally through annual appropriations and possibly leveraging international risk financing and risk transfer markets (such as insurance for public infrastructure assets or parametric insurance to support the funding of emergency assistance and recovery costs) to augment financial capacity; alternatively, they may be funded *ex post*, with appropriations made upon the occurrence of a disaster (see below).

Government compensation and financial assistance arrangements

Some government assistance schemes are aimed mainly at ***providing immediate financial assistance and compensation*** to those affected by disaster events, sometimes supplemented by other assistance such as tax relief. For instance, in **Hong Kong, China**, the *Emergency Relief Fund Ordinance* established the Emergency Relief Fund to provide prompt assistance to persons who are in need of urgent relief as a result of fire, flooding, tempest, landslide, typhoon or other natural disaster. Grants from the Fund are intended for relief rather than compensation. The Fund consists of an annual allocation from the General Revenue and donations received from the public from time to time. It is vested as a trust with the Director of Social Welfare. There are five major types of grants available under the Fund: i) grants in respect of death or personal injury; ii) grants for domestic re-accommodation, re-equipment, site formation and repair, and extensive damage to home appliances; iii) grants to repair or replace vessels and fishing gear; iv) primary producer grants; and v) special grants. The responsibility for approving grants and making payments is in most cases vested in the Agriculture, Fisheries and Conservation Department, the Marine Department, the Social Welfare Department and the Lands Department, while the Home Affairs Department is responsible for overall co-ordination at the district level. To be eligible for relief from the Fund, a person must be in need to an extent which merits relief as set out in the law.

In **China**, in accordance with the provisions relating to Chinese government financial management, the financial administration bodies of the central government take the lead during the recovery and reconstruction stage following a major disaster in investigating and determining a funding scheme. An overall reconstruction funding plan is drafted, taking into account factors such as disaster losses, local financial resources, donated funds, and the scale and standard of reconstruction. The funding plan is then confirmed following approval by the State Council and funding is distributed to the local level for allocation to particular projects in accordance with the progress of reconstruction. In order to ensure the basic livelihoods of those affected by disasters, the government has established a Central Natural Disaster Livelihood Subsidy Fund at the central government level:

- *Fund size*: The Central Natural Disaster Livelihood Subsidy Fund has an annual budget of CNY 13 billion. Between 2009 and 2013, the central government financial administration issued a total of CNY 59.737 billion, providing assistance to 80 million victims each year, supporting local governments in the emergency evacuation of 10 million people, and assisting people in disaster areas with the reconstruction of 3 million houses.
- *Application standard*: Under normal circumstances, whenever a serious or major natural disaster occurs and the People's Republic of China National Committee for Disaster Reduction initiates a disaster relief emergency response above Level IV, the central government financial administration will disburse Central Natural Disaster Livelihood Subsidy Funds, so that rural residents in the disaster area are able to obtain funds for

certain projects. The National Natural Disaster Relief Emergency Plan clearly defines the criteria for a major natural disaster as well as the criteria for the initiation of an emergency response above Level IV.

- *Types of disaster covered*: The Central Natural Disaster Livelihood Subsidy Fund covers all types of natural disasters, although disasters such as drought, flooding, typhoons, hail, freezing temperatures, snow, earthquakes, rock avalanches, landslides and mud slides are most commonly encountered in practice.
- *Funded projects* Eligible forms of assistance include disaster emergency relief, assistance to families of victims, transitional livelihood relief, reconstruction funds for the reconstruction of collapsed or damaged homes, drought temporary livelihood hardship relief, winter temporary livelihood hardship relief as well as materials procurement and management costs for central-level disaster relief stockpiles.
- *Cost-sharing arrangements*: The Chinese government has established a cost-sharing arrangement between the central government financial administration and local financial administrations, under which, in accordance with factors including the level of local economic development, financial resources and particularities of the natural disaster, etc., the central government financial administration bears 50%-70% of costs and the local financial administration accordingly bears 30%-50% of the costs. Government funding is supplemented by community fund donations which form a major source of funding for recovery and reconstruction. These include targeted donation funds, which are used in accordance with the wishes of the donor as well as disaster relief donation funds for which the donor has not stipulated a use, which are mainly used for temporary living arrangements for those affected during the disaster relief response period, the recovery and reconstruction of damaged and destroyed homes as well as the reconstruction of schools, hospitals, social welfare and other public service facilities and associated equipment and fittings.

The government of **Malaysia** established a National Disaster Relief Fund in 2006 to provide financial aid to disaster victims. Financial assistance is provided for loss of income, damaged or demolished houses, agricultural damage, livestock and aquaculture damage, and burial cost for fatalities due to the disasters. During the last decade, allocations from this fund – under the Operation Budget – have been mostly channelled to victims of flood disasters. In addition, in response to the unusually severe monsoon floods in 2006, the central bank of Malaysia allocated MYR 500 million to a Special Relief Guarantee Facility (SRGF) to aid small business recovery and the rebuilding of damaged infrastructure in areas affected by disasters. The SRGF allowed commercial and other banks to provide low interest-rate financing (2.5%) to borrowers, based on a 2.45% interest rate subsidy provided by the central bank along with an 80% guarantee on the financing extended.

In **Russia**, the federal budget provides for expenditures of the reserve fund for the prevention and elimination of emergency situations and natural disasters on costs related to the housing of the individuals affected by natural disasters. Budget allocations from the fund are made in accordance with prescribed rules, namely that repayment can be made for state housing certificates issued to Russian citizens who lost their homes as a result of emergencies, natural disasters, and acts of terrorism or suppressed terrorist acts. Accordingly, citizens who have lost accommodations as a result of natural disasters can, with the help of the mechanism of the state housing certificates, purchase new accommodations or rebuild destroyed accommodations at the expense of budgetary provisions.

In the **Czech Republic**, those responsible for providing reimbursement for damages arising from catastrophic events include the Ministry of Regional Development, Ministry of Environment, Ministry of Agriculture and Ministry of Transport. In addition to the established programs managed by these ministries, the Ministry of Social Affairs can provide "exceptional immediate relief" to provide additional financial assistance. Although aid for households is delivered with no regard to prospective insurance cover of a damaged property, the assistance provided does not cover the whole loss incurred. In the aftermath of flooding in 2013, entrepreneurs were allowed to deduct from their income tax the amount of flood-related losses as assessed by insurance companies in case of insured property or by an expert opinion in case of uninsured property. In **Chinese Taipei**, tax relief measures have also been made available to those who have suffered from a disaster.

Government schemes have also been established to ***provide or enable compensation where property is otherwise uninsurable.*** For instance, in **Hungary**, the *Wesselenyi Miklos Compensation Fund for Flood and Inland Waters Protection* is a means for individuals with real property located in areas prone to flooding to obtain coverage for uninsurable properties. In order to receive cover under the Fund, an individual must contribute to the Fund. In return compensation will be provided on an indemnity basis. The Hungarian government provides additional funds to ensure that the program can meet its obligations. Similarly, in the **Netherlands**, the government has established a compensation scheme for uninsured property damaged by major flood, earthquake and other disasters. The *Calamities Compensation Act* enables the disbursement of compensation for damages and costs experienced as a result of a catastrophe or major accident. The maximum amount of compensation that the Dutch government can provide under the Act is EUR 450 million.

In **Norway**, a National Fund for Natural Damage Assistance provides compensation for damages not otherwise covered through insurance or where insurance is not readily available. Coverage is provided for damages arising from flood, landslide, storm and tempest, earthquake, volcanic eruption, inundation or similar disasters. No compensation is available for damage arising from lighting, frost or drought. The Fund is governed by the *Natural Damage Insurance Act* which governs compensation for damages to buildings and the *Natural Damage Act* which governs compensation for damage to land, roads and bridges. The maximum amount of compensation which is recoverable is 85% of total damages. In **France**, a number of funding mechanisms exist to respond to disasters including immediate funding to support individuals with basic needs and funds from the Ministry of the Interior to compensate disaster victims for uninsured and uninsurable losses.

In some economies, financial arrangements have been established ***at the national level to fund disaster relief and recovery efforts at the state or local level***, which may have primary responsibility for responding to disaster events and providing financial assistance. For instance, in **Canada**, provinces and territories have primary responsibility for disaster response and recovery costs within their jurisdictions, as the majority of emergencies are local in nature. However, when their capacities are exceeded, or when an event is of economy-wide interest or impacts in an area of federal or shared jurisdiction, local authorities may request assistance from the federal government. Depending on the conditions, provincial and territorial authorities may request financial assistance from the federal government under several disaster assistance programs, including the *Disaster Financial Assistance Arrangements* (DFAA). The DFAA is a cost-sharing program between the federal government and the provinces and territories that reimburses a portion of eligible

provincial/territorial expenditures arising from natural disasters. Federal reimbursements are made on a progressive scale, with the thresholds defined by per capita eligible expenditures (see Table 4.1).

Table 4.1. **Funding formula for Canada's DFAA (in CAD, Canadian dollars)**

	P/T share %	Government of Canada share %
First CAD 1 per Capita	100	Nil
Next CAD 2 per Capita	50	50
Next CAD 2 per Capita	25	75
Remainder	10	90

Source: Public Safety Canada (*www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/rcvr-dsstrs/dsstr-fnncl-ssstnc-rrngmnts/index-eng.aspx*).

The DFAA Program is intended to support a disaster-affected province or territory in order to assist with costs that might otherwise place a significant burden on the regional economy and would exceed what the province or territory might reasonably be expected to bear on its own. In 2008, the government of Canada revised the DFAA Guidelines to include the sharing of costs for mitigation improvements to damaged infrastructure in order to better protect against future disasters. Under this provision, up to 15% of the estimated cost of repairs to damaged infrastructure to pre-disaster conditions can be allocated for mitigation enhancements.

In **Australia**, within the federal system, constitutional responsibility for natural disaster planning, mitigation and recovery sits with state and territory governments. Local governments own a large proportion of essential public infrastructure, including roads, bridges, and local utilities. The Australian Government also has a role both in assisting with the burden of relief and recovery after major disasters and in collaborating with all levels of government to strengthen communities' resilience to natural disasters and minimise their impact. The Australian government provides financial assistance directly to state and territory governments through the *Natural Disaster Relief and Recovery Arrangements* (NDRRA) to help alleviate the financial burden of responding to natural disasters and to facilitate the early provision of emergency assistance to disaster-affected communities (see Box 4.1).

Box 4.1. **Australia: The Natural Disaster Relief and Recovery Arrangements (NDRRA)**

The NDRRA Determination 2012 sets out the arrangements under which the Australian government provides support to state and territory governments that is automatically triggered once eligible state or territory government expenditure exceeds a specified small disaster criterion.

Under the arrangements, the Australian government contribution increases with the scale of disaster spending, with a maximum reimbursement of up to 75% payable to the state or territory for eligible relief and recovery measures.

Once the small disaster criterion has been exceeded, the proportion of the costs reimbursed by the Australian government is determined by two thresholds. The Australian government funds 75% of the cost of all eligible relief and recovery measures for all eligible

Box 4.1. **Australia: The Natural Disaster Relief and Recovery Arrangements (NDRRA)** *(cont.)*

events in a financial year assessed above the higher of two thresholds and 50% of the cost of all eligible relief and recovery measures between the two thresholds.

