Disaster Risk Assessment and Risk Financing

A G20 / OECD METHODOLOGICAL FRAMEWORK

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Background and main policy messages

Mandate

G20 Finance Ministers and Central Bank Governors along with G20 Leaders have recognised the importance and priority of disaster risk management (DRM) strategies and, in particular, disaster risk assessment and risk financing. They invited the OECD to develop a voluntary framework that could strengthen these two key components of DRM and complement a compilation of country experiences published by the Government of Mexico and the World Bank:

> *"We recognize the value of Disaster Risk Management (DRM) tools and strategies to better prevent disasters, protect populations and assets, and financially manage their economic impacts. We appreciate World Bank and OECD combined efforts, with the UN's support, to provide inputs and broaden participation in the discussion on DRM. We welcome the World Bank's and Mexico's joint publication on country experiences in this area with the support of G20 members, and the OECD voluntary framework to facilitate implementation of DRM strategies, to be completed by November."* (G20 Leaders, Los Cabos, June 2012)

A voluntary methodological framework has been developed that will provide a useful tool for Finance Ministries and other relevant stakeholders involved in DRM. This framework focuses on disaster risk assessment and risk financing and their interlinkages, acknowledging that risk assessment is also essential for other components of DRM. The framework is intended to complement and build on existing international frameworks for DRM and promote more effective and sustainable DRM strategies. It is completed by a self-assessment guiding tool.

Context

It is recognised that disasters can have widespread impacts, causing not only harm and damage to lives, buildings and infrastructure, but also impairing economic activity, with potential cascading and global effects. These impacts generate losses for households, businesses and governments as damages need to be repaired, homes and businesses rebuilt, and activities resumed. These financial costs may be catastrophic in nature, aggravating economic and social impacts. Achieving financial resilience is thus a critical component of effective DRM.

Financial strategies for DRM are intended to ensure that individuals, businesses and governments have the resources necessary to manage the adverse financial and economic consequences of disasters, thereby enabling the critical funding of disaster response, recovery and reconstruction. These strategies depend on a comprehensive identification and accurate evaluation of natural and man-made disaster risks. The financial impacts of disasters in particular need to be understood and assessed by Finance Ministries as a basis for developing financial and fiscal management strategies. These impacts can be mitigated *ex ante* through financial management tools along with physical risk reduction measures. Financial tools enhance financial resilience to disasters by ensuring that resources are available for emergency response, recovery and reconstruction, thus averting financial distress.

Finance Ministries and other relevant financial authorities play a pivotal role in DRM strategies given their responsibilities for economic, financial, fiscal and budget policymaking, planning of public investment and coordinating public expenditures. These central responsibilities as confirmed by the framework include:

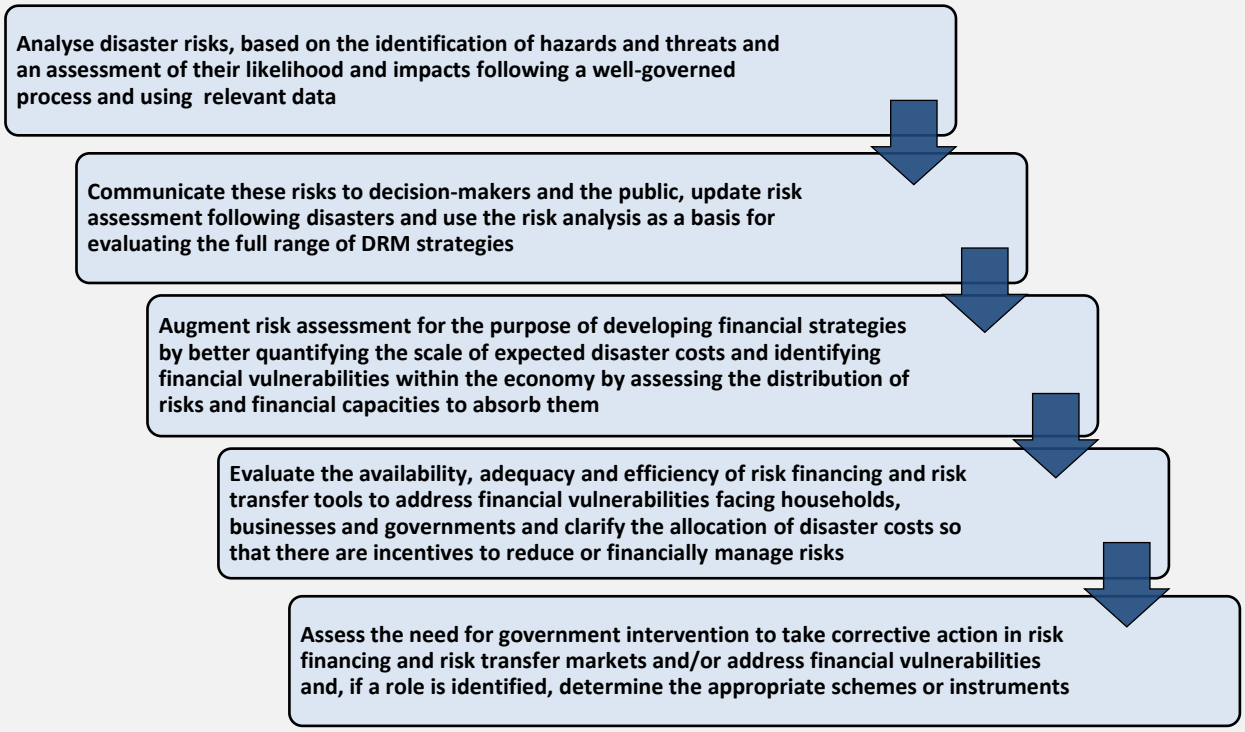
- Ensuring that ***financial vulnerabilities within the economy*** are addressed through private markets, government-backed schemes or other instruments in order to promote financial resilience, and ensuring the ***availability and efficiency of compensation mechanisms***, whether private or public
- Ensuring proper ***fiscal management*** of disaster risks by anticipating potential budgetary impacts and planning ahead to ensure adequate financial capacity and rapid release of funds, thus enabling emergency response, reconstruction of public assets and infrastructure, and targeted financial assistance
- Ensuring that ***clear rules regarding post-disaster financial compensation*** are established to enable rapid compensation, demonstrate solidarity and clarify the allocation of disaster costs, thereby promoting public confidence in country financial strategies while aligning incentives and reducing moral hazard
- 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 DRM***, including assessment of the cost-effectiveness of major ***public financial investments in disaster risk reduction*** projects

In regard to financial strategies, these responsibilities involve key decisions regarding the development and design of schemes enabling post-disaster assistance and disaster insurance and the provision of financial guarantees within these schemes, the management of disaster-related contingent liabilities within the fiscal framework, and the role of the financial sector. These decisions become increasingly critical insofar as country disaster risks are significant and insurance markets are absent or unable to cover these risks, leaving the government with potentially large financial exposures.

Methodological framework

This methodological framework is intended to help Finance Ministries and other governmental authorities in developing more effective DRM strategies and, in particular, financial strategies, building on strengthened risk assessment and risk financing. While the framework does not specifically explore disaster risk reduction policies, it highlights the strong interconnections between disaster risk assessment, risk reduction and financial management, key building blocks for dynamic and continually evolving DRM strategies.

Based on country practices and existing international DRM frameworks, the framework first addresses risk assessment as a key step for promoting risk financing strategies through a series of concrete steps:



The framework balances the need for a flexible, open-ended framework that encapsulates the key issues from a broad, economy-wide perspective and recognises country differences with the need for a framework that provides substantive guidance for decision-making, in particular by financial authorities. It is intended to be non-prescriptive and applied voluntarily by any country seeking to strengthen physical and financial resilience to disasters.

Key policy messages for Finance Ministers and other relevant stakeholders

- ***Country risk assessment is a critical foundation for disaster risk management and related financial strategies and requires clear rules and governance.***
  - Risk assessment needs to be comprehensive and well orchestrated both within government and with stakeholders, requiring a robust governance process and framework
  - Agreed definitions and rules are needed to ensure consistent and reliable outcomes
  - Risk assessment outcomes need to be communicated to decision-makers and the public
  - Establishing a solid evidence base through the collection of data on hazards, exposures, vulnerabilities and losses is crucial to this effort and DRM strategies overall
- ***Disaster risk assessment needs to consider financial vulnerabilities within the economy***
  - With disasters presenting potentially severe impacts, ensuring that the economy has the necessary financial resources to recover and rebuild is critical to growth and effective DRM
  - Country risk assessment therefore needs to consider financial impacts and their consequences for individuals, businesses and governments in light of their risk-bearing capacities
  - These efforts should complement the assessment of other types of vulnerabilities such as human, social, environmental and institutional as well as consider self-protection capabilities and coping capacities that can limit exposure, mitigate impacts and/or enable recovery
- ***Country risk assessment needs to be integrated into financial strategies***
  - Finance Ministries need to integrate risk assessment into financial strategies, leveraging the full resources of government and ensuring a comprehensive view of risks, including interlinkages among hazards and potential cascading effects which could multiply financial impacts
- ***A comprehensive and integrated approach is required for financial strategies***
  - Risk financing and risk transfer tools such as insurance along with physical risk reduction serve to reduce financial vulnerabilities. It is thus important to ensure that the financial sector is sound and resilient, capable of delivering promised payments and financing in the event of a disaster.
  - The development of private risk financing and transfer markets needs to be promoted where feasible as a mechanism for financial protection; in countries where private markets are less developed, this may require the development of innovative products and other instruments
  - Parallel systematic efforts by governments to address broader post-disaster financial needs can be pursued. Public and private efforts need to be well coordinated so that incentives for private protection do not diminish, which could burden governments and crowd out private markets.
- ***Finance Ministries are uniquely placed to ensure that financial strategies for DRM are well integrated, efficient and effective, and thus play a central role in ensuring financial resilience***
  - They are well placed to evaluate the role of insurance markets in covering risks and may deploy policy, regulatory, fiscal and financial tools to support these markets
  - They can leverage risk assessment and their understanding of insurance markets to design more effective and complementary government compensation programs and arrangements
  - These efforts help clarify the government's contingent liabilities for disasters, a necessary basis for efficient fiscal management, an ongoing concern for Finance Ministries
  - They can clarify the allocation of disaster costs, helping to align incentives with a shared vision of how risks are to be retained, mitigated and transferred within the economy and thus promoting a culture of risk within society

INTRODUCTION

G20 Finance Ministers and Leaders have recognised the importance and priority of adequate DRM strategies and have, in particular, highlighted the key components of disaster risk assessment and risk financing: *"We recognize the value of Disaster Risk Management (DRM) tools and strategies to better prevent disasters, protect populations and assets, and financially manage their economic impacts"* (Los Cabos, 19 June 2012).