These thresholds are calculated as a proportion of state or territory revenue. Linking the thresholds to government revenue helps ensure that the level of support takes into account the capacity of state and territory governments to meet the costs of disasters within their own means. Furthermore, state spending on natural disasters in excess of that funded by the Australian government through the NDRRA is taken into account in determining a state's GST share under the fiscal equalisation arrangements.

The NDRRA includes two specific assistance measures relating to public infrastructure: the restoration or replacement of an essential public asset to its pre-disaster standard and the restoration or replacement of an essential public asset to a standard more disaster resilient than its pre-disaster standard ("betterment"). Where a state or territory seeks NDRRA funding for betterment, it must seek an agreed commitment from the Australian government to contribute to the cost of betterment. Betterment policy requires states to demonstrate the costs and benefits of the infrastructure investment, with the Australian government having the opportunity to assess investment and project risks and prioritise the expenditure. As a general condition of assistance under the NDRRA, a state or territory is also required to have reasonably adequate capital or access to capital to fund liabilities or infrastructure losses before being granted access to funds, including through commercial or state insurance or reinsurance.

A range of additional measures are available under the NDRRA, including support for personal hardship and distress assistance; counter disaster operations; loans for small businesses and primary producers; transport freight subsidies for primary producers; and loans and grants to voluntary non-profit organisations. Following severe disaster events, additional support for holistic community recovery and clean-up and recovery for small businesses and primary producers may be activated.

Similarly, in the **Czech Republic**, aid for recovery and reconstruction is provided to municipalities and regions if their budgets are not sufficient. In **Mexico**, FONDEN provides the 32 Mexican states and the federal agencies in charge of federal infrastructure with the necessary resources to cover the losses and damages caused by natural disasters, whose magnitude may exceed their financial capacity, including resources for the reconstruction of public infrastructure at all levels of government (federal, state, and municipal); reconstruction of low-income housing; and restoration of forestry, protected natural areas, rivers, and lagoons. FONDEN is responsible for quickly providing federal funds in response to natural disasters without compromising existing budgetary plans and approved public programs. To access FONDEN resources, the affected federal and state agencies must demonstrate that the magnitude of reconstruction needs exceeds their financial capacity and file specific requests detailing the extent of the damage and estimated cost of reconstruction. FONDEN continues to innovate to improve its operations; for example, it has been an early mover in adopting information technology to streamline the damage assessment process and has adopted a "build back better" approach to reconstruction financing. FONDEN's Program for Reconstruction, with its resources allocated through the FONDEN Trust, forms the cornerstone of building back (and building back better) in a timely manner following a disaster in Mexico (see Box 4.4).

In **South Africa**, municipalities and provinces are legislatively required to respond to any emergencies that occur. In the event that they are unable to cope with the effects of an occurrence, funds for emergency relief can be requested from the national government. National government funds for immediate disaster response are provided through special Provincial and Municipal Disaster Grants. These conditional grants are designed to allow for the rapid release of funds and are intended to fund amongst other items: emergency repairs, shelter and food as well as essential services during the first three months following a declared disaster. Once the immediate impacts of a disaster have been addressed, funds are allocated for post disaster reconstruction and rehabilitation through the Medium-Term Expenditure Framework budget process (or in the adjustments budget) for the repair or replacement of assets and infrastructure damaged by declared disasters.

In **India**, a National Disaster Response Fund (NDRF) as well as a State Disaster Response Fund (SDRF) have been established to provide liquidity to fund relief expenditures after natural disasters, including avalanche, cyclone, cloud burst, drought, fire, earthquake, tsunami, flood, hailstorm, landslides, pest attack, frost and cold wave. The NDRF and SDRF are funded by both state governments and by the government of India in pre-defined proportions. The SDRF is the responsibility of the Ministry of Home Affairs with the government of India contributing 75% of the funding for the states in the general category and 90% of the funding for the states in the special category.

In the **Philippines**, local governments have the primary responsibility to provide immediate relief to their constituents. Where local resources are not adequate, the central government will provide additional resources through the National Disaster Risk Reduction and Management Fund. The Fund serves as a calamity fund for disaster relief and rehabilitation and has recently been made more flexible so as to be used for disaster risk reduction purposes (e.g. preparedness and mitigation programs, training and procurement of equipment, construction of evacuation centres and other facilities, payments for insurance policies, etc.). Furthermore, under the Department of Social Welfare and Development, various programs provide financial assistance to communities affected by a natural disaster including for: i) relief goods and services to victims of natural disasters; ii) rice subsidies; iii) core shelter assistance programs; iv) food for work programs; and v) assistance to victims of specific natural disasters. The main target population for most of these programs are the poorest segments of the society. Livelihood support in the form of farming inputs are likewise provided by the Department of Agriculture to farmers affected by disasters (see Box 4.3).

In the **United States**, a Capital Fund, monitored by the Department of Housing and Urban Development, serves to assist government departments and housing authorities to pay for reconstruction costs of public housing when their insurance coverage has been exhausted or there is no other federal assistance available. The Fund can be used for damage from a presidentially declared disaster or, in some instances, a non-presidentially declared disaster for damage arising from an extraordinary event (earthquake, flood, tornado or hurricane). A public housing authority may apply for assistance from the Fund by providing the requisite documentation with a cost estimate.

An overarching system also exists for EU member states in the form of the EU Solidarity Fund (see Box 4.2).

Box 4.2. **EU Solidarity Fund**

The EU Solidarity Fund was established in 2002 with the objective of assisting EU member states to recover from natural disasters. The Fund was set up to cover non-insurable losses and to provide assistance for critical infrastructure (energy, drinking water, and waste management), temporary accommodation for disaster victims, emergency services and clean-up of disaster areas.

The receipt of funding under the EU Solidarity Fund is not automatic and it takes a significant period of time for the funds to be provided to the relevant member state. The first pre-condition is that there must be a major natural event. An event will be classed as a major natural event if the damages exceed EUR 3 billion (2002 prices) or the total losses exceeds more than 0.6% of the gross national income of the member state seeking funds. The member state must then apply to the EU Solidarity Fund for financial assistance within ten weeks of the first damage occurring. When the member state submits an application for funding they must provide an estimate encompassing any foreseen assistance.

The annual budget for the EU Solidarity Fund is currently EUR 500 million in addition to any unallocated funds from the previous year. A provision requires that one quarter of this amount must remain at 1 October of each year in order to ensure sufficient funds for the remainder of the calendar year. If there is a shortfall, additional funds can be mobilised from the following year's budget.

Source: European Commission (*http://ec.europa.eu/regional_policy/thefunds/solidarity/index_en.cfm*).

Fair and efficient deployment of funds

A crucial element of effective compensation schemes is that such schemes provide fair, timely and efficient disbursement of funds for disaster relief, recovery and reconstruction. Not only must financial resources for disaster response and reconstruction efforts be available, they must also be deployed in a well-timed and targeted manner. Clear and streamlined administrative procedures, including *ex ante* specific procedures for the disbursement of public and/or international donors' funds in the aftermath of an event, are key for ensuring a fair and efficient distribution of funds and promoting transparency and accountability at the public sector level.

A number of economies have established ***detailed procedures for the use and monitoring of, and reporting on, compensation funds*** which supports timely disbursement and accountability in the use of public funds. In **Mexico**, the FONDEN operating guidelines are designed to ensure the efficient disbursement of appropriate levels of reconstruction financing while balancing accountability and transparency concerns. The process for accessing and executing reconstruction financing can be broken into four phases: i) declaration of a natural disaster; ii) damage assessment and request for FONDEN resources; iii) disbursement of resources and implementation of reconstruction activities; and iv) public reporting on post-disaster activities. The program's operating guidelines are intended to ensure efficient disbursement of financial resources for reconstruction of federal and state assets.

The financial arrangements for Mexico's FONDEN provide for some flexibility in the disbursement of funds, allowing for the acceleration of funding for certain purposes. The main mechanism for financing reconstruction is the FONDEN Program for Reconstruction, FONDEN's primary budget account which channels resources to specific reconstruction

programs. After a disaster, funds committed to a specific reconstruction program will be transferred to a dedicated sub-account in the FONDEN Trust and will be held until reconstruction programs are implemented. FONDEN also has a Revolving Fund that can be used to provide resources for immediate response and for the acquisition of emergency supplies. It allows FONDEN to provide humanitarian assistance before, during, and after a disaster. While the Revolving Fund is financed by the FONDEN Trust, it operates under its own rules, ensuring that funding requests meet certain conditions. In addition, a new financing mechanism, known as "Immediate Partial Support", has been established to provide partial financial support immediately after a disaster to finance urgent post-disaster needs and actions without the need to wait for the completion of a full damage assessment and the fund approval process. The operation of the FONDEN Trust ensures fiscal transparency whereby the resources are in the trust and payments are made directly from the trust, centralising the process and enhancing the timeliness of payments, particularly disbursements related to aid supplies for victims of disasters.

In **Hong Kong, China**, the government has established procedures for handling payments under a centralised web-based Enterprise Resource Planning system. The design of the system enables a timely and effective disbursement of payments, including those arising from disasters. Also, the Social Welfare Department prepares an annual report on the Emergency Relief Fund that is tabled at the Legislative Council for public scrutiny. Investigations are undertaken by the District Officer to determine whether the applicants were eligible for the grant, in accordance with the guidelines.

In **China**, in order to effectively improve the use and management of natural disaster livelihood relief funds, the Ministry of Finance, jointly with the Ministry of Civil Affairs, issued *Interim Regulations on the Management of the Natural Disaster Relief Funds*, which clearly define the assessment of natural disaster grading and investigation, funding programs and content, application requirements, financing and disbursement of funding, funding burden ratio and assessment, and supervision and monitoring of funds, among other procedures. In terms of the disbursement of funds, the Regulations stipulate that work processes are strictly subject to democratic appraisal, recording, posting and public release, and that relief recipients are determined in accordance with a four-step process of: i) reporting at the household level; ii) assessment at the village level; iii) review at the township level; and iv) decision-making at the county level. Where a cash assistance method is used, the relevant rules of financial management must be complied with, and areas subject to specific criteria must disburse the natural disaster livelihood funds by means of a "Smart (discount) Card" system; where an in-kind assistance method is used, this must strictly comply with the rules relating to government procurement management, such that relief supplies are procured and placed in the hands of those affected in a timely manner. The Regulations also define liability, penalties, and sanctions for illegal activities in the management and use of Natural Disaster Livelihood Assistance Funds, in accordance with the provisions of the Regulations on penalties and sanctions for fiscal violations.

A specific process has also been established to ensure that disaster aid is properly targeted. Natural disaster relief funding is applied for by the affected persons or those nominated by a villagers' or residents' group. Applications are evaluated by the village or residents' committee, and those which comply with the funding criteria are put on public display within the village or community. Where no objection is raised or where a democratic appraisal objection by the village or residents' committee is not sustained, the

village or residents' committee submits their comments and associated documentation to the township's People's government or sub-district office for review. The application is then submitted to the Civil Affairs and other departments at the county-level People's government for approval. When arranging natural disaster relief funding at all levels, priority is provided to vulnerable groups such as those receiving social assistance and households with persons with disabilities.

In addition, relevant departments of the Chinese government have adopted a number of measures to ensure sound management of public funds:

- *Establishing regulations, procedures, and guidelines for disaster relief funds*. A number of regulatory measures,[1] working procedures and guidance have been established in order to provide a solid basis for the use, management and supervision of disaster relief funds, and to improve the standardised management of disaster relief funds from the grass-roots level upward. In accordance with the relevant regulations, natural disaster livelihood funds undergo dedicated accounting to ensure that funds are used appropriately and are not misused, diverted, misappropriated or used for other purposes.
- *Establishing and improving the supervision mechanism*. Under the leadership of the Ministry of Civil Affairs and with the participation of the Ministry of Finance, the People's Bank of China and the State Council Office for Rectifying Malpractice, a disaster relief special fund supervision work leadership group has been created, and a team communication and status reporting mechanism has been established. The leadership group holds regular meetings, organises joint inspections of key areas, and provides timely resolution of illegal activities of all kinds relating to the disbursement, management and use of disaster relief funds.
- *Improving the disclosure of information, and proactive acceptance of social supervision*. In order to ensure the disclosure and transparency of information on management and use of disaster relief funds, social supervision should be accepted in accordance with the provisions of the *Regulation on the Disclosure of Government Information* and *Regulations on the Relief of Natural Disasters*, such that the disclosure of information is a major component of the management of disaster relief funds. Disclosure of all disaster relief fund allocations and usage to the public via a website and the news media allows a proactive response to social concerns and a level of supervision of the use of the funds by society at large and public opinion.

In the **United States**, all agencies that disburse federal funds to disaster survivors are required to abide by applicable regulations. FEMA conducts a reconciliation process with all Public Assistance grantees to reconcile estimates and obligations, and to recover funds that were spent on disallowed costs. Additionally, the Department of Homeland Security Inspector General regularly audits Public Assistance projects to determine if waste, fraud, or abuse has occurred. In **Australia**, a Reconstruction Inspectorate[2] was established by the Australian government in February 2011 to oversee the government's funding of reconstruction and recovery activities implemented by the Queensland and Victorian state governments. The Reconstruction Inspectorate seeks to provide assurance that the expenditure of both Commonwealth and state funds on recovery and reconstruction represents value-for-money by: i) examining reconstruction projects undertaken by local governments and state government agencies; ii) analysing benchmark prices to ensure value-for-money; iii) where appropriate, completing examinations prior to execution of complex or high value contracts; iv) responding to complaints by the public; and v) advising

the Australian government of any lessons learned through the Reconstruction Inspectorate's oversight, so as to inform future disaster recovery responses.

In the **Philippines** (see Box 4.3), the National Disaster Risk Reduction and Management Council (NDRRMC) is responsible for managing and mobilising resources for DRM, including the National Disaster Risk Reduction and Management Fund (National DRRM Fund), and for monitoring and providing the necessary guidelines and procedures for Local DRRM Fund disbursements as well as the use, accounting, and auditing of these disbursements. Moreover, Local Disaster Risk Reduction and Management Councils have been established to monitor and evaluate the use and disbursement of the Local DRRM Funds.

Table 4.2. **Examples of government compensation/financial assistance arrangements**

National programme	Name of initiative	Perils covered	Purpose and coverage provided
Australia	*Disaster Recovery Allowance (DRA)*	All hazards (natural and man-made)	Purpose: To provide individuals who had income directly affected by a natural disaster with financial assistance without standard waiting periods under existing social welfare regulations. The Australian government has discretion to provide DRA payments. In order for the DRA to be activated, a government determination must be made. The Australian government will consider the event being of national significance and impacting one or more industries or one or more areas. The DRA can be provided to those with a direct nexus between a natural disaster and income loss. The DRA can provide individuals with income for up to thirteen weeks.
Australia	*Australian Government Disaster Recovery Payment (AGDRP)*	All hazards (natural and man-made)	Purpose: To provide individuals with a one off payment after a disaster for recovery needs. The Australian government has discretion to provide the AGDRP, a one-off, non-means-tested, payment of AUD 1000 for eligible adults and AUD 400 for eligible children. In order for the AGDRP to be activated, a government determination must be made. The Australian government will consider the number of individuals affected and the nature or unusualness of the disaster when making a determination.
Belgium	*National Calamity Fund (Caisse Nationale des Calamites) and the National Agricultural Calamities Fund*	Storm Earthquake Flood Public sewage overflow Landslides Ground subsidence	Purpose: Provides assistance to individuals and public establishments. The system was set up to provide compensation and ensure damage is compensated at real value. Prior to compensation, there must be a declaration of a natural calamity made by the Director of Calamities who will seek a scientific opinion regarding the potential classification of the event as a national calamity. Subsequently, approval must be received by the Ministry of the Interior and Council of Ministers. A Royal Decree is created, signed by the King and published in the Belgium Official Gazette. Those seeking to make a claim must do so within three months. The Governor will send an expert to assess the damage which will be payable to the victim. In some exceptional cases it may be possible for the government to grant an exceptional loan at the rate of 5% under the scheme. Those receiving compensation which exceeds EUR 250 will face a deductible (franchise).
China	*Central Natural Disaster Livelihood Subsidy Fund*	Drought Flooding Typhoons Hail Freezing temperatures Snow Earthquakes Rock avalanches Landslides & Mudslides	Purpose: To ensure a basic living standard is retained after natural disasters for those affected. In order to obtain funding, the Emergency Plan allows rural communities to obtain funds for designated projects. These projects include disaster emergency relief, assistance to families of victims, traditional livelihood relief, funds for the reconstruction of collapsed or damaged homes, drought temporary livelihood hardship relief, and winter temporary livelihood hardship relief. The Fund has an annual budget of CNY 13 billion. Between 2009 and 2013, a total of CNY 59.737 billion in financial assistance was provided.
Hong Kong, China	*Emergency Relief Fund Ordinance*	Fire Flood Tempest Landslide Typhoon Other natural disasters A court order may be granted for damage caused by a natural disaster.	Purpose: To provide prompt assistance to persons who are in need of urgent relief. The *Emergency Relief Fund Ordinance* establishes the Emergency Relief Fund. The Fund has an annual allocation from the General Revenue and donations from the public. The Fund provides five main types of grants which are grants in respect of death; domestic re-accommodation, re-equipment, site formation and repair grants and grants for extensive damage to home appliances; grants to repair or replace vessels and fishing gear; primary producer grants; and special grants. Persons seeking relief must fulfil the criteria in section 4 of Chapter 1104 of the Laws of Hong Kong, China.

Table 4.2. **Examples of government compensation/financial assistance arrangements** *(cont.)*

National programme	Name of initiative	Perils covered	Purpose and coverage provided
Hungary	*Wesseléyi Miklós Compensation Fund for Flood and Inland Waters Protection*	Flood	Purpose: To provide assistance to individuals who cannot otherwise obtain flood insurance. Covers: Uninsurable real property on an indemnity-basis. Individuals must contribute to the fund to be eligible for compensation.
Malaysia	*National Disaster Trust Fund*	Natural Disasters Earthquake Tsunami Typhoon Volcanic eruption Flood Landslide	Purpose: Provides financial aid to disaster victims to alleviate the loss of income and provide compensation for damaged or demolished houses, agricultural, livestock & aquaculture damage, as well as burial cost for fatalities due to disasters. Every family who is affected by a disaster and is moved to an official evacuation centre will receive assistance amounting to MYR 500 as a token. The government of Malaysia allocated MYR 10 million in 2010, MYR 60 million in 2011; and MYR 100 million in 2012 and 2013. Allocations from this fund have been mostly channelled to victims of flood disasters.
Netherlands	*Calamities Compensation Act (Wet tegemoetkoming schade bij rampen [WTS])*	Earthquake Freshwater floods Major disasters	Covers: Damage to uninsurable property from flooding (flooding is not insurable in the Netherlands) and other major disasters. Compensation provided on an ad hoc basis under the *Calamities Compensation Act*. Maximum compensation is capped at EUR 450 million.
Norway	*National Fund for Natural Damage Assistance*	Floods Landslide Storm and tempest Earthquake Volcanic eruption Inundation Exclusions: Lightning, frost, drought	Purpose: Provide assistance to those who cannot obtain insurance thorough the insurance markets. Covers: Damage to uninsurable land, roads and bridges, as defined under the *Natural Damage Insurance Act* and the *Natural Damage Act*. Compensation is not provided when damages are covered by insurance or when it was possible to contract cover against such damage through normal or ordinary insurance. Compensation is capped at a maximum of 85% of total damages with a deductible of NOK (Norwegian kroners) 10 000 to be applied on the resulting sum.
Chinese Taipei	*Secondary Reserve Fund*	Typhoons Earthquakes Floods	Purpose: To have funds set aside to assist in recovery and reconstruction after a natural disaster. Covers: The categories of assistance under the Fund include deceased victims, missing victims, severely injured victims, relocation, housing, farmland, fish farms, etc. The Standard Assistance includes TWD 200 000 for each deceased or missing victim, up to TWD 20 000 for a damaged house and TWD 1 000 for 0.01 hectare of fish farm losses. These amounts are determined under the Categories and Standards of Assistance for Debris Flow Disaster. The central government may disburse disaster reserve funds of TWD 2 billion each year and up to TWD 8 billion each year from the secondary reserve fund.
Russia	*Disaster Reserve Fund*	Man-made disasters Acts of terrorism Natural Disasters Flooding	Purpose: To provide funds to individuals to protect their houses from natural disasters and alleviate the effects of natural disasters on individuals. Budget allocations from the fund are made in accordance with prescribed rules, namely that repayment can be made for state housing certificates issued to Russian citizens who lost their homes as a result of emergencies, natural disasters, acts of terrorism or suppressed terrorist acts. The fund provides eligible individuals with state housing certificates, to purchase new premises or rebuild destroyed premises at the expense of budgetary provisions. The state determines the list of regions that can apply for help for loss or damaged housing if this housing is owned by the citizens and not the state.
National/sub-national arrangements	Name of initiative	Perils covered	Coverage provided
Australia	*National Disaster Relief and Recovery Arrangements (NDRRA)*	Bushfire Earthquake Flood Storm Cyclone Storm surge Landslide Tsunami Meteorite strike	*Funding arrangement for state governments*. Agreement between the Australian government and the state governments. Covers: Personal hardship and distress assistance, counter disaster operations, loans for small businesses and primary producers, transport freight subsidies for primary producers, loans and grants to voluntary non-profit organisations, cost of restoring or replacing essential assets (state, territory or local government), clean up and recovery packages, grants for small businesses.