The OECD was invited to develop a voluntary framework to facilitate the assessment of disaster risk and development of financial strategies in support of effective DRM. While the role of civil protection authorities, urban planners, infrastructure developers and other stakeholders in DRM has been studied extensively, the role of financial policymakers has received less attention. This framework aims to fill this gap for developed and emerging market countries exposed to disaster risks by focussing on these two components of DRM that are of most immediate relevance to financial policymakers.

Disasters present a broad range of human, social, financial, economic and environmental impacts, with potentially long-lasting, multi-generational effects. In addition to causing direct damages to lives, buildings and infrastructure, they produce indirect damages with the potential for cascading and systemic effects such as business interruption, loss of employment and output, decreased tax revenues, impaired institutional capacities and a rise in poverty levels.

Disasters can present financial challenges to governments. With countries facing more frequent and severe disasters and increasingly constrained public finances, the development of disaster risk management (DRM) strategies has become indispensable for enhancing the resilience of societies against disasters and reducing their long-term social and economic costs.

A comprehensive approach to DRM comprises pro-active policies and actions that span several phases: assessment, prevention, mitigation and emergency preparedness in the pre-disaster phase to reduce disaster risks, through to disaster response, rehabilitation and reconstruction in the post-disaster phase to minimise their destructive impacts and enable recovery. There are well-established national, regional and international frameworks that outline the broad array of efforts needed to support DRM.

Effective DRM depends fundamentally on the ability to identify and evaluate natural and man-made disaster risks. A well-developed understanding of the likelihood and potential impact of disasters, and their underlying physical and societal drivers, provides the basis for elaborating and assessing the full range of DRM strategies, such as cost-benefit analysis of risk reduction measures, contingency planning and financial preparedness. It also enables DRM decision-making and capacity building to be tailored to local risk profiles and conditions and underpins risk communication strategies, necessary for enhancing society's awareness of risks. Establishing a solid evidence base through the collection of data on hazards, exposures, vulnerabilities and losses can be crucial to the success of this effort and DRM strategies overall.

Financial strategies aimed at mitigating the potential adverse economic and financial consequences and funding rapid response, recovery and reconstruction are of equal importance for effective DRM, not only to ensure overall economic resilience amidst disaster events but also to ensure continued productive investment for the purposes of economic growth and disaster risk reduction. Financial strategies depend on a sound risk assessment process that can identify financial vulnerabilities and quantify financial impacts.

Finance Ministries and other relevant financial authorities play a pivotal role in DRM strategies, and especially related financial strategies, given their responsibilities for economic, financial, fiscal and budget policymaking, planning of public investment and coordinating public expenditures. These central responsibilities include:

- Ensuring that ***financial vulnerabilities within the economy*** are addressed through private markets, financial schemes, subsidies and/or other instruments in order to promote overall financial resilience, and in this respect ensuring the ***availability and efficiency of compensation mechanisms***, whether private or public

- Ensuring proper ***fiscal management*** of disaster risks by anticipating potential budgetary impacts and planning ahead to ensure adequate financial capacity and rapid release of funds, thus enabling emergency response, reconstruction of public assets and infrastructure and targeted financial assistance

- Ensuring that ***clear rules regarding post-disaster financial compensation*** are established to enable rapid compensation, demonstrate solidarity and clarify the expected allocation of disaster costs, thereby promoting public confidence in disaster response while aligning incentives and reducing moral hazard

- 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 DRM***, including assessment of the cost-effectiveness of major ***public investments in disaster risk reduction*** projects

In regard to financial management strategies, these responsibilities involve key decisions regarding the development and design of schemes enabling post-disaster assistance and disaster insurance and the provision of financial guarantees within these schemes, the management of disaster-related contingent liabilities within the fiscal framework, and the role of the financial sector in providing coverage against disaster risk. These decisions become increasingly critical insofar as country disaster risks are significant and insurance markets are absent or unable to cover these risks, leaving the government with potentially large financial exposures. Finance Ministries can also play an instrumental role in promoting, if not augmenting, risk assessment and supporting its coordination, enabling a comprehensive view of disaster risks and permitting the proper calibration of financial management strategies.

This methodological framework is intended to help Finance Ministries and other governmental authorities in developing more effective DRM strategies and, in particular, financial strategies, building on strengthened risk assessment and risk financing. Based on country practices and existing international DRM frameworks, the framework first addresses risk assessment as a key step for promoting risk financing strategies through a series of concrete steps:

- Analyse disaster risks, based on the identification of hazards and threats and an assessment of their probabilities and expected impacts following a well-governed process and using relevant data

- Communicate these risks to decision-makers and the public, update risk assessment following disasters and use the risk analysis as a basis for evaluating the full range of DRM strategies

- Augment risk assessment for the purpose of developing financial strategies by better quantifying the scale of expected disaster costs and identifying financial vulnerabilities within the economy by assessing the distribution of risks and financial capacities to absorb them

- Evaluate the availability, adequacy and efficiency of risk financing and risk transfer tools to address financial vulnerabilities facing households, businesses and governments and clarify the allocation of disaster costs so that there are incentives to reduce or financially manage risks

- Assess the need for government intervention to rectify problems in risk financing and risk transfer markets and/or address financial vulnerabilities and, if a role is identified, determine the appropriate schemes or instruments

The framework is divided into sections that reflect this sequential order, outlining main actions to be taken. Explanatory notes follow, providing guidance to elaborate on these key actions. A self-assessment guiding tool accompanies the framework.

The framework highlights the strong interconnections between risk assessment, risk reduction and financial management, key building blocks for dynamic and continually evolving DRM strategies. It also emphasises the key role of data: data and information on hazards, exposures and vulnerabilities and losses are needed for identifying risks, reducing them over time and ensuring preparedness.

The framework does not present a specific methodology as such but is rather intended to serve as a strategic reference point for the elaboration of specific country approaches and methodologies. These activities can be complex, difficult and resource-intensive, requiring pragmatic approaches and strategies that recognise financial constraints and the inherent unpredictability of disasters.

The framework complements and reinforces existing international overall frameworks, such as the OECD's *Good Practices for Mitigating and Financing Catastrophic Risks,* the United Nations' *Hyogo Framework for Action* and the World Bank's *Five-Pillar Disaster Management Framework*. While this framework is addressed primarily to governments, the actions needed to implement it will promote more widespread risk assessment and risk financing activities within the economy and society, and enhance awareness of disaster risk amongst communities, businesses, and individuals.

Figure 1: Methodological framework

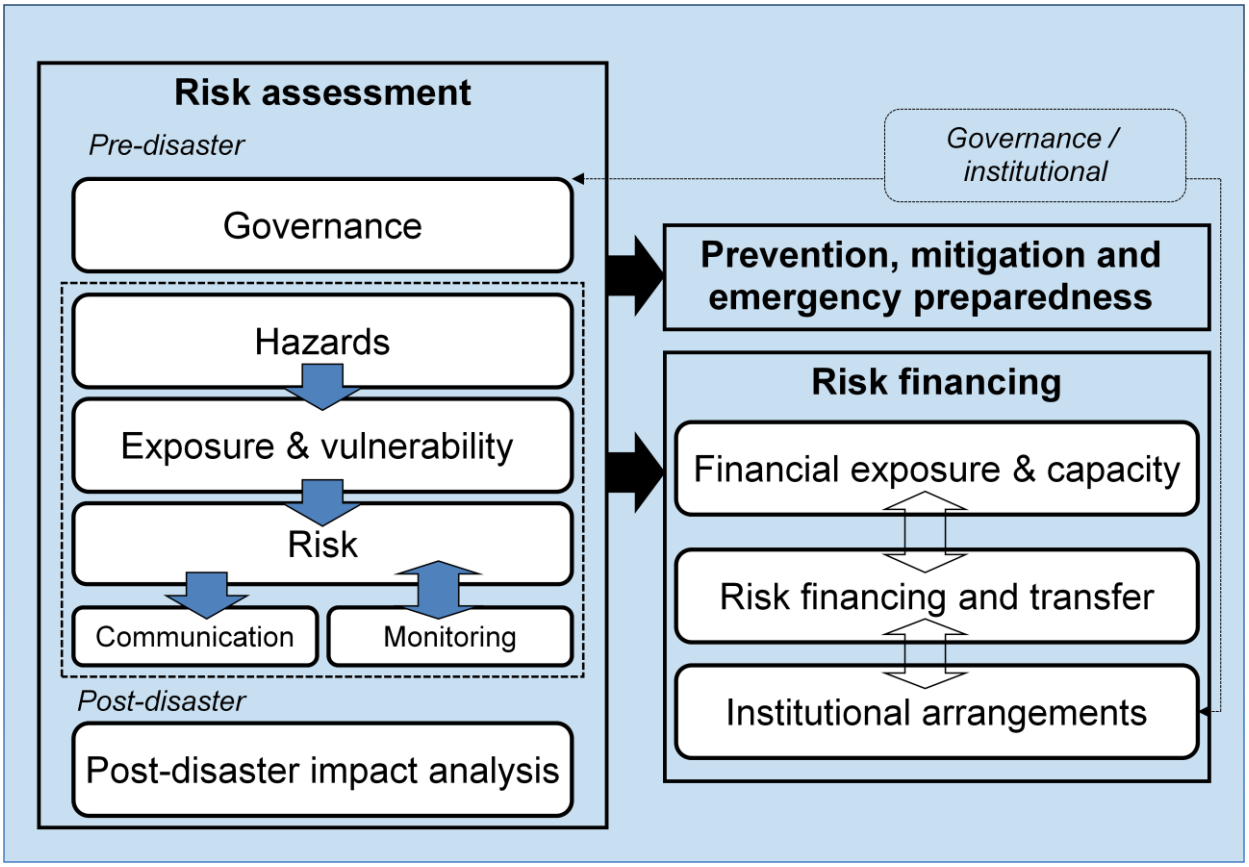
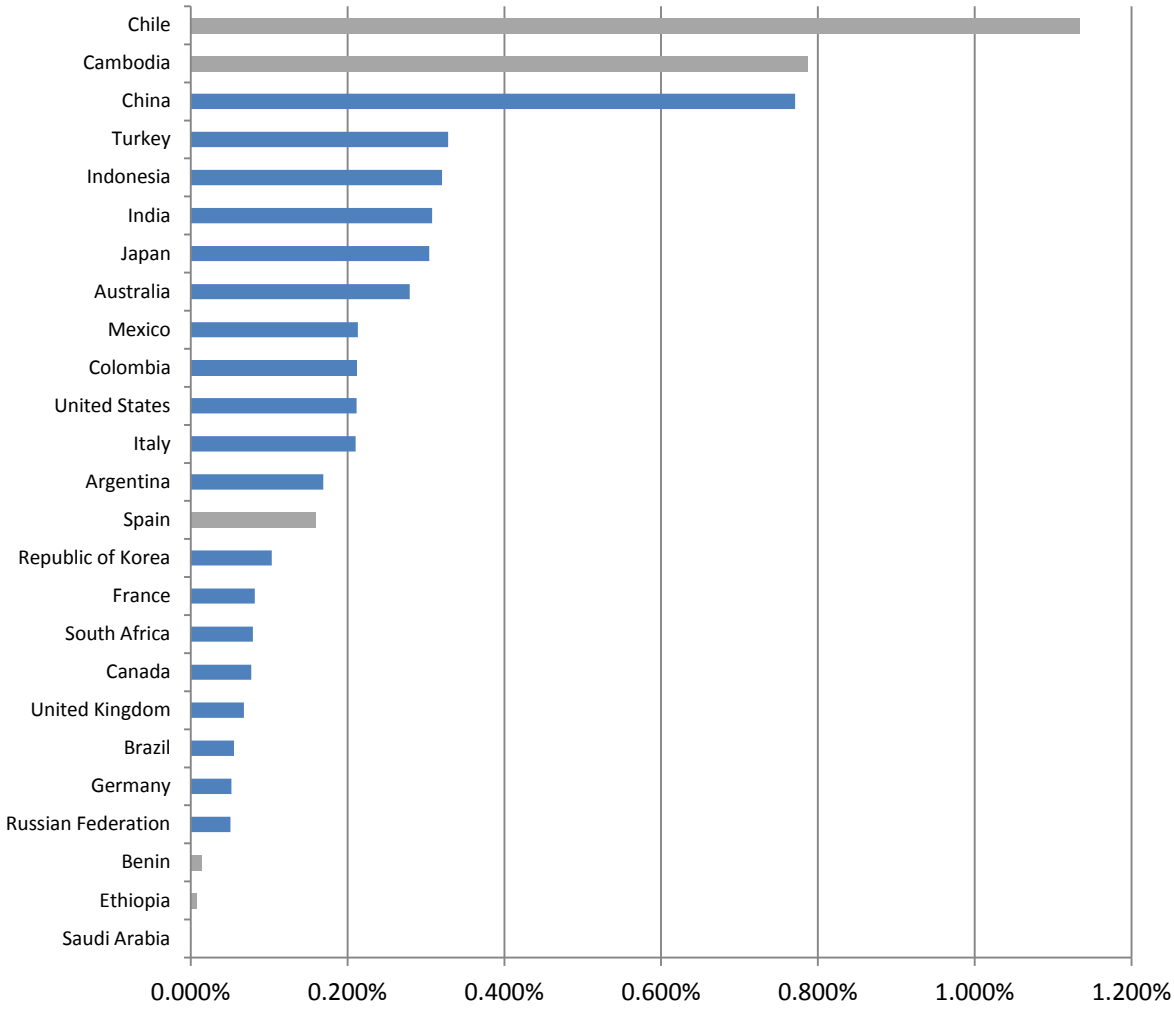