Table 4.2. **Examples of government compensation/financial assistance arrangements** *(cont.)*

National/sub-national arrangements	Name of initiative	Perils covered	Coverage provided
		Tornado Terrorism Exclusions: Drought, frost, heat wave, epidemic	For a state government to be eligible for a 50% reimbursement, their expenditure must have exceeded a first threshold; and for a 75% reimbursement, the state expenditure must have exceeded a second threshold. Thresholds are based on costs as a share of state revenue.
Austria	*Austrian Catastrophes Fund*	Flood Avalanche Earthquake Landslide Hurricane and hail	Purpose: Assuring adequate aid to injured persons and for reconstruction of damaged infrastructure. Disaster damage to private property is usually compensated by the states, for up to 20-30% of the loss suffered, and their compensation expenses are 60% reimbursable by the Fund. Damage to public infrastructures in the states or other local jurisdictions is financed up to 50% by the Fund. The Fund covers protective measures and provides financial assistance to victims of disasters (individuals, enterprises). It also contributes to the funding of equipment for disaster relief by the fire brigades. In the event of a disaster, additional funds can also be mobilized by the government for the compensation of losses. Additionally the provincial governments have budget lines for disaster relief.
Canada	*Disaster Financial Assistance Arrangements (DFAA)*	Natural perils	*Funding arrangement for provincial governments*. Provides coverage when the capacity of the provincial or territorial government has been exceeded (cost sharing reimbursement scheme). Federal reimbursement is on a progressive scale within predefined eligibility criteria.
India	*National Disaster Response Fund and State Disaster Response Fund*	Natural Calamities Cyclone Drought Earthquake Fire Flood Tsunami Hailstorm Landslide Avalanche Cloud burst Frost Cold Wave Pest attack	Purpose: To support affected individuals to meet immediate basic needs and regain livelihood. Financial assistance is provided on a case-by-case basis. The fund is structured to provide immediate relief to the victims with additional financial and logistic support provided by the central government (who assists the state governments). In order for the funds to be activated the natural calamity must be deemed severe. Currently there are no legislatively entrenched criteria or threshold for a natural calamity to be deemed as severe - the government of India has discretion to categorise an event in this way. Payments to the fund are made bi-annually in June and December with some funds being granted unconditionally and others subject to satisfying certain procedures. The SDRF is the responsibility of the Ministry of Home Affairs with the government of India contributing 75% of the funding for the states in the general category and 90% of the funding for the states in the special category.
Mexico	*Fund for Natural Disasters (FONDEN)*	Earthquake Volcanic eruption Avalanche Tidal wave/Extreme wave Landslide/Slope movement Drought Cyclone Extreme rain/Severe rain Snowfall Hailstorm Floods Tornado/Hurricane Forest fires Tsunami Tropical storm Subsidence	Purpose: To provide the 32 Mexican states and the federal agencies in charge of federal infrastructure with the necessary resources to cover the losses and damages caused by natural hazards, whose magnitude may exceed their financial capacity. One component involves *funding arrangements with state governments* for the repair of infrastructure and reconstruction of low-income housing. States must demonstrate that reconstruction needs exceed their financial capacity. Coverage includes: Reconstruction of infrastructure (including components of the natural environment), reconstruction of low-income housing, restoration of forestry, protected natural areas, rivers and lagoons, emergency assistance to affected populations
New Zealand	*National Government Financial Support (CDEM Expense)* *Local Authority Protection Programme disaster fund*	Earthquake Storms Floods Cyclones Tornados Volcanic eruption Tsunami	Purpose: To provide funding to local governments to assist them with critical infrastructure and uninsurable essential services that may be damaged by a disaster. The New Zealand government provides financial support to local governments for costs incurred in providing assistance to displaced persons and infrastructure repair (based on thresholds related to local government financing capacity).

Table 4.2. **Examples of government compensation/financial assistance arrangements** *(cont.)*

National/sub-national arrangements	Name of initiative	Perils covered	Coverage provided
		Disasters of a catastrophic nature	Local governments have established a Local Authority Protection Programme disaster fund (LAPP) which is a cash accumulation mutual pool operating since 1993 to help local authority members pay their share of infrastructure replacement costs for water, sewage and other generally uninsurable essential services if damaged by natural disaster. The LAPP is to cover a local authority's 40% share above the threshold set by central government for recovery assistance. The LAPP has 46 members. Members' contributions to the Fund are set annually and are assessed on a risk based actuarial formula which takes into account the replacement value of each member's infrastructural assets adjusted to recognize geographical exposures. At the time of writing, LAPP funds had been depleted leading to a review of its future role.
Philippines	*National Disaster Risk Reduction and Management Fund (National DRRM Fund)*	Disaster which seriously disrupts the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts. Flood Storms Typhoons Wind-related events Landslides	Purpose: Provide a calamity fund for disaster relief and rehabilitation. The National DRRM Fund can be employed for relief, recovery, reconstruction and other work or services in connection with natural or human-induced calamities, and for disaster risk reduction or mitigation, prevention and preparedness activities such as the training of personnel, procurement of equipment, and capital expenditures. The fund has been extended to encompass disaster risk reduction expenses. Up to 30% of the National DRRM Fund and the funds of the Local DRRM Fund can be allocated towards a Quick Response Fund or a Stand by Fund. National DRRM Fund had annual allocations of USD 46 million but this was inadequate. The allocation increased by 200% in 2011, amounting to USD 115 million, and was further increased to USD 174 million in 2012.
South Africa	*Provincial and Municipal Disaster Grants*	Major perils	Grants are intended to fund emergency repairs, shelter and food, essential services, amongst other short-term expenses when provincial and local capacity is insufficient. Funding for post disaster reconstruction and rehabilitation are allocated through the Medium-Term Expenditure Framework budget process (or in the adjustments budget) for the repair or replacement of assets and infrastructure damaged by declared disasters.
Turkey	*Disaster Reserve Fund*	Natural Disaster Earthquake Floods Windstorms	The Disaster and Emergency Management Presidency (AFAD) is authorized to allocate the disaster response and recovery budget to the related institutions and the local government in the scope of their needs. In addition to the AFAD budget, the Ministry of Finance has a Disaster Reserve Fund which can be used for the disasters during the period of recovery.
United States	*Capital Fund*	Extraordinary events Earthquake Flood Tornado Hurricane	Purpose: To provide assistance to help rebuild public housing where existing insurance is exhausted or is not available. Capital Fund assists government departments and housing authorities to pay for reconstruction of public housing when insurance has been exhausted and there is no other federal assistance. The Capital Fund is for presidentially declared disasters and non-presidentially declared disasters for damages arising from extraordinary events.
Regional Initiative	Name of initiative	Perils covered	Coverage provided
European Union	*EU Solidarity Fund*	Major natural perils	Annual budget is EUR 500 million. The maximum amount available for extraordinary regional disasters is limited to 7.5% of the EU Solidarity Funds annual budget.

Sovereign risk financing strategies: policy options for governments

As outlined in the G20/OECD Methodological Framework, governments may have disaster risk exposures and therefore need to assess carefully the potential role of risk financing and risk transfer in managing those exposures. For governments, disaster risk exposure arises from a variety of sources. Losses may arise from damages to public property and infrastructure, pre-arranged (or *ad hoc*) financial assistance and compensation as well as guarantee or (re)insurance schemes, and changes in macroeconomic conditions, including possible lower growth or loss in tax revenues that may affect the fiscal position.

These government contingent liabilities may be explicit or implicit: expenditures that might arise from reconstruction of public assets and infrastructure or from pre-arranged financial commitments are explicit; by contrast, those expenditures that do not reflect any type of *ex ante* commitment or responsibility but which can nonetheless be expected to occur due to a perceived obligation are implicit.

If there are significant populations or sectors that are financially vulnerable and, for whatever reason, uninsured or not protected through an *ex ante* insurance or compensation scheme, governments need to factor implicit contingent liabilities into financial planning given expected post-disaster funding pressures. A similar consideration applies to any explicit contingent liabilities created by governmental involvement in an institutional scheme for risk financing or risk transfer. Governments also need to consider that they may be expected to handle any peak risks that lie beyond the financial capacity of others, including the insurance sector, to absorb.

Governments have, in theory, the ability to self-finance through existing budgetary resources (including through budget cuts and reallocations), post-disaster debt financing and taxation and other means and can spread disaster costs not only across the current population but also across future generations. Governmental risk-bearing capacity can be assessed by reference to current debt levels and fiscal position, the degree of flexibility to reallocate budgets, diversification in revenue sources, access to international aid and multilateral financing,[3] ability to obtain external debt financing on favourable terms and conditions amid shocks, scope for changing fiscal parameters (e.g. imposition of taxes), the macroeconomic environment and prospects for growth (e.g. level of GDP and expected GDP growth, unemployment rate, degree of economic diversification, expected population and productivity growth). Assessment of the risk-bearing capacity of government should also consider the capacity of sub-national governments, which may be significantly affected by disasters and may have face more significant constraints in terms of fiscal flexibility (OECD, 2012).

In order to mitigate these impacts, governments may complement the investment in physical risk reduction with *ex ante* DRF tools. These *ex ante* financial tools may address short-term (emergency response), mid-term (recovery) or long-term (reconstruction) disaster impacts, and can be used in combination to cover different risk layers, based on the relative frequency and severity of the expected events. In particular, governments may employ the following *ex ante* or pre-disaster DRF tools:

1. **Government reserves** such as dedicated contingency reserves for disasters (with allocated funds lapsing at year end), or multi-year disaster reserve funds (with allocated funds building up over time).
2. **Insurance**, which enables the transfer of risks and indemnifies against damage (e.g. to cover damage to government assets such as buildings and infrastructure).
3. **Contingent credit arrangements** with a financial institution or international organization.
4. **Catastrophe bonds** or other types of catastrophe-linked securities or derivatives which provide an alternative means for risk transfer.[4]

Table 4.3 provides an overview of the various options governments have in terms of the financing of disaster risk.

Table 4.3. **Approaches to financing government disaster risk**

Examples of methods	
Ex ante financing	**Ex post financing**
• Dedicated reserve fund	• Budget reallocation
• Insurance	• Debt financing/borrowing
• Contingent credit facility	• Taxation
• Catastrophe bond, other CAT-linked security/alternative risk transfer instrument	• Multilateral/international borrowing
	• International aid

Source: G20/OECD Methodological Framework for Disaster Risk Assessment and Risk Financing, *www.oecd.org/daf/fin/insurance/OECD_APEC_DisasterRiskFinancing.pdf*.

In determining the appropriate strategy for managing the costs of disasters, **timing**, among other elements, is an important consideration, as different financial tools can be employed depending on when financial resources are needed. For instance:

- **Government reserve funds** may provide an immediate source of funding, although the level of funds obtainable may be very limited in comparison with market-based instruments.
- **Market-based parametric risk transfer tools** – in the form of index-based insurance contracts, financial derivative contracts, or catastrophe-linked securities – can provide financial resources quickly in the aftermath of a disaster, as the meticulous loss verification and adjustment procedure associated with insurance are not required.
- Longer term financial needs, such as those for the reconstruction phase, may be better served by other types of products, including **traditional insurance and reinsurance**, depending on the circumstances.

As outlined in the G20/OECD Methodological Framework, the expected frequency and severity of disaster events also affect the choice of risk financing and transfer instruments, based on cost-benefit analysis, keeping in mind that there is always a trade-off between addressing financial vulnerabilities on the one hand and generating returns through the alternative use of funds on the other (i.e. the opportunity cost of those funds). For high-frequency events, moreover, investments in physical risk reduction may be the most efficient use of government resources to reduce vulnerabilities. Generally, but particularly in countries where insurance markets are limited and not capable of covering private assets, and where government risk-bearing capacity is limited, it is important for governments to assess carefully the potential role of disaster risk financing and risk transfer instruments in their fiscal management strategy (OECD, 2012). Table 4.4 provides an overview of the advantages and limitations related to the various approaches to risk financing.