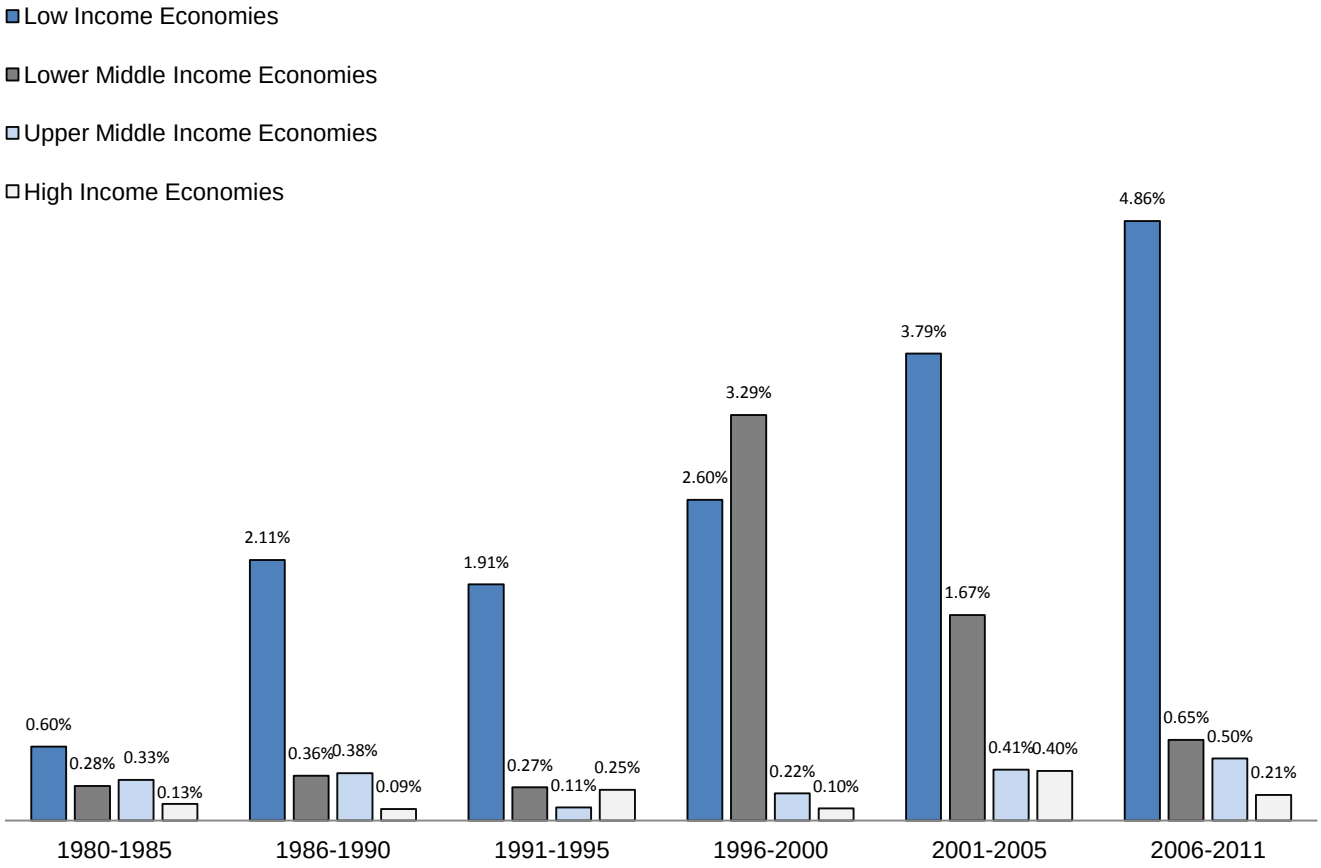
Figure 2: Disaster losses in G20 + selected countries as % GDP, average 1980-2011



Notes:

1. Includes G20 countries (blue) and invited countries (grey) for 2012 (Benin, Chile, Cambodia, Ethiopia, Spain).
2. Russian Federation: Data for period 1989-2011.
3. Cambodia: Data for 1993 - 2011. Disaster damages for Cambodia for 1991 not included (USD$150 million). GDP for 1991 not available.
4. Calculations based on data obtained from EM-DAT: The OFDA/CRED International Disaster Database and GDP data from World Bank. Percentage based on yearly values in constant dollars. Data by year for disasters includes: drought; earthquake (seismic activity); extreme temperature; flood; mass movement dry; mass movement wet; storm; volcano and wildfire.

**Figure 3: Disaster losses as % GDP,
By income groups, average 1980-2011**



1. World Bank income categories based on GDP per capita.
2. Calculations based on data obtained from EM-DAT/CRED, concern direct physical losses only, and GDP data from World Bank. Percentage based on yearly values in constant dollars (2012).
3. Data by year for disasters includes: drought; earthquake (seismic activity); extreme temperature; flood; mass movement dry; mass movement wet; storm; volcano and wildfire.
4. Countries without any data on disaster damages or GDP for the period 1980-2011 were excluded.
5. For each period, countries were included only if both GDP and data for direct disaster losses were available.

SECTION I – RISK ASSESSMENT

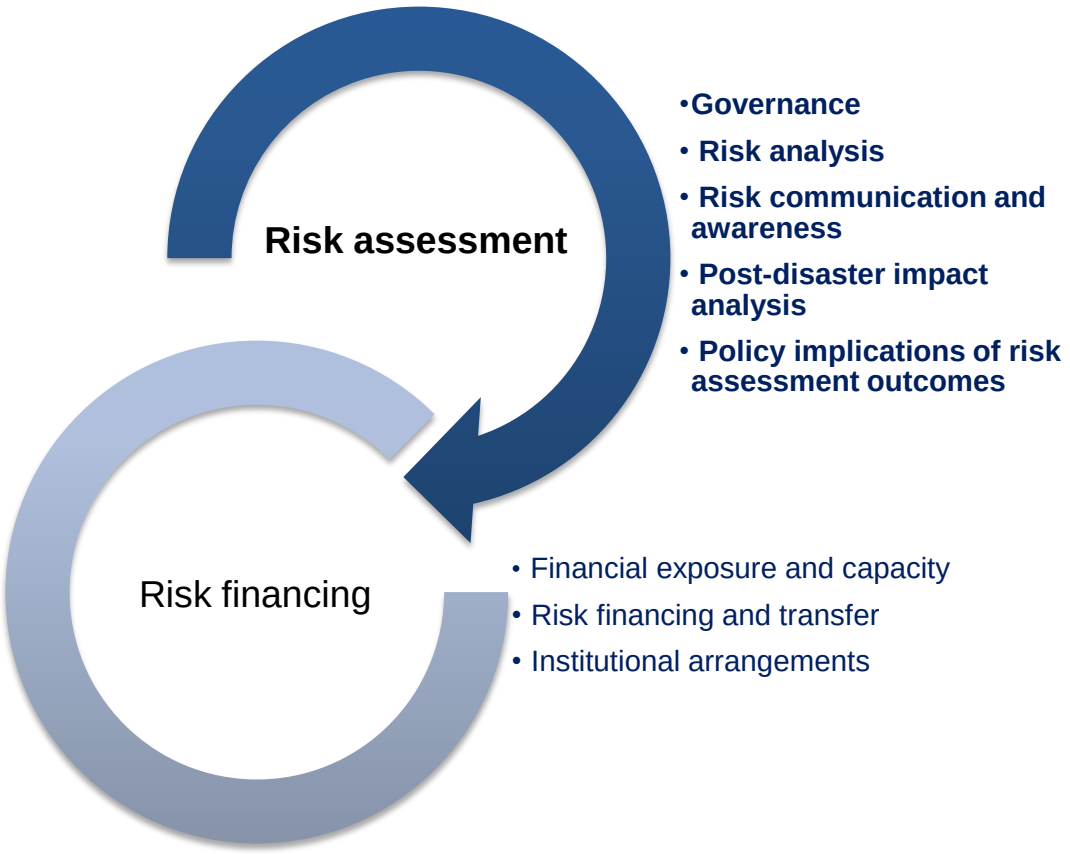
Risk assessment guides the optimal allocation of scarce resources available to the phases of disaster risk management (DRM). By identifying and assessing the likelihood and consequences of potentially disastrous events, risk assessment provides governments with the basis for the prioritisation of investments in disaster risk reduction, the improvement of emergency management capabilities and the design of financial protection strategies in a manner tailored to local conditions, needs and preferences. The results may be used also to inform and educate all relevant stakeholders about the most important threats society faces and thereby contribute to a culture of risk amongst communities and individuals. Risk assessment is thus an essential prerequisite for the full array of DRM plans and policies that contribute to overarching governmental objectives of reducing society's vulnerability and enhancing its resilience.

Countries need to identify the broad range of natural and man-made hazardous events and assess those that could cause significant damage and disruption to their vital interests. A holistic approach is important to uncover complex risks arising from vulnerabilities and interdependencies across sectors. To capture all hazards, a whole-of-government approach, involving all relevant government agencies and ministries, helps to assess the full spectrum of risks, and identify gaps in risk ownership and preparedness. This continual process benefits from being documented, monitored and regularly re-evaluated over time.

A comprehensive risk assessment considers the full range of potential disaster events and their underlying drivers and uncertainties. It can proceed from retrospective data and interpret the relevance of historical events as well as incorporate forward-looking perspectives, integrating the anticipated impacts of phenomena that are altering historical trends, such as climate change. In addition, it may consider remote events that lie outside projections but which could conceivably occur. This requires the aggregation of assorted information and interdisciplinary findings, along with scenario building and simulations, which can be supplemented by expertise from a wide range of disciplines and countries. Data repositories on hazards, exposures, vulnerabilities and losses enhance the accuracy of risk assessment, contributing to more effective measures to prevent, prepare for and financially manage disasters.

In addition to deterministic approaches that can be used to assess disaster impacts of a given hazard scenario, probabilistic methods can be employed to obtain more refined estimates of hazard frequencies and damages. The process is characterised by inherent uncertainties, partly related to the intrinsic randomness of hazards, and partly resulting from incomplete understanding and measurement of the phenomena under consideration.

When performed at the national level, risk assessment culminates in a defined risk analysis, which may be presented to the highest political levels to give the right impetus for risk treatment. Countries may leverage the analysis, underlying data and relevant information about exposures and vulnerability to optimise their financial strategy for addressing contingent liabilities generated by disasters.


Risk assessment
•Governance
• Risk analysis
• Risk communication and awareness
• Post-disaster impact analysis
• Policy implications of risk assessment outcomes
Risk financing
• Financial exposure and capacity
• Risk financing and transfer
• Institutional arrangements

1. GOVERNANCE

Scope, objectives, definitions and methodology

- Adopt a comprehensive, all-hazards approach to disaster risk assessment
- Define and communicate objectives
- Agree on definitions of core terms and methodology

Transparency and accountability

- Promote transparency of the methodology used for risk assessment
- Disclose sources of data, information and expert opinion
- Establish reporting mechanisms, both internal and external, and accountability

Multi-level governance, multi-actor participation

- Identify and involve key groups of stakeholders in risk assessment
- Assign a lead national government authority to coordinate a national risk assessment, ensure adequate coordination among ministries and consultation mechanisms, and interface with relevant, sub-national bodies, local centres of scientific research, operators of critical infrastructure and supra-national institutions
- Clearly identify authorities at sub-national levels of government responsible for conducting local risk assessments and establish a process for coordination with the co-ordinator of the national risk assessment
- Ensure adequate institutional capacity to support training programmes in the use of risk assessment methodology, and provide adequate resources to ensure an up-to-date and forward-looking risk assessment process

a) Scope, objectives, definitions and methodology

Scope

Disaster risk assessment is best able to capture the full range of losses if it adopts a comprehensive, all-hazards approach, i.e. covering all types of major hazards or threats, whether natural or man-made (e.g., industrial accidents and terrorist attacks). An all-hazards approach permits an integrated assessment of a country's portfolio of risks, be they sudden or gradual in onset. It facilitates the identification of commonalities and interlinkages between natural phenomena and man-made events, the possible sequencing of hazardous events and follow-on impacts across borders. Events such as disruptions to trans-boundary infrastructures and suppliers of critical goods and services, or failing institutions, may themselves trigger new hazards and multiply exposures. An all-hazards approach can facilitate the development of a comprehensive financial strategy for disasters that considers the full portfolio of risks.

Objectives

Risk assessments are conducted for various purposes in the disaster risk management cycle, for instance to develop risk maps for land-use and urban development, guide structural risk reduction, develop financial strategies to support disaster response, recovery and reconstruction, prioritise

capabilities-based contingency planning, and draw-up evacuation plans. While risk is inherently difficult to measure, the purpose of risk assessment is to obtain at least orders of magnitude of potential risks in order to achieve these various objectives. The objectives of risk assessment can also vary among countries in terms of the assets they want to protect, for instance: population, public infrastructure, private dwellings, small and medium-sized enterprises, farmers. Such objectives are established before the risk assessment is conducted and clearly communicated to the contributors of data, information and expert opinion, as the intended purpose may determine the type and quality of data required, the most suitable methodology to use and appropriate risk communication tools to be developed.

Definitions and methodology

Substantive differences in terminology across disciplines and policy areas may impede integration of data, comparability of analysis and the usefulness of risk assessment results. Countries can benefit from agreed definitions of central terms, such as "risk", "disaster" and "hazard", to foster co-operation between experts from different disciplines and support the communication of results to decision-makers and stakeholders.

A common understanding of core terminology promotes the development of consistent approaches to disaster risk assessment and thereby facilitates the comparability of outcomes. It also promotes transparency and accountability in risk assessment and DRM strategies more broadly. For example, a specified definition of "disaster" provides clarity for the activation of emergency response, recovery actions and financial resources for reconstruction.

The features of an event that would constitute a "disaster", and thus call for prevention measures, emergency response capabilities planning, and financial management strategies, need to be identified and understood. This initial step distinguishes the many potential sources of harm to society from those relevant to DRM and thereby provides clarity regarding the circumstances when sudden calls for response, recovery and reconstruction funding might occur. Similarly, agreeing at the outset on a methodology or set of methodologies for the risk assessment helps to ensure consistency in procedures and promotes greater comparability of outcomes.

Table 1: The definition of disaster

UN ISDR	Mexico
"A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources."	*"A situation resulting from one or more severely and/ or extremely disruptive events, simultaneous or not, of natural origin or human activity, in which the occurrence in time and a determined geographic area causes damages of such magnitude that it exceeds the response capacity of the affected community."* - General Law on Civil Protection (2012).

b) Transparency and accountability

Transparency

To ensure credible and useful results, it is important that the risk assessment a process incorporates transparency and accountability. Transparency leads to consistency and comparability of results, while accountability reinforces trust in policy outcomes.

While risk assessment is not simplistic, its results should be easy to understand. Transparency can be fostered, where appropriate, by identifying and documenting the sources of data and any limitations, as well as making them accessible. Access to data and information on exposures and vulnerabilities could be used to improve risk mapping, support the development of preparedness plans and reduce the cost of financial risk transfer tools. Disclosure, however, needs to take into account such considerations as cost, privacy, confidentiality, and national security. Public institutions may wish to open access to risk assessment models to facilitate objective review and continuous improvement.

Box 1: Open data initiatives

Sharing data and creating open systems promote transparency and accountability and can ensure a wide range of actors are able to participate in the challenge of building resilience through better informed decisions. Open data initiatives combined with bottom up approaches such as citizen mapping initiatives can be an effective way to build large exposure databases.

The *Community Mapping for Resilience* program in Indonesia is an example of a large-scale exposure data collection system. The main goal is to use OpenStreetMap to collect building level exposure data for risk assessment applications. OpenStreetMap offers several important features: open source tools for online or offline mapping, a platform for uploading and hosting data with free and open access, and an active global community of users. In a little over a year, more than 160,000 individual buildings have been mapped and partners, including five of Indonesia's largest universities, local government agencies, international development have been trained and are using the platform.

Source: Improving the assessment of disaster risks to strengthen financial resilience (World Bank, 2012).

Review of results is facilitated by disclosure of the risk assessment methodology that is used, along with clear definitions, key assumptions, methods and a description of its advantages and disadvantages. Results could be documented and independently evaluated. When expert opinion is relied upon, for example in developing scenario-based approaches to risk assessment, any potential conflicts of interest, and the means for containing bias, need to be disclosed.

Box 2: Importance of objectivity and impartiality in risk assessment

To control for bias and promote reliability of outcomes Canada, the Netherlands and the United Kingdom take such measures to ensure objectivity and to prevent bias in experts or institutions that might otherwise exaggerate risks for which they have ownership or a personal interest at stake. They pay attention to understand the basic assumptions of expert opinions about the impact and likelihood of different risk scenarios. To provide clarity and a basis for review and continuous iteration in the conduct of their national risk assessments they:

i) Agree on the methodology, including definitions, procedures and scoring criteria, at the start of the risk assessment process
ii) Record the methods used and their levels of uncertainty
iii) Note the justification for including or excluding specified hazards
iv) Devise a protocol for the use of expert opinion
v) Record the scores allocated to each risk and their justification
vi) Develop an evaluation or report that summarises results
vii) Communicate results to decision-makers

Accountability

Government reporting mechanisms, both internal and external, and accountability create sound incentives for high-quality risk assessment and promote communication of risks, both internally for government decision-makers as well as externally for stakeholders. These mechanisms form a part of the broader institutional arrangements for DRM, and integrate the data collection from national and sub-national levels of government.

Accountability ensures actions and decisions taken by public officials are subject to oversight so as to guarantee that government initiatives meet their stated objectives and respond to the needs of the community they are meant to be benefiting. Accountability in risk assessment can be fostered by clearly assigning responsibility for the development, implementation and maintenance of the risk assessment process. Accountability is facilitated by oversight requirements and a process for periodic review.

c) Multi-level governance, multi-actor participation

The risk assessment process may involve collecting input from many sources, including those who actually use its results to craft disaster risk management policies, the risk owners responsible for managing impacts and the stakeholders whose lives, assets or resources are exposed to hazards.

Within the DRM institutional architecture it is important to designate a lead national government authority to coordinate risk assessment both across central government ministries and different levels of intervention from sub-national bodies and the private sector. This facilitates the development of an integrated view on the most significant risks facing the country (see Table 2 on National Risk Assessments) and enhances the accountability of the whole DRM system. Responsibilities may include coordinating input from relevant ministries to ensure the best available expertise across policy sectors, and producing and delivering guidelines to ensure consistent and systematic approaches to risk assessment across sub-national levels of government.