Table 4.4. **Risk financing and risk transfer tools: main advantages and limitations**

	Advantages	Limitations
Reserves	• Funds immediately available for disbursement • Funds still available even if no disaster occurs • Can lower costs relative to insurance given lower payments (covering annual expected loss without any risk buffer or profit load) and lower opportunity costs as funds set aside to meet future disaster costs earn returns • Reduces dependency on debt financing (e.g. for economies concerned about credit ratings) • Can provide a structure for inter-agency co-ordination and facilitate the earmarking of budget funds on a recurring basis • For markets lacking insurance and disaster risk financing, or where access to such markets is limited, may be the only available *ex ante* financial tool	• Opportunity cost of maintaining a liquid reserve • Time delay for the build-up of an appropriate levels of funds to cover disaster risks at initial set-up and following any depletion of funds; less protection compared with insurance during the build-up of funds • May prove more challenging as the level of severity and frequency of disaster events increase; it may be difficult to build up sufficient reserves and, between events, there may be a temptation to use the funds for other purposes

Table 4.4. **Risk financing and risk transfer tools: main advantages and limitations** *(cont.)*

	Advantages	Limitations
Contingent credit facilities	• Funds immediately available for disbursement • May be more efficient as the scale of disaster risk increases, as it may be more difficult to build up the necessary amount of internal funds to meet the increased expected costs of disasters and since such funds might, in the meantime, be more productively invested elsewhere	• Opportunity costs linked to the holding fee and interest costs if risk financing is triggered post-disaster • Counterparty credit risk • Access to specialised facilities limited to governments
Insurance	• Immediate, effective transfer of disaster risk; no accumulation of funds needed as in the case of reserves • Provides useful protection against catastrophic disaster events that might otherwise have a material impact on wealth and greatly impede recovery, at a cost that should reflect diversification benefits gained from risk pooling	• For indemnity-based products, payment may not be immediately available • Counterparty credit risk • Opportunity costs of ongoing insurance premiums • In contrast to reserves, funds deployed to manage risk cannot accumulate if a disaster does not occur • Pricing subject to fluctuations in pricing in global insurance markets • May become relatively expensive and possibly unviable as the absolute size and level of uncertainty surrounding the occurrence of a risk event increases
Catastrophe-linked securities (including CAT bonds)	• Effective transfer of disaster risk; no accumulation of funds needed as in the case of reserves • In comparison with reinsurance, can provide greater security and rapidity of payment as securities are fully backed by collateral and are based on clear, easily verifiable triggers, particularly if a parametric trigger is used • Are less sensitive to potential disruptions in global insurance markets and can provide multi-year coverage	• Opportunity costs of ongoing interest payments (similar to insurance) • May present relatively large fixed costs if bespoke securities are issued • For parametric products, may present basis risk (triggered benefits may not match actual losses) • Potential regulatory barriers for recognition of catastrophe-linked securities as a risk management tool • Investor knowledge and education may be limited, limiting demand and affecting pricing • May negatively impact non- or lightly-regulated investors, given limited knowledge of long-tailed risks; transparency of the risk distribution is important in capital market solutions • Reinsurance solutions may prove more flexible, competitive

Source: Based on G20/OECD Methodological Framework for Disaster Risk Assessment and Risk Financing (2012), Section II, Table 10.

Ex ante *financing*

Reserve funds are one of the mechanisms that may be used by governments to secure advance financing of disaster costs. These funds, which may be specifically dedicated to disasters or may serve a more general purpose of addressing contingencies, are financed by annual appropriations and can be drawn down in the event of a disaster. Absent a disaster or other call on the fund, they may, depending on the arrangements, lapse at the end of year or be allowed to be built up over time. Reserve funds act as an explicit form of self-insurance for governments.

Governments may use reserve funds as their primary means to finance disaster risks, for instance where they face frequent but lesser impact hazards. When they face more substantive disaster risks, they may use reserve funds as part of a broader, multi-layered financial strategy; for example, reserve funds may be used to finance the first layer of disaster risk, with higher layers of risk transferred to insurance markets and/or to capital markets via catastrophe-linked securities. Reserve funds may be used for a variety of purposes, such as emergency response and relief, recovery, and reconstruction (or for certain types of reconstruction, such as public assets and infrastructure). Increasingly, economies are allocating portions of their reserve funds towards investments in risk reduction.

Dedicated disaster reserve funds that can be used to ***cover an array of natural disasters and provide funding for different purposes*** have been established in a number of economies. In the **Philippines**, the National DRRM Fund is funded through annual allocations from the national budget. This allocation increased by more than 200% in 2011 (amounting to USD 115 million), and was further increased to USD 174 million in 2012, highlighting the priority attached to DRM issues. In addition, not less than 5% of the estimated revenue

from regular sources must be allocated each year to the Local DRRM Fund to support disaster risk management activities such as pre-disaster preparedness. Under certain conditions, the Local Disaster Risk Reduction and Management Council (LDRRMC) may transfer resources from its Fund to support disaster risk reduction activities of other LDRRMCs which are declared under a state of calamity. Unexpended resources in the Local DRRM Fund accrue to a special trust fund for the sole purpose of supporting disaster risk reduction and management activities of the LDRRMCs within the following five years. Any amount still not fully utilised after five years reverts back to the general fund and can be made available for other social services identified by the local *sanggunian* (council).

In September 2011, the government of the Philippines entered into a special contingent credit arrangement with the World Bank called the Disaster Risk Management Development Policy Loan with a Catastrophe Deferred Drawdown Option (CAT-DDO). This financial tool, aimed at covering disaster costs in excess to the funds allocated pursuant to *Philippine Disaster Risk Reduction and Management Act (2010)*, is a contingent credit line that provides immediate liquidity up to an amount of USD 500 million in the aftermath of a natural disaster. The credit line was triggered in December 2011 by President Aquino's official declaration of a State of National Calamity (*Proclamation n.303 of 20 December 2010*) following the heavy losses and damages caused by Tropical Storm Sendong (Washi) and provided the government with immediate access to the necessary resources to finance the relief, recovery and reconstruction costs.

In **Indonesia**, at the central level, the Rehabilitation and Reconstruction Fund is the main budget instrument to finance public post-disaster expenditures. The central government also provides funding for disaster reserve funds in state budgets. The amount of the reserve fund reflects the potential disasters that might occur and the financial capacity of the state government concerned. In **Malaysia**, the National Disaster Relief Fund is funded by contributions from the Malaysian government as well as annual contributions from the commercial sector and communities to help disaster victims who benefit from the Fund. In **Hong Kong, China**, the Emergency Relief Fund to provide prompt assistance to persons who are in need of urgent relief as a result of fire, flooding, tempest, landslide, typhoon or other natural disasters is funded by an annual allocation from the General Revenue and donations received from the public from time to time. In **Brunei Darussalam**, the Ministry of Home Affairs is allocated a sum of BND (Brunei dollars) 5 million each year for natural disaster related purposes. In **Russia,** a reserve fund has been established for the prevention and elimination of emergency situations and natural disasters, including costs related to the housing of individuals affected by natural disasters. In the **United States**, the Capital Fund, which provides support to government departments and housing authorities for the rebuilding of public housing, receives a dedicated amount of funding every year.

In **Chinese Taipei**, provisions are made for disaster reserve funds in the annual budgets of both the central and local governments. If these resources prove to be insufficient to address disaster needs, a Secondary Reserve Fund can be accessed to readjust the budget to finance recovery and reconstruction. If municipal governments are unable to meet expenditures arising from major natural disasters, the central government may assist them with special centrally-funded tax revenues (approximately TWD 10 billion each year). In **Viet Nam**, states are required to contribute between 2%-5% of their budget to a reserve fund to address natural disaster costs. If the amount in such a fund is insufficient, there is a national Financial Reserve Fund that can be accessed. In **India**, the NDRF and

SDRF compensation funds are financed through reserves. Payments to the funds are made bi-annually in June and December. If there is a surplus after the fiscal year, interest is payable on the surplus funds and the interest is injected back into the fund to enlarge the pool of assets.

Box 4.3. **Philippine Disaster Funds**

In the Philippines, one of the most disaster-prone economies in the world, risk financing is listed as one of the priority projects by the National Disaster Risk Reduction and Management Plan 2011-2028, in keeping with the aims and objectives of the comprehensive reform enacted with the *Philippine Disaster Risk Reduction and Management Act*. Prior to the passage of this Act, the focus of disaster risk reduction and management in the Philippines was on relief and reconstruction. The massive impact of Typhoons Ketsana and Parma in 2009 served as the catalyst to highlight the need to address disaster risk reduction and fiscal risks.

The reform established the National Disaster Risk Reduction and Management Council (NDRRMC) which among other duties was tasked with developing appropriate risk transfer mechanisms and revamping the National and Local Calamity funds in order to finance *ex ante* disaster risk preparedness and mitigation activities. Aside from existing budgetary appropriations for government departments and agencies, the main disaster funds that can be tapped to finance disaster relief, recovery, and reconstruction are:

- National Disaster Risk Reduction and Management Fund (National DRRM Fund)
- Local Disaster Risk Reduction and Management Fund (Local DRRM Fund).

Local governments have the primary responsibility to provide immediate relief to their constituents. Yet in many cases, local resources are not adequate and must be complemented by central government resources. Under the Department of Social Welfare and Development, various programs provide financial assistance to communities affected by a natural disaster: relief in the form of goods and services to victims of natural disasters; rice subsidies; core shelter assistance programs; food for work programs and assistance to victims of specific natural disasters. The main target population is the poorest segments of society.

The NDRRMC is responsible for managing and mobilising resources for DRM, including the National DRRM Fund, and monitoring and providing the necessary guidelines and procedures on the Local DRRM Fund releases as well as the use, accounting, and auditing of these releases. The Local Disaster Risk Reduction and Management Council (LDRRMC) monitors and evaluates the use and disbursement of the Local DRRM Fund. Under the Act, a certain amount of the allocated funds are set aside for the payment of insurance premiums for the coverage of public assets, which in the past have often been uninsured or underinsured, particularly at the local government level.

Formerly known as the National Calamity Fund, the National DRRM Fund can, given its new-found flexibility, be employed not only for relief, recovery, reconstruction and other work or services in connection with natural or human-induced calamities, but also for disaster risk reduction or mitigation, prevention and preparedness activities such as the training of personnel, procurement of equipment, and capital expenditures such as the construction of evacuation centres.

A share equal to 30% of both the National DRRM Fund and the Local DRRM Fund are to be allocated to a Quick Response Fund (QRF) or a Stand-by Fund for relief and recovery programs. This strengthens the legal and institutional capacities of local government units for self-determination through devolution and decentralisation of responsibilities and authority that have been bestowed upon them by the Local Government Code of 1991.

In **Mexico**, a multi-layered approach is used to finance FONDEN. FONDEN is a reserve fund established to finance the costs of recovery and reconstruction of damaged public assets and infrastructures. Mexico has constructed reinsurance and catastrophe bond programmes to augment the financial capacity of FONDEN and limit the financial exposure of Mexico to disaster risk (see Box 4.4).

Box 4.4. **Mexico: A layered approach**

In Mexico, a fund for natural disasters (FONDEN) was established in 1996 as a tool to finance the costs of recovery and reconstruction of damaged public assets and infrastructures and co-ordinate the actions of intergovernmental and inter-institutional entities. The creation of FONDEN was linked to the development of an integrated DRM framework involving risk assessment, prevention, reduction and transfer tools. Both the Ministry of Finance and the Ministry of Interior appoint members to the FONDEN Board.