Sub-national levels of government can benefit from use of these guidelines in developing local risk registries, which identify hazards and analyze risks at the local level. A process whereby national risk assessments can take into account data and information on risks collected at sub-national levels promotes cohesion between the macro and local views.

Box 3: Community risk registers

Just as national governments are subject to different risks than those in different countries, each region and community has its own risk profile, Under the United Kingdom's Civil Contingencies Act (2004), local authorities are required to carry out and publish local assessments of the risk of non-malicious emergencies in a 'Community Risk Register'.

In the City of London, for example, approximately 60 risk scenarios are identified in the Community Risk Register, each of which is supported with an individual risk assessment. The Risk Register is then used by the London Resilience Partnership as a method of prioritising resilience activities towards those risks judged to have a higher rating. The risks included in the London Community Risk Register represent 'reasonable worst case scenarios' and their inclusion in the register does not mean that they are going to happen, or that if they did that they would be as serious as the descriptions included in the Register. The Reasonable Worst Case scenarios are nationally developed and informed by historical and scientific data, modelling and trend surveillance and professional expert judgment.

Risk assessment at both national and sub-national level would benefit from instituting effective partnerships and regular consultative venues to learn from and take into account views from operators of

critical infrastructure (e.g. energy, transport, information and communication technology networks and finance), the broader private sector including insurers, relevant centres of scientific research and civil society. Collaborations with academia, non-profit institutions, the insurance sector and other relevant organisations may help in generating useful, detailed information on hazards, exposures and vulnerabilities.

Box 4: Leveraging scientific collaborations – The Natural Hazards Partnership

In the United Kingdom, the Natural Hazards Partnership (NHP) provides information, research and analysis on natural hazards for the development of more effective policies, communications and services for civil contingencies, governments and the responder community across the UK. It focuses on natural hazards that disrupt the normal activities of UK communities or damage the UK's environmental services. The NHP also provides the international community with a model for cross-government hazard management based on a platform of world-class environmental sciences.

The NHP brings together expertise from across leading public sector agencies including: Environment Agency, Flood Forecasting Centre, Health Protection Agency, Health & Safety Laboratory, Met Office, Natural Environment Research Council, British Geological Survey, Centre for Ecology and Hydrology, National Centre for Atmospheric Science, National Oceanography Centre, Ordnance Survey, Scottish Environment Protection Agency, and the UK Space Agency.

The NHP also contributes towards the Hazard Impact Model (HIM), which combines data and expertise from partners to identify areas and assets which are most vulnerable to a particular hazard. This is currently in a research phase but it is hoped that this will help to prioritise where to deploy 'responder' services, as well as identifying when and where to issue hazard alert warnings.

The NHP also contributes to the National Risk Assessment (NRA) process by providing recommendations on: scientific overview for natural hazards and advising on any new risks that may need inclusion, supplementing current advice on scenarios for existing risks identifying NRA risks that could be linked and could occur concurrently.

Adequate resources and expertise are required to ensure an ongoing and well-developed risk assessment process at the national and sub-national levels. Ensuring adequate institutional capacity to this end may require support for training programmes in the use of risk assessment methodology, the development of information and knowledge management systems and the documentation of processes and procedures to ensure risk assessments are modified and improved in light of lessons learned from ongoing experiences.

Table 2: Compendium of National Risk Assessments						
Country	**National Risk Assessment?**	**All hazards approach?**	**Whole-of-government approach?**	**Lead Department?**	**Time horizon of events included?**	**Used for capabilities based planning?**
Australia*	Risk assessments are performed at a State level	Natural, biological, technological, industrial + other human phenomena	No info	---	---	Yes
Canada	Yes	All: natural, technological accidents, manmade, health	Yes	Public Safety Canada	5 years	Yes
China*	Yes	Natural hazards (Earthquake, Tropical Cyclones, Flood, Drought, Landslide, Sandstorm, Storm Surge, Hail, Snow, Low Temperature, Forest Fire and Grass Fire)	A national natural disaster risk atlas entitled "Atlas of Natural Disaster Risk on China" was released in 2011. This document maps risks of all natural disasters with the formula "R= H*V*E" (H: Hazard, V: Vulnerability, E: Exposure of population, buildings, crops, assets and so on) at national and provincial levels. The atlas was completed by Beijing Normal University, National Disaster Reduction Centre of China affiliated to MoCA (Ministry of Civil Affairs), Institute of Geography Science and Natural Resource Research CAS (Chinese Academy of Sciences), Peking University etc.			Yes
France	Under development.	All: Natural hazards, manmade, industrial accidents	Yes	General Secretariat for Defence and National Security	5 years	Yes
Germany*	Yes	All: Natural, manmade, industrial	---	Ministry of the Interior	---	---
Hungary	Yes	Natural, industrial accidents, migration	Yes	Ministry of the Interior	3 years	Yes
Mexico*	Yes	Natural hazards, industrial accidents	R-FONDEN is a software-based tool used to estimate potential material and human losses that may occur for earthquake, flood or tropical cyclone events. Losses are estimated for a data base containing geo-coded information on the main federal public infrastructure assets: hospitals, schools, hydraulic and			No, it is used to generate essential elements for the design of financial risk

			energy infrastructure, roads and bridges, public buildings, among others. The information on assets includes structural characteristics and replacement values (see text Box 9 in Section 2 of Framework).			transfer instruments.
The Netherlands	Yes	All: Natural, manmade, industrial accidents, and other potential risks to national security	Yes	Ministry of Security and Justice	5 years	Yes
New Zealand*	Yes	Natural, manmade	---	National Assessments Bureau, PM and Cabinet	---	---
Norway	Yes	All: Natural, manmade, industrial accidents, ICT, infrastructure	No, conducted at agency level	Ministry of Justice (CEP coordinator)	6+ years	No
Switzerland	Yes	All: Natural, manmade, industrial	No	Department of Defence	1 year	No
Sweden	Will have one in 2013	All: Natural, manmade, industrial	Yes	Ministry of Defence, Swedish Civil Contingencies Agency	5+ years	No
Turkey	To be developed within next two years.	All: Natural, man-made, industrial	---	Disaster and Emergency Management Presidency and Ministry of Environment and Urban Planning	---	Yes
United Kingdom*	Yes	All: Natural, manmade, industrial	Yes	Cabinet Office	5 years	Yes
United States	Yes	All: Natural, manmade, industrial	Yes	Department of Homeland Security	3-5 years	Yes

Source: Country responses to OECD High Level Risk Forum question sheet on National Risk Assessments (December 2011), unless indicated by *.

Table 3: Hazard scenarios: parameters and central questions	
A hazard scenario describes the event clearly and in sufficient detail in order to provide a precise and consistent basis for the assessment of an event's likelihood and impact. It should include a description of the type, spatial dimension, intensity and duration of the expected event.	
PARAMETER	**CENTRAL QUESTIONS**
Hazard	What type of hazardous incident is considered, i.e. (the nature and scale) one or more inter-related events that have consequences for public safety and security? What are the effects of the incident on the continuity of critical infrastructure?
Scene of occurrence	Where does the event take place?
Spatial Dimension	What area is affected by the event?
Intensity	How strong is the event?
Time	When does the even take place? (time of year/time of day, if applicable)
Duration	How long do the event and its direct impact last?
Development	What is the lead-up to the incident? What is the underlying cause and the trigger, which actually creates the incident? How does the event unfold over time?
Notice time for warning	Is the event expected? Is the population able to prepare for the event? Are public authorities able to prepare for the event?
Who and what is affected?	What segment of the population and what assets are affected by the event? (Public assets, vulnerable populations, environmental resources, etc.)
Reference incidents	Have there been comparable events in the past?
Further information	How well prepared are the responsible authorities/ response units/ relief organisations? Findings on damage susceptibility and/or robustness of the affected persons/elements.

2. RISK ANALYSIS

Hazard identification and analysis

- Identify and analyse the characteristics of events ("hazards") that could have a significant, adverse or disruptive impact on the population, assets, and economy
- Generate a range of hazard scenarios and determine the likelihood of selected hazard events
- Collect and disseminate data on hazards in standardised formats and promote consistency and interoperability of national, sub-national, regional and global hazard databases

Vulnerability and impact analysis

- Identify exposed populations, assets and activities, and characterise the nature of these exposures, including physical, social, economic, and environmental
- Identify and analyse the factors that render exposed populations, assets, and activities susceptible to damage
- Estimate, if possible, the potential impacts from hazards, including physical, human, financial and economic, social, and environmental
- Establish location-based inventories of exposed populations and assets and of the infrastructures that reduce exposure and vulnerability

Risk evaluation

- Based on hazard, exposure and vulnerability analyses, evaluate risk
- Document outcomes and assess the level of uncertainty

Risk monitoring and re-evaluation

- Monitor hazards and threats over time, observe and project changes to evolving exposures and vulnerabilities, and update necessary data
- Update risk assessment periodically including identifying improvements in risk assessment governance and data quality
- Identify emerging risks and future potential risks over the longer term

a) Hazard identification and analysis

Scan the environment

The risk assessment begins with the identification of natural phenomena, accidental or deliberate man-made events ("hazards") that could have a significant, adverse impact on society. While countries are generally aware of the major hazards in their environment based on historical experience, collaborations with local academics and (re)insurers can provide detailed information about spatial occurrence, frequency, and magnitude.

The judgement of the "significance" of an event will vary among countries, due to different conditions such as the severity of hazardous phenomena, level of economic development and social preferences. Establishing clear threshold criteria will help to promote consistency in the assessment of different types of hazards. For example, a country could deem an event significant if its impacts compromise any one or a combination of its vital interests, such as: territorial integrity, physical safety, economic security, ecological security, social and political stability.

Box 5: Is the risk imminent enough to be worth assessing?

Due to the numerous types of risks that confront countries, and the infinite potential risk scenarios, the decision must be made what risks are prima facie important enough to assess. Countries may establish a clear time horizon beyond which a risk scenario is not considered. For example, the event in question might occur within 1 year, 5, 10, 15, 20 years or more. If it has a sufficiently low likelihood of occurring within the next five years investment in emergency response capabilities might not be justified in the immediate term. This process helps to prioritise the types of risk scenarios for which investments are needed now in prevention, mitigation or emergency response capabilities to reduce or manage disaster impacts. Different time horizons may be used based on the type of risk assessment performed.

Beginning with the hazard identification phase, risk assessment may benefit from integrating a wide range of disciplines and perspectives to ensure a rich understanding and evaluation of risks, and their tendency to change over time. Different types of expertise are relevant, such as the natural sciences, economics, geography, finance, sociology and other disciplines. Expertise may be usefully drawn from different sources, such as government services, academia, industry, civil society and research institutes, and when there are gaps in the national expertise, opportunities for knowledge sharing can be found in the international community.