The main purpose of FONDEN is to provide the 32 Mexican states and the federal agencies in charge of federal infrastructure with the necessary resources to cover the losses and damages caused by natural phenomena, whose magnitude may exceed their financial capacity. FONDEN is made up of three main financial components:

- The FONDEN Program for Reconstruction: Designed to provide financial support to rehabilitate and reconstruct public assets, the program has a budget line within the Federal Budget every year and works mostly as a cash transfer to the Trust. It focuses on:
  - the reconstruction of public infrastructure at all levels of government (federal, state, and municipal);
  - the reconstruction of low-income housing; and
  - the restoration of forestry, protected natural areas, rivers, and lagoons.
- The FONDEN Trust: Established to provide resources for the activities of the FONDEN Program, it is the financial tool through which the reconstruction costs are paid and the acquisition of risk transfer tools is financed, including insurance and catastrophe bonds.
- The Revolving Fund: A tool designed to respond to the immediate needs of the affected population in the post-disaster phase.

The reconstruction costs of infrastructures belonging to states and municipalities are covered by FONDEN up to 50%, while the remaining portion of the loss is absorbed by local governments, which have access to a credit line provided by the Reconstruction Fund for local entities.

Originally created as a budgetary tool to allocate funds on an annual basis, in 1999 FONDEN was transformed into a multi-year reserve fund, the FONDEN Trust, accumulating the unspent disaster budget of each year. Moreover, the government encouraged and provided incentives to the local states to insure their assets and infrastructure, in order to gradually reduce the impact on federal and local budgets when a major event occurs.

In 2006, FONDEN issued a USD 160 million parametric catastrophe bond against earthquake risks in three zones for a three year duration; in addition, it secured USD 290 million of parametric reinsurance coverage for the same three zones for three years, bringing its total protection to USD 450 million. In October 2009, it issued a USD 290 million multi-peril parametric catastrophe bond covering both earthquake and hurricane risks with a three-year maturity. After the 2009 bond matured, a third issuance was made in October 2012. MultiCat 2012 is a three-tranche catastrophe bond, with an overall value of USD 315 million, covering earthquake and hurricane risks in multiple regions

Box 4.4. **Mexico: A layered approach** *(cont.)*

with a parametric trigger. Starting from 2011, moreover, FONDEN secured a USD 400 million indemnity-based excess of loss reinsurance treaty that will cover the losses sustained by the federal government for government assets and low-income housing, limited to replacement costs.

FONDEN demonstrates that a strong legal and institutional framework with effective governance arrangements can be critical to co-ordinating the efforts of central and local authorities in the various phases of DRM, from risk assessment to risk financing and transfer. Such a framework is also crucial for supporting public decision-making on how different risk layers should be managed. In Mexico, a wide range of financial tools are employed, selected on the basis of the frequency and severity of disaster events: recurring events are covered by the annual budget line (which is also available to finance the purchase of insurance by government dependencies); a multi-year reserve fund, the FONDEN Trust, is aimed at covering less-frequent events; deviations from the assessment of future potential reconstruction costs are covered by the indemnity-based non-proportional reinsurance program; finally, catastrophe-linked securities are employed to finance emergency response costs triggered by major disaster events. Although there is some flexibility in transferring risk through an insurance contract or other transfer mechanism, FONDEN cannot contract debt.

In other economies, ***general fiscal reserves*** may be used as a cushion against unforeseen events. In **Japan**, the Contingency Reserve can be secured for addressing unexpected situations and was used to address the needs arising from the Great East Japan Earthquake. In **Chile**, the Economic and Social Stabilisation Fund, which is used to manage external shocks to Chile's economy, could potentially be used to meet disaster costs in the future. In the **Czech Republic**, both approaches are used. An ongoing-stable reserve (funded annually in the state budget as an obligatory item) is readily-available for emergency response costs and can be promptly released. Based on estimates from individual Ministries, a second reserve is set aside from a general government budget reserve, on the basis of a government decision, to cover costs related to disaster aid and recovery.

In regards to ***the use of insurance by governments*** for the coverage of public assets, the picture is mixed. In the **Philippines**, insurance of public assets is mainly provided by the Government Service Insurance System (GSIS) through the Property Insurance Fund, which was established in 1951 to indemnify or compensate the government for any damage to, or loss of, its properties due to fire, earthquake, storm, or other casualty. The Fund was later renamed the General Insurance Fund in 1973. Notwithstanding the GSIS, government assets, particularly those of local governments, were in the past often uninsured or underinsured. Now that government reserve funds must set aside a certain amount for the payment of insurance premiums for coverage of public assets, this issue may be resolved.

In **Indonesia**, several local governments have made use of insurance to protect public assets against disasters. Almost all local governments are owners of *PT Bangun Askrida*, an insurance company through which insurance is usually provided. In **Russia**, insurance of critical infrastructure is present. For instance, all nuclear power plants are governed by a single company *Rosenergoatom*, which selects an insurer to provide protection against catastrophic risks.

In **Australia**, a key principle of the Natural Disaster Relief and Recovery Arrangements (NDRRA), under which the Australian government provides financial assistance to state and territory governments, is that the support provided is not to supplant or operate as a disincentive for insurance or disaster mitigation. States are required to explore a range of insurance options in the market place and assess available options on a cost–benefit basis. Similarly, in **New Zealand**, individual government departments are not required to insure against all their risks; instead, they are required to systematically assess all risk management options available to them, of which insurance is one option. The Minister of Finance retains an interest in the insurance arrangements of departments given their relevance for the government's overall financial position and ownership interests in departments. Departments are encouraged to share best practice in relation to insurance and risk management. This may also involve the development of shared services schemes where practical.

In the **Czech Republic**, state property is insured to a lesser extent than private property. State authorities have to duly consider if the state property should be insured against disasters or if possible damages should be covered by the resources of the state (or regional or municipal) budget. Thus, the costs of insurance and prospective budget constraints have to be taken into account. The decision to enter into an insurance policy is the responsibility of the particular state authority responsible for administering the particular state property. In **Chinese Taipei**, the government has to date not purchased insurance for public infrastructure based on its evaluation of the costs and benefits. In **Hungary**, at present, insurance products are not offered for public goods of high value such as roads, railway tracks and pipelines. In **Switzerland**, state-owned infrastructure (e.g. roads or buildings of the Swiss confederation) is usually not insured.

Ex post *financing*

Although there can be great utility in making use of *ex ante* disaster risk financing tools, there are significant opportunity costs involved, especially in terms of investment potential. Holding a cash fund in the expectation that it may be drawn upon at some stage in the future to finance disaster responses is not typically a costless exercise. From this perspective, the concept of holding a cash fund to finance disaster recovery is ultimately a question of cash management and when the government chooses to raise its finance. The government can set cash aside *ex ante* or it can finance disaster recovery after a disaster. It is for this reason that those economies that are well placed to access international capital markets and have the ability to create fiscal resources quickly when needed often opt against establishing reserve funds or purchasing insurance, preferring instead to utilise *ex post* disaster financing mechanisms.[5] Such mechanisms include in-year budget reallocations, longer-term realignment of investment budgets, taxation, debt financing and international assistance (OECD, 2012; World Bank, 2012).

In **Australia**, the Australian government's contributions to disaster recovery costs under the NDRRA provide *ex post* funding support to Australia's state and territory governments. For an economy like Australia that is well placed to access the financial markets, raising cash as and when needed to finance disaster recovery measures is consistent with efficient balance sheet and cash management. Australia publishes every year the best estimate of its liability under the NDRRA in the Commonwealth Federal Budget Paper (see Box 4.5). In **Germany**, costs related to large-scale damage are managed, as necessary, through budget reallocations as the national and sub-national governments

are deemed to possess sufficient resources to manage the cost of emergencies. In addition to the *ex ante* reserves described above, the **Czech Republic** has used several *ex post* financial tools in recent years to allow for adequate compensation in the aftermath of flood events. In 2010, government bonds were issued and bought by the European Investment Bank to cover flood costs. In 2011, a special anti-flood tax (CZK (Czech korunas) 100, approximately EUR 4 monthly) was imposed during 2011 on every taxpayer aimed at covering losses caused by the 2010 floods.

In **New Zealand**, there are special legislative arrangements that facilitate *ex post* funding of disaster losses. The New Zealand *Public Finance Act* allows for expenses or capital expenditures to be incurred in emergencies without further authority from Parliament when certain conditions are met. In the **United States**, federal funding for disaster events may only be provided when the President declares a major disaster or state of emergency. In these situations, the *Budget Control Act* supports a cap adjustment exclusively for disaster relief, providing a budget vehicle for disaster requirements and facilitating a shift from a reliance on supplemental appropriations.

Box 4.5. **Australia: Reporting contingent liabilities**

Australia publishes a best estimate of its liability under the NDRRA in the Commonwealth Federal Budget Paper. The figures in the budget paper are based on the NDRRA estimates which are updated during the financial year. Typically, an update is prepared every quarter or as required by the Australian government. The outcomes of the NDRRA estimates are then fed into various processes such as the Federal Budget, Mid-Year Economic and Fiscal Outlook, pre-Expenditure Review Committee and the Final Budget Outcome. Due to the inherently unpredictable nature of natural disasters and the continuously fluctuating estimates for recovery costs, the initial estimate in the budget paper will change in subsequent quarterly updates. In other words, while the budget paper offers the best estimate of the Australian government liability under the NDRRA at the time that the budget paper is prepared, it should not be assumed that this figure will stay the same throughout the financial year.

Regional risk pooling initiatives

A number of smaller economies have collaborated on the establishment of regional risk pooling arrangements as a means to mutualise risk and create economies of scale for accessing international capital and/or reinsurance markets.

Pacific Disaster Risk Financing and Insurance (PDRFI)

The PDRFI Program provides the Ministries of Finance of PIEs with advisory services to help improve their macro-economic planning against extreme natural events and develop a disaster risk financing strategy.[6] Based on catastrophe models developed in the context of PCRAFI (see Box 2.4), a pilot catastrophe risk transfer program supported by a grant from the government of Japan was launched in January 2013 to provide the governments of five PIEs (Marshall Islands, Samoa, Solomon Islands, Tonga and Vanuatu) with immediate funding if a major natural disaster occurs. Coverage of the emergency response costs – up to USD 45 million in aggregate for the year 2013 – is provided by the private (re)insurance market[7] against the risk of losses due to earthquakes, tsunamis and tropical cyclones,

based on a parametric trigger formula. Pay-outs are made under a catastrophe swap transaction based on modelled government emergency response costs that are calculated using physical parameters for the event derived from the Joint Typhoon Warning Centre and the USGS. The five derivative contracts specific to participant members have been placed on the international reinsurance market as a single, diversified portfolio of risks, which allowed for significant price reduction. The World Bank, through the International Development Agency (IDA), acted as the intermediary and entered into back-to-back catastrophe swap transactions.

The aim of this financial tool is not to replace post-disaster international donor assistance, but rather to increase the budget flexibility and reduce the contingent liabilities of participating' governments, thereby strengthening the ability of these economies to withstand a disaster event from a financial viewpoint.

Caribbean Catastrophe Risk Insurance Facility (CCRIF)

PDRFI was inspired by the CCRIF, a mutual insurance company controlled by participating Caribbean islands governments.[8] CCRIF was initially capitalised by the participating members, with support from donor partners. A portion of the pooled risks is retained through reserves, which reduces the cost of insurance premiums. The residual risk is transferred by purchasing reinsurance and catastrophe swaps.

CCRIF helps to mitigate the short-term cash flow problems that small developing economies face after major natural disasters. A critical challenge is often the need for short-term liquidity to maintain essential government services until additional resources become available. CCRIF represents a cost-effective way to pre-arrange access to the necessary short term liquidity to begin recovery efforts after a catastrophic event, thereby filling the gap between immediate response aid and long-term redevelopment. As a result, members benefit from: i) the ability to transfer a portion of their hurricane and earthquake risk to the CCRIF at a price lower than what they would pay if they were to obtain coverage individually in international insurance markets or the cost of the capital they would need in order to self-insure; and ii) the financial protection of a prompt cash pay-out, within two weeks or less, following a covered event.

Since its establishment, CCRIF has rapidly built its capital and risk bearing capacity. As CCRIF's financial strength has improved, it has lowered the premiums charged, in order to make its coverage more affordable. Since its first year of operations, CCRIF has lowered its pricing various times for a total reduction of about 30%. In 2014, an agreement was reached to extend CCRIF to economies in Central America.

African Risk Capacity (ARC)

Another regional disaster risk financing initiative inspired by CCRIF is ARC.[9] ARC is an extreme weather insurance scheme designed to help African Union member economies resist and recover from natural disasters. The scheme uses advanced satellite weather surveillance and software – developed by the WFP – to estimate and disburse immediate funds to African economies hit by severe drought, with other hazards to follow in the coming years. Economies that participate in ARC will benefit from an index-based insurance mechanism for infrequent, severe drought events.

The concept for ARC is roughly based on the CCRIF, modified for the special features of African multi-seasonal weather risk in its financial design and based on Africa RiskView

(see Box 2.6). The pool's governance structure mirrors the CCRIF as an African-owned stand-alone entity. However, unlike the CCRIF, pay-outs from the ARC are specifically targeted at financing early and timely responses to food insecurity caused by extreme weather events. Participating members need to develop contingency plans in the event of a pay-out and the ARC governing body needs to develop a process for ensuring that funds in the pool are protected and spent in a way that best addresses the pressing issues facing the most vulnerable populations. By bringing together the concepts of insurance and contingency planning, ARC aims to create a new way of managing weather risk by transferring the burden away from African governments and their vulnerable populations, who depend on government assistance, to international financial markets that can better manage the risk.[10]

Reportedly, up to a 50% saving can be obtained from diversification of drought-related losses across Africa, that is to say a 50% reduction in the contingent funds needed if the risk is pooled among nations and managed as a group rather than borne by each economy individually. These are savings that can then be invested in longer term development projects and disaster risk reduction activities.

Solvency and sustainability objectives are achieved using a variety of different financing approaches and instruments, including the co-ordinated use of risk retention, risk transfer and contingent financing from international financing entities to create a layered financing structure within the pool and also within participating economies themselves:

- Retention by participants in the scheme: Members retain a portion of risk, using existing resources to manage the impact of less severe, localised or frequent events.
- Risk pool reserves (ARC retention): Reserve layers of the pool are based on contributions of participating members in the form of annual premiums, in addition to initial donor capitalisation.
- Risk pool contingent financing (ARC risk transfer): The ARC risk pool transfers extreme drought risk that it believes it would be inefficient to hold as reserves within the pool to international carriers via reinsurance, derivative contracts and/or catastrophe-linked securities.

Implementation challenges

Economies that participated in the survey reported a number of challenges to developing and implementing effective compensation arrangements and sovereign risk financing and transfer approaches.

In terms of compensation and financial assistance arrangements, the main challenges cited include the difficulty in fairly allocating limited available financial resources among different categories of disaster victims, a lack of clarity in terms of the allocation of responsibility for disaster losses (between government entities and between the public and private sectors), and the practical difficulties in establishing procedures that allow for speedy compensation while guaranteeing transparency and accountability.

There are a number of challenges to the effective distribution of financial assistance, including: i) the disbursement of funds can be slow due to the numerous levels of approval required, the time needed to properly identify victims, and the remoteness of some impacted communities; ii) local responsibility for the management of disaster relief funding is unclear, as certain sub-national governments may not have established disaster

relief funding distribution mechanisms at the local level, leading to an excessive reliance on the use of higher-level disaster relief funding; iii) the lack of established procedures for the disbursement of funds at the local level; and iv) disaster investigation may be inaccurate, and a disaster relief classification mechanism may yet to be fully implemented.

In terms of the financial management of sovereign exposures, the main challenges cited include: i) the lack of financial resources committed *ex ante*, both at central and local levels of government, to DRF tools; ii) the lack of information sharing among government divisions and communities to identify funding needs; iii) the lack of proper documentation to demonstrate the credibility of risk assessments; and iv) the unavailability of a proper legal and regulatory framework for the design and implementation of market-based sovereign risk transfer mechanisms.

Obstacles related to the use of specific DRF instruments may include: for contingent credit, it was believed that such arrangements are of less value where the government has a strong fiscal position and has regular access to capital markets; for catastrophe bonds, their complexity and pricing challenges were seen as problematic. There may be a need for improved understanding of the relative costs and benefits of index-based and parametric insurance cover.

Notes

1. These include: Regulations on the Relief of Natural Disasters, Natural Disaster Relief Emergency Plan, Interim Regulations on the Management of the Natural Disaster Relief Funds, and Natural Disaster Statistics System.
2. Further information on the Reconstruction Inspectorate is available at: *http://reconstructioninspectorate.gov.au/*.
3. In the context of the negotiations under the United Nations Framework Convention on Climate Change (UNFCCC), an agreement has been reached to establish the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts. Among the proposals being considered for operationalising the mechanism is an internationally-funded insurance pool that would provide funding to low-income economies impacted by climate-change related natural disasters. For more information, see: *http://unfccc.int/adaptation/workstreams/loss_and_damage/items/8134.php*.
4. Catastrophe-linked securities create opportunities for the transfer of disaster risks, including risks that are not sufficiently covered by insurance markets, thus potentially broadening the overall financial coverage of such risks (OECD, 2011).
5. The expectation of international assistance to support recovery and reconstruction post-disaster could also be seen as disincentive for economies to set aside funds ex ante to manage disaster-related financing needs although the limited financial means of the economies that tend to receive international assistance is likely a greater impediment to establishing ex ante financial management arrangements.
6. The technical assistance focuses on three core aspects: i) the development of a public financial management strategy for natural disasters, recognizing the need for ex ante and ex post financial tools and acknowledging the different financial requirements associated with the different layers of risk; ii) post-disaster budget execution processes, to ensure that funds can be accessed and disbursed easily and effectively post disaster; and iii) the insurance of critical public infrastructure, to reduce the much larger funding requirements for recovery and reconstruction needs.
7. The participating insurers are Sompo Japan Insurance, Mitsui Sumitomo Insurance, Tokio Marine & Nichido Fire Insurance and Swiss Re.
8. Seventeen governments are currently members of the Facility: Anguilla, Antigua & Barbuda, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Dominica, Grenada, Haiti, Jamaica, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, Trinidad & Tobago, Turks & Caicos Islands, and Nicaragua.

9. The original signatories of the Establishment Treaty on 23 November 2012 are: Burkina Faso, Burundi, Central African Republic, Chad, Republic of Congo, Djibouti, Gambia, Guinea, Liberia, Libya, Malawi, Mozambique, Niger, Rwanda, Western Sahara, Senegal, Togo and Zimbabwe. Kenya and Mauritania joined on 28 January 2013, Ivory Coast on 6 February 2013 and Comoros on 15 February 2013.
10. The donors to the program include the Rockefeller Foundation, DFID, Swedish International Development Cooperation Agency (SIDA), International Fund for Agriculture Development (IFAD) and SDC.

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Chapter 5

Key priorities for strengthening financial resilience

This chapter provides an overview of the main findings of the report, including common implementation challenges and a set of priorities to improve the financial management of disaster risks, as identified by surveyed economies.

The introduction of disaster risk management on the agenda of G20 and APEC leaders in recent years and the launch of international initiatives such as the Sendai Framework for Disaster Risk Reduction suggest that DRM is increasingly being recognised at the highest level of governments as a policy priority. The high economic losses inflicted by natural hazards and man-made threats in the recent past, together with the expected impacts of future potential events, make ***financial resilience*** against disasters a key policy objective.

G20 Finance Ministers and Central Bank Governors along with G20 Leaders have recognised the importance and priority of DRM strategies and, in particular, disaster risk assessment and risk financing. At the Los Cabos meeting in June 2012, they invited the OECD to develop a voluntary framework that could strengthen these two key components of DRM. After the publication of the *G20/OECD Framework for Disaster Risk Assessment and Risk Financing*, they encouraged "further efforts by the World Bank and OECD in co-operation with other relevant international organizations to leverage the voluntary framework in order to address remaining challenges".

Building on the work already undertaken in 2012 under the aegis of the G20, APEC Finance Ministers highlighted in their Joint Ministerial Statement of 30 August 2012 the importance of *strengthening resilience against disasters* in the region through the introduction or expansion of risk sharing and risk transfer markets and products and also called for the exchange of knowledge and practices on financial strategies among APEC member economies. A report on *Disaster Risk Financing in APEC economies – Practices and Challenges* prepared by the OECD in co-operation with the ADB, the UNISDR and the World Bank was subsequently published for the APEC leaders meeting in Indonesia in September 2013.

This report provides a review of the practices of a broad range of economies relative to the guidance elaborated in the G20/OECD Methodological Framework. It builds on the APEC report on disaster risk financing by adding case studies and examples from a number of other economies and regions. It is based on the responses of APEC, OECD, and other economies to a questionnaire circulated in 2013, as well as on research conducted by the OECD and other international organisations such as the ADB, ASEAN, World Bank and UNISDR.

This report is meant to promote effective and widespread implementation of the G20/OECD Methodological Framework in the OECD and APEC regions and beyond in the area of disaster risk financing. While the G20/OECD Framework underscores the central role played by financial policy makers in DRM and provides a general framework for action, the present report provides practical illustrations of the concrete ways in which the step-by-step action items can be implemented in different economies, including those with scarce financial resources and limited insurance markets. It shows that relevant actions can be taken even in economies where the spending capacity of the most vulnerable layers of the population is severely constrained.

The specificities of local disaster risk exposures, the historical development of private insurance, reinsurance and financial markets, the legal and administrative frameworks,

and the level of economic development and financial capacities within the economy, among other factors, contribute to shape domestic and regional risk financing strategies. Given the diverse economic profiles presented in this report, policies designed to manage the financial impacts of disaster risks are not fully replicable from one economy to another. Keeping this in mind, illustrative practices such as those presented and discussed in this report facilitate learning across economies and can help to identify viable risk financing options for the different segments of the economy and population that can be adapted to the needs of different types of economies.

As highlighted by the G20/OECD Methodological Framework, *disaster risk assessment and risk modelling* provide the starting point for the development of disaster risk financing strategies. Important initiatives have been undertaken in this area within many economies in recent years. In some of them, the analysis of financial and economic impacts is built on a comprehensive risk assessment process, following an approach that evaluates the impacts of specified worst-case scenarios. In other economies, probabilistic risk assessment and modelling has been employed, or is currently under development, often as part of a strategy to develop risk financing options for government. This report also presents examples of tailored efforts to develop pre-disaster impact analysis and risk modelling to address specific DRM purposes, such as emergency management, urban planning and zoning.

Efforts have been made to strengthen the *foundations for risk assessments*, such as the elaboration of risk maps and the collection of data on hazards, exposures, vulnerabilities and losses. Research institutions and the private sector are contributing to these efforts in many economies. Furthermore, a number of economies have developed systems, tools, and databases in order to track disaster impacts and losses. These may be in place in the public sector or private sector, particularly the insurance sector. This information provides input for future disaster risk assessment but is also critical for the provision of compensation for disaster response and recovery. In order to improve the estimation of damages and post-disaster needs, methodologies have been developed to ensure rigour and consistency.