Characterise identified hazardous events

Hazards can be described, e.g., in terms of physical phenomenon, probability/frequency, location/path, intensity/scale, and duration. The description of their likelihood of occurrence within defined geographic parameters/locations may entail the development and use of probabilistic approaches and/or deterministic scenarios.

The immediate causes and sources of hazards need to be identified, whether they originate on the national territory or from abroad, as well as any interlinkages (e.g. earthquake leading to a tsunami) or external drivers (e.g., climate change, deforestation, suburban development) that could affect exposure, vulnerability, or possibly the hazard itself. Identifying risks arising from interconnections or interlinkages may present complexities, which have to be acknowledged when conducting risk assessment.

The expression of likelihood as a variable to determine risk needs to reflect the type of hazard, the information available and the purpose for which the risk assessment output is to be used. For instance, a return period can be formulated for many hazards as the average length of time in years for an event of given magnitude to be equalled or exceeded. A 7.0 Mw earthquake with a 100 year return period at a given location means that an earthquake of 7.0 Mw, or greater, should occur at that location on the average only once every 100 years.

For events associated with extreme randomness, such as terrorist attacks, a return period cannot be formulated, but information on such elements as intent and opportunity, economic and social trends and threat analyses can help to determine plausibility.

Table 4: Description of likelihood

Type of event	*Example*	*Occurrence measure*	*Determination*	*Source of information*
Hazard	Earthquake, flood	Probability	Return period	Government agencies, research institutes, reinsurers
Threat	Terrorist attack	Plausibility	Intent, opportunity, economic or social trends	Intelligence services

In cases where the occurrence and severity of hazards is more quantifiable, generating hazard information may involve modelling potential extreme events according to physical models of processes such as earthquake generation or the behaviour of hurricanes or precipitation, as for instance derived from extreme event simulations in global circulation climate models. However, when data about the occurrence and severity of significant hazards are limited, a probabilistic assessment may be extremely difficult to perform. The use of risk scenarios is an alternative in which a plausible event leading to significant impacts is selected as an informative example.

Scenario building is mainly based on experiences from the past, but can also consider events and impacts that have not yet occurred in order to take into account the potential full range of hazard events and the long-term trends that may not yet be fully captured in the historical evidence (see Figure 2). For instance, the Great East Japan Earthquake was caused by the interlocking of several epicentral areas in the Japan Trench -- a type of earthquake that could not be found in the historical record of Japan stretching back several hundred years. It is important that scenarios be based on a coherent and internally consistent set of assumptions about key relationships and driving forces. For risk assessments on a high level of aggregation, such as national risk assessments, a fundamental issue is the selection of scenarios, as this will determine how useful the risk assessment will be to depict reality. National risk assessments have attempted to deal with the selection issue by making reference to some standard, such as a "reasonable worst case" or other similar benchmarks.

In practice, risk scenarios are often built with reference to certain levels of impacts. These levels are also referred to as protection levels and can be defined, e.g., in terms of (prevented) casualties. Other terms of reference may include the probability of a certain hazard exceeding a certain threshold level and this suddenly boosting the impacts, e.g., the breaking of a dyke, or wind stress exceeding certain design standards. The definition of a scenario is made explicit so that scenarios can be reviewed and updated.

Guidelines are useful to define a minimum common understanding for the selection of scenarios and for probabilistic risk assessments, where feasible and appropriate. Generally, risk scenarios will be used both in the hazard identification phase as well as in the subsequent vulnerability analysis, which aims to estimate impacts. At the stage of hazard assessment, scenario building is to be devised in the most inclusive way and may refer to rough estimates or qualitative analysis. At the stage of risk analysis it is important to estimate quantitative probabilities for each scenario if possible.

Collect and disseminate data on hazards

The collection and dissemination of data on hazard events and their characteristics is fundamental to hazard analysis. Data collection on hazards may begin as part of the horizon scanning effort but will deepen as the risk assessment proceeds. The extent to which data is required or useful depends on the objectives of risk assessment, as well as on the resources and expertise available to use and interpret the data; orders of magnitude may be adequate for analysis.

National meteorological, seismological, and hydrological agencies are, in the case of natural hazards, central to data collection and reporting, which requires the installation of hazard monitoring equipment and recording systems that can capture the parameters of hazard events. Historical archives may also provide information on more infrequent, but higher impact, events that took place in the past but which could recur.

The collection and dissemination of data on hazards and their characteristics in standardised formats will help to promote consistency and interoperability of national, sub-national, regional and global hazard databases, and thus deepen the pool of data available for hazard analysis (see Table 5 for selected regional and global hazard databases). Care should be exercised so that valuable hazard information is not lost in the process.

The completeness, consistency, reliability, and granularity of hazard data influence the availability and cost of risk financing and risk transfer instruments. Insurance markets require good quality data on hazards in order to underwrite hazard-related risks. Capital-market instruments have evolved whose payouts are triggered by the physical parameters of hazard events exceeding pre-specified thresholds in defined geographical areas, making the extensiveness and quality of hazard data, as well as the governance and independence of the data collection and dissemination process itself, critical.

b) Vulnerability and impact analysis

Vulnerability describes the susceptibility of exposed elements to injury or damage due to hazardous events. The concept incorporates the notions of exposure, resistance and resilience. Exposure refers to the concurrence in time and space of a person or asset to a hazard. Resistance refers to the ability of an exposed person or asset to withstand a physical impact through internal forces or structures, and thus resist or avoid fatality, injury, or damage. Resilience is the capacity of a person, asset, resource or community to adapt to disturbances resulting from hazards by persevering, recuperating or changing to reach and maintain an acceptable level of functioning.

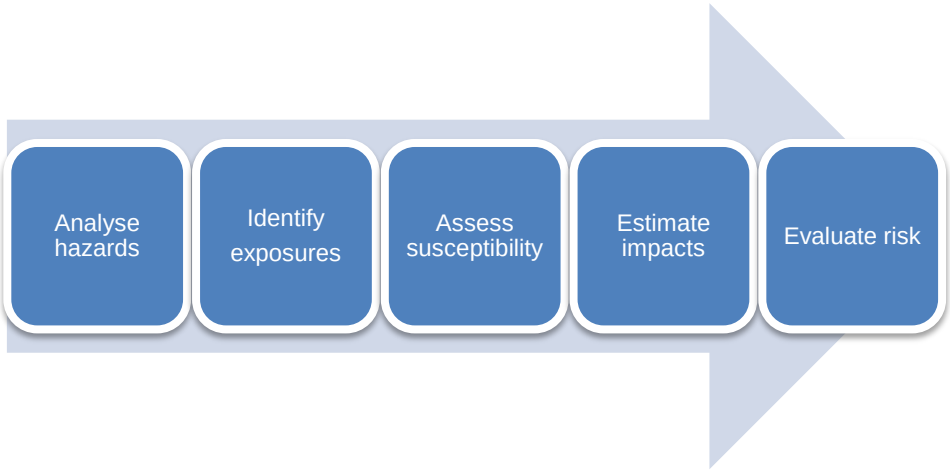
Table 5: Regional and global databases on hazards

(including national databases if they are global in scope)

Initiative	Institution	Type of hazard(s)	Description	Geographic scope	Status	Availability
National Earthquake Information Center	United States Geologic Survey (USGC)	Earthquake	Global database of earthquakes from 1973 – present, providing latitude/longitude, depth, magnitude and event date. http://earthquake.usgs.gov/regional/neic/	Global	Active	Open
Earthquake Hazards Program	US Geological Survey (USGS)	Multi-hazard (earthquake, volcano, landslide)	Provides relevant scientific information and data on natural hazards.	Local (USA)	Active	Open
Committee for the Advancement of Strong Motion Programs (CASMP)	Consortium of Organizations for Strong-Motion Observation Systems (COSMOS)	Earthquake	Acquisition, processing, dissemination, and application of the earthquake strong-motion data.	Global	Active	Open
Prompt Assessment of Global Earthquakes for Response	United States Geologic Survey	Earthquakes	In addition to the information provided by the NEIC, the PAGER catalog also provides fatality and economic loss impact estimates following significant earthquakes worldwide http://earthquake.usgs.gov/earthquakes/pager/	Global	Active	Open
EMSC Catalog	European-Mediterranean Seismological Centre	Earthquakes	Global database of earthquakes from 2004 – present, providing latitude/longitude, depth, magnitude and event date. The EMSC catalog also includes witness descriptions and photographs. http://www.emsc-csem.org/	Global	Active	Open
Global Earthquake Model (GEM)	Gem Foundation (GEM)	Earthquake	Provides seismological data relevant to seismic hazard. (Global instrumental earthquake catalog; Global active faults and seismic sources).	Global	Active	Open
PERILS	Perils AG	European windstorm and UK flood	European database of insured losses from European windstorm and UK flood events. Exposure information for the continent also available at CRESTA level http://www.perils.org/web.html	Europe	Active	Requires subscription

International Best Track Archive for Climate Stewardship	National Oceanic and Atmospheric Administration	Tropical cyclone	Global "best track" data for tropical cyclones. Provides latitude/longitude, central pressure (where available) and maximum sustained 10 minute wind speed for all TCs. The dataset begins in 1842 and completion varies across basins and years. Global dataset is near complete post-1945. http://www.ncdc.noaa.gov/oa/ibtracs/index.php	Global	Active	Open
NOAA/WDC Tsunami Event Database	National Oceanic and Atmospheric Administration	Tsunami	Global database of all tsunamis from 2000 – present, providing wave source, run-up, height and date. The data is available by geographic region http://www.ngdc.noaa.gov/hazard/tsu.shtml	Global	Active	Open
Flood Maps	Dartmouth Flood Observatory	Flood	Global database of all floods from 1985 – present. Location, event characteristics and losses (economic and population) available http://floodobservatory.colorado.edu/	Global	Active	Open
NatCatSERVICE	Munich Re	All kinds of natural hazards	Database documents all loss relevant events (description of event, economic and insured losses, fatalities, injured, homeless) since 1980, more than 30,000 events in database, classification of events in respect to intensity	Global	Active	For research, political authorities and other non commercial organisations information accessible

Figure 4 Steps in risk analysis



Identify exposures

Populations, assets or environmental resources that are exposed to hazards and consequently susceptible to death, injury or damage need to be identified. The nature of these exposures, be they physical, social, economic, environmental, can be assessed, and their magnitude or importance measured and, if possible, quantified.

Assess susceptibility to damage

The factors, processes, and conditions that create vulnerability are to be identified and analysed, together with the nature and extent of these vulnerabilities, which can be classified along a number of dimensions, including:

- **Physical** – the quality and strength of buildings and infrastructure, and the quality and strength of prevention infrastructure (e.g., housing stock, flood defences).
- **Human and social** – the health and social fabric of a population, including physical health, literacy and education, health infrastructure, peace and security, social equity and social solidarity.
- **Economic and financial** – the economic fabric, such as wealth, capital stock, income, productivity, level of financial protection (e.g., insurance) and income equality.
- **Environmental** – the quality and diversity of the natural resources (such as biodiversity, water, soil, air) and availability of natural resource service, e.g., clean air, soil, water, access to water and food.
- **Institutional** – the quality of governance and decision-making arrangements (e.g., collective decision-making capacities, responsiveness, transparency), knowledge base, etc.