A number of economies are making significant efforts to *identify financial vulnerabilities* within the population and economy and promote the development of *adequate and affordable risk financing and transfer tools* to address these vulnerabilities, particularly among households and small-scale agricultural enterprises. The cost of DRF tools becomes increasingly important in economies where a significant proportion of the population is low income, with limited financial capacity to pay for these instruments. In this regard, public and private investments in disaster risk assessment, quantification, reduction and mitigation enable the development of more affordable market-based products, reducing the need for public subsidies. For governments, notwithstanding important progress being made, developing an accurate risk assessment based on quantitative approaches remains a challenge and a weak link in the DRM cycle.

A comprehensive and integrated approach is required for financial strategies, following an assessment of the availability, adequacy and efficiency of different types of financial tools available to the population and within the economy, as well as of their relative costs and benefits, in comparison with possible further disaster risk reduction. Private insurance provides one of the main risk financing tools for businesses and households to strengthen their financial resilience against disasters. Innovative financial products developed in the capital markets may also be accessed by large corporations, insurers, and governments.

In a very limited number of economies the availability and affordability of disaster insurance is not considered problematic, due to a relatively low level of risk. In others, the situation is different, with disaster risks being more material, which has led governments to provide support for disaster insurance through disaster insurance schemes, subsidies or other approaches to support widespread coverage of catastrophe risk. Where disaster insurance schemes have been established, governments are acting as primary insurer or as reinsurer and/or guarantor. In yet another group of economies, disaster coverage may be limited due to the limited scope of insurance markets. In these markets and more generally, efforts are being made to enhance the availability and penetration of disaster insurance.

Efforts are being made in several economies to promote the *development of targeted approaches to disaster insurance* to address the needs of specific vulnerable segments of society. The development of micro-insurance has been one avenue through which governments have sought to enhance financial protection among the financially vulnerable, such as small-scale farmers. Non-traditional products using parametric or index-based structures have also been developed, for instance in the areas of crop insurance, weather insurance and earthquake insurance. Parametric structures, however, require reliable data and technology to monitor hazard levels, which may be costly to acquire, manage and maintain, presenting important implementation challenges. On the other hand, existing technological and financial networks can be exploited to improve accessibility and lower transaction costs for financial tools: for instance, mobile phone technology can enhance access to micro-insurance while the purchase of portfolio protection against disasters by credit cooperative or rural banks and micro-finance institutions can enhance access to finance.

Ensuring the *capacity of the financial sector to manage disaster risk* is a key priority within the economies reviewed, forming part of a broader strategy to ensure financial sector resilience, including through capital adequacy and liquidity requirements, stress testing, and business continuity management. In many economies, financial institutions are required to establish business continuity management strategies to cope with emergencies, as well as to develop crisis management manuals and business continuity plans. Other initiatives have also been undertaken by financial authorities to ensure that the financial sector – and in particular the insurance sector – is sound and resilient, capable of delivering the promised payments and financing in the event of a disaster that are crucial to disaster recovery. A number of economies are specifically monitoring the performance of private sector players (e.g. insurance companies) in claims management, with a view to ensuring fair and efficient treatment of disaster victims.

Disaster risk awareness is a key element of DRM strategies. Promoting awareness of the financial impacts of disasters and the need to plan for – and mitigate – these impacts through the development of financial strategies, including investment in physical risk reduction and financial tools, can boost financial resilience. In some economies, awareness and financial preparedness have been enhanced by communicating information on disaster impacts and providing information about the availability and main characteristics of DRF tools. Many economies have launched campaigns seeking to raise public awareness about the importance of preparing for emergencies of all kinds; meanwhile, some economies have launched campaigns specifically focussed on the financial impacts of disasters and the need for financial protection.

Government financial assistance programmes have also been established by some of the economies examined in this report to cover basic living expenses and losses linked to disaster impacts. These programmes are financed either *ex ante* or *ex post* and are designed to ensure timely appropriations or release of funds within pre-specified parameters, thereby ensuring timely disbursement of disaster funds for emergency assistance, social protection, recovery and reconstruction.

Securing a *fair, timely and efficient disbursement of funds* for disaster relief, recovery and reconstruction is a key component of effective DRF strategies. Not only must financial resources for disaster response and reconstruction efforts be available after an event, they must also be deployed in a well-timed and targeted manner. Timely availability of funding can reduce the indirect impacts and secondary consequences of a disaster significantly. A number of economies are addressing this challenge by establishing *ex ante* clear and streamlined administrative procedures and guidelines for the disbursement of public and/or international donors' funds in the aftermath of an event, in some cases by appointing an independent body tasked with reviewing public spending for disaster relief and reconstruction.

Some governments are *employing DRF tools* to mitigate the financial impacts of disasters on public budgets and to complement investments in physical risk reduction. These *ex ante* financial tools may address short-term (emergency response), mid-term (recovery) or long-term (reconstruction) disaster impacts, and may be used in combination to cover different risk layers, based on the relative frequency and severity of the expected events. Reserve funds have been used within a number of economies for a variety of purposes in relation to DRM, such as emergency response and relief, recovery, and reconstruction. The funds ensure that resources can be rapidly secured and disbursed in the event of a disaster event. There appears to be a trend toward enabling a portion of the reserve funds to be allocated towards investments in risk reduction. In addition, some governments have used insurance for the coverage of public assets. Others are currently financing disaster risk on an *ex post* basis – e.g. through budget reallocations, debt financing, increased taxation and international aid – or by adopting an approach that blends *ex ante* and *ex post* instruments.

Regional initiatives have demonstrated how economies can join together to share the costs of developing and implementing financial strategies, including risk assessment and the pooling of risks, which may enable enhanced access to international reinsurance markets. Regional risk assessment and quantification efforts, moreover, can have multiple applications: from risk reduction, to early warning and emergency management, to disaster risk transfer and financing.

A number of the responding economies provided recommendations on national and international priorities for improving disaster risk management and areas where further international collaboration would be helpful (see Table 5.1). Among the ***top priorities for strengthening financial resilience***, the improvement of the *availability and quality of data* on hazards, exposures, vulnerabilities and losses has been highlighted by several economies as a means to support the assessment of risks and financial vulnerabilities. At the international level, existing discrepancies have led to calls for in-depth reviews of data collection and dissemination practices. Finance Ministers and other public and private institutions concerned would greatly benefit from the promotion of regional and international co-operation and synergies in the collection and sharing of data on disaster risks,[1] as well as in the modelling of the nature of these risks.[2] The development of an

international risk assessment platform which amalgamates the risk assessments of economies within proximity to one another, for instance, was identified as a tool that could prove useful for developing a common regional perspective of risk that accounts for the increasing interlinkages and interdependencies among regional economies.

Table 5.1. **Key priorities (identified by economies)**

Risk and financial vulnerability assessment	• Supporting risk assessment, including at a cross-border level which can enhance regional perspectives on risks and risk reduction and recognition of the interlinkages and interdependencies among economies • Improving the consistency of disaster impact assessments and understanding risk-bearing capacities across society in order to better target financial assistance and improve cost-effectiveness in the delivery of recovery assistance.
Disaster data	• Improving the availability, consistency, and quality of data on hazards, exposures, vulnerabilities and losses in order to enhance the understanding of risk and improve capacity to undertake cost-benefit analysis of various approaches to reducing and managing risks (zoning, risk reduction investment as well as risk modelling and financing).
Technical and institutional capacities and co-ordination among domestic stakeholders	• Strengthening technical and institutional capacities in risk assessment, disaster management and risk financing within Ministries of Finance and across all levels of government (and particularly at local levels). • Supporting innovation and technology to facilitate disaster risk management and the delivery of disaster risk financing options. • Enhancing co-ordination among the various domestic stakeholders in disaster management.
Financial capacities and DRF markets	• Enhancing the financial capacity to deal with disasters by promoting the development of DRF tools and markets, including supportive legislative and regulatory frameworks, with the aim of supporting broad coverage of disaster risks across all segments of society (including national governments). • Undertaking research into various approaches for providing DRF, including public-private partnerships, and regional and international solutions.
Prevention	• Investing in disaster risk prevention and reduction with the aim of reducing insurance exposures.
Financial sector resilience	• Ensuring financial sector resilience, including through business continuity planning.
Risk awareness and financial preparedness	• Enhancing hazard awareness in order to encourage risk reduction across all segments of society. • Promoting awareness of the financial impacts of disasters, the financial vulnerabilities within the population and economy, the allocation of responsibilities, and the need for financial protection.
Deployment of funds	• Securing a fair, timely and efficient disbursement of funds for disaster relief, recovery and reconstruction, while ensuring transparency and accountability in the process.
Finance Ministries network	• Promoting co-operation and the exchange of knowledge and information on best practices and challenges regarding DRF strategies. • Integrating disaster insurance into national policy-making and planning.

Key priorities also include the enhancement of *technical and institutional capacities*, involving the development of multidisciplinary technical skills and expertise as well as supporting technologies, and *co-ordination* among the various governmental authorities in charge of DRM at the central and local levels. The effective financial management of disaster risks requires strong co-ordination across government departments and agencies, potentially under the leadership of Ministries of Finance, with the aim of identifying the most effective and efficient means to address disaster risks, whether through prevention, mitigation or risk financing and transfer. Promoting *awareness of the financial impacts of disasters* and *the need for insurance protection* is yet another priority area.

Many economies are also seeking to foster the development of DRF markets and enhance insurance market penetration, including through analysis of *public-private, regional and other innovative approaches to disaster risk financing*. In this respect, there is interest in better understanding parametric insurance and how a reasonable premium can be determined. Increased insurance coverage of disaster risks requires sound insurance markets, which reinforces the importance of strengthening *financial sector resilience*, including *business continuity planning* and *stress testing of disaster exposures* across the financial system.

For other economies, promoting more robust operating procedures to improve the efficiency of distribution and targeting of *public financial assistance* was a key challenge and priority for future work.

Many economies have stressed the value of strengthened co-operation and knowledge and information exchange among member economies on topics related to DRF. Such co-operation and exchange of knowledge and information should focus on addressing the priorities identified by the economies under review. Strengthened co-operation can support capacity building and enhance understanding of different DRF strategies and tools and their potential benefits and limitations, including necessary preconditions, and thus support the development and evaluation of DRF strategies and policies across economies.

Notes

1. Efforts towards common understanding and possible harmonisation, when relevant, of basic definitions and classification criteria, including for the quantification of total economic losses caused by a disaster on a global scale, should also be enhanced further.
2. A notable example concerning geophysical hazards is constituted by the Global Earthquake Model (GEM) initiative, promoted by the OECD. At present, GEM is established as a foundation, a public-private partnership that drives a collaborative effort aimed at developing and deploying tools and resources for earthquake risk assessment worldwide, based on uniform global databases, methodologies and open-source software. See: *www.globalquakemodel.org*.

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OECD PUBLISHING, 2, rue André-Pascal, 75775 PARIS CEDEX 16
(21 2015 02 1 P) ISBN 978-92-64-23423-9 – 2015

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A GLOBAL SURVEY OF PRACTICES AND CHALLENGES

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Consult this publication on line at ***http://dx.doi.org/10.1787/9789264234246-en.***

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ISBN 978-92-64-23423-9
21 2015 02 1 P