Weaknesses along these dimensions, such as quality of housing stock, outdated or otherwise inappropriate building standards, illiteracy, poor access to health care, lack of savings and soil

degradation, provide conditions or factors accounting for vulnerability. The quality of housing stock in particular transcends several susceptibility factors and is a key variable in the ability of a community to withstand or quickly recover from a disaster; in some countries. In some countries, for instance the United States, the quality of housing bears a strong inverse relationship with the amount of financial transfers. The relevance of each dimension will depend on the nature of the hazard and exposures. Likewise, self-protection capabilities and coping capacities that can limit exposure at the outset, mitigate impacts and/or enable recovery, such as early warning systems, emergency response capacity and financial tools (e.g., insurance), are relevant in analysing vulnerability.

Indicators of vulnerability may be used as a tool to measure vulnerability. For example, the Inter-American Development Bank has developed a Prevalent Vulnerability Index that estimates predominant vulnerability conditions by providing a measure of direct as well as indirect and intangible impacts of hazard events. The index is a composite indicator that provides a comparative measure of a country's vulnerability pattern or situation.

Table 6 - Prevalent Vulnerability Index

Exposure in prone areas	*Socioeconomic fragility*	*Lack of social resilience*
Population growth, average annual rate (%)	Human Poverty Index, HPI-1	Human Development Index, HDI
Urban growth, average annual rate (%)	Dependents as proportion of working age population	Gender-related Development Index, GDI
Population density, people/5 Km2	Inequality as measured by the Gini coefficient.	Social expenditures on pensions, health and education, % of GDP
Poverty-population living on less than US$ 1 per day PPP	Unemployment, as % of the total labour force	Governance Index (Kaufmann)
Capital stock in millions US$ dollar/1000 km2	Annual increase in food prices %	Infrastructure and housing insurance, % of GDP
Imports and exports of goods and services, % GDP	Share of agriculture in total GDP growth (annual %)	Television sets per 1000 people
Gross domestic fixed investment, % of GDP	Debt service burden as a % of GDP	Hospital beds per 1000 people
Arable land and permanent crops, % land area	Soil degradation resulting from human activities (GLASOD)	Environmental Sustainability Index

It is important to identify and assess the trends and possible underlying factors influencing vulnerability, for instance economic development, urbanisation and migration, technological change, and environmental and climate change. Similarly, society's capacity to respond to these longer-term trends through appropriate policy and regulatory responses and self-protection capabilities and coping capacities need to be evaluated.

Describe and estimate impacts to exposed population and assets

The degree of vulnerability can be evaluated by assessing the potential impacts of hazardous events. The quantification of impacts can support this evaluation, provided the hazard is amenable to reliable measurement and the objectives of the risk assessment would best be served by such an approach. Quantification permits a more precise and comprehensive understanding of the range of potential damages and losses that might arise from a hazard within a selected time horizon, allowing for the calculation of a risk metric such as "expected annual loss" or "probable maximum loss", useful for risk

financing purposes. If the objective of country risk assessment is to consider the use of risk financing or risk transfer instruments, then a quantitative approach is necessary. It is also desirable for other purposes, such as evaluating the costs and benefits of risk reduction measures. However, qualitative approaches may be suitable and adequate for government-led country risk assessments, given that the objective of such assessments may be to obtain orders of magnitude of potential risks as opposed to precise risk quantification and since less quantifiable dimensions of vulnerability (e.g., human, social, environmental and institutional) need to be considered in these assessments.

Describing the impacts of disasters pays due attention to such factors as:

- the expected sequence or chain of events that may ensue from a hazard event or set of events (i.e., the "disaster chain")
- possible amplifiers, i.e., factors, processes, or systems that can accelerate, intensify, or spread destructive impacts such as critical infrastructures and key central services (e.g., energy, fuel, transport, money supply)
- possible interdependencies and spillovers, for instance due to damaged networks or infrastructure or environmental damage
- possible stress or "tipping" points
- the expected duration of events
- the distribution of impacts across the population and economy, including by major segments such as government, households, the financial sector and corporate sector (with relevant breakdowns such as critical industries), and their nature and scale

The impacts of disasters can be direct or indirect. Direct impacts refer to stock effects, namely injury or damage to the population, buildings, infrastructure, natural resources and services, and other assets or the reduction of population through international migration. Indirect impacts refer to flow effects arising from the destruction or reduction of stock, namely impairment of activity or functioning due to injury or damage to people and assets or migration. Direct impacts are more easily quantifiable for physical assets, such as damage to property and infrastructure, whereas direct human impacts and indirect impacts generally are less easily quantifiable.

Physical and human impacts can be measured by quantifying physical harm to populations and damage to assets and determining the number and extent of injuries and illnesses and number of displaced persons and fatalities. Economic and financial impacts are obtained by measuring the costs attributable to damaged, injured or, as the case may be, displaced, populations, assets, and environmental resources and impaired activity of economic agents. This will lead to an estimate of financial loss. Economic loss considers the net costs attributable to economy-wide damage and impairments, taking into account the potential benefits that might flow from disasters, such as reconstruction. Insured loss is a subset of financial loss and can be used to assess the extent to which financial losses might be mitigated, thus lowering a key vulnerability.

Quantification of impacts given varying levels of hazard severity can be obtained on the basis of historical data, scenarios, and modelling. When historical or comparable information is available, efforts need to be made to cite and document the source. For physical property and infrastructure, quantification requires an assessment of the physical damage that might result from hazards given the degree of hazard severity, the nature of exposed assets, such as location, condition and quality of construction, and the extent of exposures.

Box 6: Hazards: United States (Hazus)

HAZUS is a nationally applicable standardised methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. It graphically illustrates the limits of identified high-risk locations due to earthquake, hurricane, and floods. Users can then visualise the spatial relationships between populations and other more permanently fixed geographic assets or resources for the specific hazard being modelled, a crucial function in the pre-disaster planning process.

Hazus can be used in the assessment step in the mitigation planning process (as well as preparedness and response). This phase is the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. Government planners, GIS specialists, and emergency managers use Hazus to determine losses and the most beneficial mitigation approaches to take to minimise them.

Hazus is being used by states and communities in support of risk assessments perform economic loss scenarios for certain natural hazards and rapid needs assessments during hurricane response. Other communities are using Hazus to increase hazard awareness. Successful uses of Hazus are profiled under Mitigation and Recovery and Preparedness and Response. Emergency managers have also found these map templates helpful to support rapid impact assessment and disaster response.

Based on physical damage, economic and financial losses linked to direct impacts can begin to be calculated, including insured losses. A range of hazard scenarios can be considered to determine how the level of damage or losses change as the intensity, duration or scale of a hazardous event changes. These scenarios can include, for analytical purposes, events that have not yet have occurred. This information can then be used to estimate, with the known probabilities of hazard events, expected financial or insured losses. The translation of physical property damage into financial terms requires a determination of how the damaged assets will be replaced, i.e. whether they will be rebuilt to their original state (i.e., replacement cost), or whether improvements and/or relocation will be considered in rebuilding. Knowledge of financial and economic losses, and their distribution within the economy, provides the basis for financial management strategies.

Build data inventories[1]

Data inventories are useful to catalogue elements at risk and enable an assessment of exposures and vulnerabilities. Collecting location-based information on exposed populations, assets, and activities (e.g., census information, business registries, land use information) enables quantification of exposures, which is essential for the design of financial risk transfer instruments.

Inventories may also usefully include location-based information on the characteristics and vulnerability of properties and infrastructure (e.g., value, use, age, building materials, soil conditions, number of floors, number of occupants) (see Table 7 for selected regional and global databases on exposures). Such location-based data permits the layering of hazards and exposed populations, assets, and activities to obtain an integrated view within a defined geographical area. Maps may then be produced that allow these exposed elements to be quickly viewed, possibly at a high level of resolution, and assessed. The mobility of persons may introduce difficulties in assessing the exposures of populations.

[1] See also section below on "Post-Disaster Impact Analysis."

Table 7: Regional and global databases on exposures

Initiative	Institution	Description	Geographic scope	Status	Availability
Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)	SPC/SOPAC, World Bank/GFDRR, ADB	Multi-hazard (EQ, TS, TC) Probabilistic Risk Modelling results, Historical impacts, Exposure (Buildings, Infrastructure, Crops, Population)	Regional --15 Pacific Countries	Complete	Open
GLIDE	Asian Disaster Reduction Centre (ADRC)	Continuously updated database of multi hazard disaster information	Global	Active	Open
Gridded Population of the World, GRUMP	CIESIN, Columbia University	Population	Global	Complete	Open
Landscan	Oakridge National Laboratory, USA	Ambient population	Global	Complete	Public/not for commercial use
EERI World Housing Encyclopaedia	EERI	Housing Stock	Global	Active	Open
NERA European Building Database	NERA (FP7)	Housing Stock	Regional -- Europe	In progress	Open
PERILS	PERILS	European Windstorm and UK flood industry exposure database, property sums insured	Regional -- Europe	Complete	Commercial
Meridian World Data	Meridian World Data	Georeferenced Key infrastructure database	Global (select)	Complete	Commercial
SkyscraperPage	SkyscraperPage	Buildings (skyscrapers)	Global (select)	Complete	Commercial
Dun and Bradstreet	Dun and Bradstreet	130 million buildings covered, georeferenced	Global (select)	Complete	Commercial
Emporis	Emporis	Building inventory data for 420,000 buildings in 190 countries.	Global (select)	Complete	Commercial
Global Building Stock Database	Pike Research	Commercial and residential building floor space by country and building type	Global	Complete	Commercial
OpenStreetMap	OpenStreetMap	Free and open platform with user generated basemaps including roads, building, infrastructure	Global	Active	Open

Box 7: CAPRA: Probabilistic Risk Assessment Initiative

A free, modular, open-source, and multi-hazard tool for risk assessment, CAPRA provides a risk calculation platform integrating exposure databases, physical vulnerability functions and hazard assessments in a probabilistic methodology. CAPRA evaluates risk in terms of physical damage and direct economic and human losses in standard risk metrics (AAL, PML) to visualise hazards and risk on geographical information system (GIS).

Building on — and strengthening — existing initiatives, CAPRA was developed by Latin American experts with the support of the Central American Coordination Centre for Disaster Prevention (CEPREDENAC), the World Bank, the Inter-American Development Bank (IDB) and the International Strategy of United Nations for Disaster Reduction (UN-ISDR), in partnership with Central American governments Risk assessment and visualisation tools such as CAPRA can enable many applications.

Other types of information, while more difficult to secure, could be useful as a means to assess vulnerability, such as evacuation and business continuity plans, supply chain interdependencies, and more generally information on critical infrastructure networks and systems. The collection of information on insurance coverage helps to assess the extent of society's financial protection against disaster risk and is one of several key factors in determining the extent of a government's contingent liabilities related to a disaster. Such information includes premiums paid as well as insured values and main scope of coverage; any breakdowns by major economic sector (e.g., households, corporate sector) and/or by geographic region can facilitate analysis of financial resilience. Information on insurance coverage also helps in assessing the exposure of the insurance sector to disaster-related risks. Collecting information on the exposures of the banking sector and other components of the financial sector (e.g., exchanges, clearing and settlement systems) would also be helpful in understanding the sector's exposures.

Box 8: Location based inventories of risk mitigating infrastructures

The collection of location-based information on infrastructures that serve to limit exposure and reduce vulnerability (e.g., flood defences, early warning systems, lifelines) is also valuable, and merits being inventoried. A few countries have begun to inventory some of these assets, and provide up to date and publicly available information about their condition and maintenance. In the United States, the Army Corps of Engineers launched the National Levee Database includes information on most federal levee systems. The collection of data on investments intended for disaster risk reduction can help to keep track of efforts to reduce vulnerability and aid in cost benefit analysis.

The collection of information on exposures and vulnerabilities in standardised formats promotes consistency and facilitates linkages and exchange of data between national, sub-national, regional and global hazard databases. Such data collection, moreover, needs to take into account such considerations as cost, privacy, confidentiality, and national security. Data collection may, given scarce resources, be limited and focussed on the highest priority variables, and dissemination may be restricted. In principle, however, efforts are necessary to ensure that data and information is made available and, where possible, disseminated.

c) Risk evaluation

Risk is determined through the investigation of hazards (e.g., probabilities, expected intensities), exposures (elements at risk), and vulnerability (potential damages given intensities), and can be expressed as a function of probability and likely impacts within a given time horizon.

How risk evaluation is conducted and used depends on the objectives of the risk assessment process and available resources, and on the nature of the hazard and its amenability to measurement and quantitative analysis. Depending on how the results are to be used risk can be viewed in different terms, e.g. a ranking or score based on the relative likelihood and impact of different types of events described in qualitative terms, or where risk is quantified, the relevant risk measure can then include expected risk cost (i.e., expected annual losses), variance, and downside risk (e.g., probable maximum loss).

Box 9: Comparing the results of deterministic scenarios

National risk assessments conducted at central government level estimate the relative impact and likelihood of different hazard scenarios based on common criteria, and rank the risks they present to guide capabilities based planning. The result of such a comparative risk assessment may be visualised within a matrix, in which each risk factor, determined by its "likelihood" and "impact", is shown as a point (see annotations for 'Risk Matrix' under Section 3 "Risk communication").

For disaster risk financing and transfer strategies, anticipated losses that cannot easily be managed within existing resources create a demand for risk financing and risk transfer tools as a means to reduce the potentially crippling financial consequences of disasters and ensure rapid recovery. Estimating loss is simplified if only direct impacts are considered, although such an approach can significantly underestimate losses for some of the largest and most complex catastrophes when indirect impacts prove to be financially significant. For governments, consideration needs to be given to how disasters affect macroeconomic conditions, including the fiscal position and the sustainability of public finances, and thus impact the fiscal balance in the long term (known as "secondary effects"; see "Risk Financing" section below).

Where there is sufficient data, a probabilistic risk-modelling framework will provide useful results for a range of DRM applications, such as territorial planning, infrastructure risk assessment, preparedness measures and insurance premium calculations (see Table 8 for selected risk modelling initiatives and other types of disaster databases). Several countries have used probabilistic models, such as some Caribbean and Pacific Island countries, Mexico and Morocco.

Hazard and risk modelling requires developing an understanding of the underlying mechanics of hazards and extrapolating to more extreme events than those found in historical data. Where possible, pre-existing international efforts to create global hazard and risk models could be leveraged. International agencies, insurance sector firms or countries that have already developed a risk modelling framework may be solicited for required expertise. However, the data entered into the risk model regarding hazards, exposures, and vulnerabilities need to be specific to that territory and updated on a regular basis. The required level of detail needs to reflect the highest priority national risks and critical needs.

Table 8: Risk modelling initiatives and consequence databases

(The table below contains information on risk modelling initiatives, selected based on the availability of (open) tools to run/interrogate the model (outputs), inclusion of hazard/exposure)

Initiative	Tools	Database			Purpose	Geographic scope	Status	Availability
	Hazards	*Hazard*	*Exposure*	*Historical damage / losses*				
Risk modelling platform								
Global Earthquake Model (GEM Foundation)	EQ	Yes	Yes	Yes	Probabilistic dynamic earthquake risk model, risk communication	Global	In progress	Open
CAPRA (World Bank)	EQ, TS, RF, TC, LS, VO	yes (restrictions for distribution depending upon countries	yes (restrictions for distribution depending upon countries	no	Multi-hazard (EQ, TC, FL, VO, RF, LS) Probabilistic Risk Model	Central America, South America, Caribbean, South Asia	Complete, with upgrades in progress	Open
HAZUS (FEMA)	EQ, TC, FL	Yes	Yes	No	Multi-hazard (EQ, FL, TC) Risk Model	US	Complete	Open
Global Volcano Model (GVM Collaborative Partnership)	VO	Yes (in development)	Yes (in development)	Yes (in development)	Sustainable, accessible information platform on volcanic hazard and risk	Global	Planned	(In development)
Global Flood Model (WRN, Deltares)	FL	Yes	Yes	Yes	Probabilistic Flood Risk Model	Global	Planned	Open
RiskScape (GNS)	EQ, FL, TS, VO, Windstorm	Yes	Yes	No	Multi-hazard risk model, probabilistic model to be implemented in future revisions	New Zealand	Complete, with upgrades in progress	Commercial
EQRM (GA)	EQ	No	No	No	Probabilistic earthquake hazard & risk software	Australia/Global	Complete	Open
Global Assessment Report 2015 multi-hazard probabilistic risk model (UNISDR)	Multi	Yes	Yes		Monitor and evaluate HFA, quantify global disaster trends	Global	Planned	Open

Post-event impact estimation								
PAGER (USGS)	EQ	Yes	Yes	No	Rapid post event earthquake damage estimation	Global	complete	open
Global Disaster Alert and Coordination System (GDACS) (UN, EC)	Multi	Yes	Yes	Yes	Rapid post event multi hazard damage estimation	Global	planned	open
Other								
Global Risk Data Platform (UNEP-GRID) Index based risk modelling output interrogation	Multi	Yes	Yes	No	Platform to share spatial data information on global risk from natural hazards	Global	Complete	Open
MATRIX (German National Research Centre for Geosciences) multi-hazard tool and research knowledge database	Multi	No	No	No	Multi-type risk assessment tools, tuned to the European context that may be exploited by researchers, disaster management and civil protection authorities.	Europe	Planned	(In development)
SAFE - Scenario Assessment for Emergencies (BNPB, AIFDR, WB/GFDRR) Multi hazard risk impact	Multi	Yes	No	No	Multi-hazard impact tool for rapid post event impact, contingency planning	Indonesia -- InaSAFE	Planned for flexible, global use	Open
OpenDRI (World Bank GFDRR) Data sharing and decision support for risk information	Multi	Yes	Yes	No	Reduce the impact of disasters by empowering decisions-makers with better information and the tools to support their decisions.	Global (select)	Active	Open
CatNet (SwissRe) Hazard/risk map atlas	Multi	Yes	Yes	Yes	Natural hazard information and mapping system	Global	Complete	Commercial
ABBREVIATIONS EQ: Earthquakes TC: Tropical Cyclones FL: Floods LS: Landslides VO: Volcanic eruptions TS: Tsunamis RF: Rainfall								

Box 10: R-FONDEN: The financial catastrophe risk model of the Ministry of Finance and Public Credit in Mexico

Mexico has developed a comprehensive financial protection strategy relying on risk retention and transfer mechanisms, including reserve funds, indemnity-based reinsurance, parametric insurance, and catastrophe bonds. An in-depth understanding of the risks has allowed the Mexican government to successfully access international reinsurance and capital markets to transfer specific risks.

A fundamental feature of the program is the R-FONDEN, a probabilistic catastrophe risk assessment platform developed to estimate the government's financial exposure. R-FONDEN offers scenario based, as well as probabilistic analysis at national, state, and sub-state levels for four major perils (earthquake, floods, tropical cyclones, and storm surge) for infrastructure in key sectors (education, health, roads, and low-income housing).

R-FONDEN takes as input a detailed exposure database (including details of buildings, roads, and other public assets) and produces as outputs risk metrics including Annual Expected Loss (AEL) and Probable Maximum Loss (PML). This model is currently used by the Ministry of Finance, in combination with actuarial analysis of historic loss data, to monitor the disaster risk exposure on FONDEN's portfolio and to design risk transfer strategies.

The confidence in determining the level of risk and its sensitivity to preconditions and assumptions is a key factor in the analysis. Factors such as divergences of opinion among experts, the level of uncertainty surrounding risk estimates, the availability, quality, quantity and ongoing relevance of information, or limitations on modelling are relevant to confidence levels and need to be examined and clearly documented.

Good knowledge management involves verifying and keeping trace of the outcomes of risk analysis. For instance, a national risk assessment process – i.e., knowledge of the nature and measure of risk in terms of their relative likelihood and impacts – can be documented in risk maps or risk registers. A risk register or log may, for instance, describe each risk, assess likelihood and expected impacts, assign a grading in terms of risk, and identify mitigation and adaptation strategies. For example, Canada has very detailed risk registries. These logs may be compiled and analysed as a "portfolio" of risks, permitting systematic comparisons and an assessment of interdependencies. Documentation of this nature may also facilitate risk monitoring.

d) Risk monitoring

Risks emerge and threats evolve. For this reason risk assessment requires ongoing monitoring of risks, particularly those that are significant or dynamic in nature. Canada, the Netherlands, Norway and the United Kingdom have conducted continuous iteration of their risk assessment and its adaptation to changing contexts to ensure that it remains useful for strengthening overall country resilience.

A cyclical process will help to support regular review and re-assessment of hazards, exposures and vulnerabilities, including periodic re-evaluation of the risk assessment process, its governance, methods and practices. Countries find it useful to incorporate a forward-looking element (potentially as a separate risk assessment process), whereby a long-term horizon is adopted to identify and assess future potential risks. These sustained efforts will enable an understanding of the evolving risk landscape and capture improvements in risk knowledge as a result of new data, preparedness exercises, evolving risk assessment practices and results, and experiences with recent disasters.

3. RISK COMMUNICATION AND AWARENESS

Internal and external communication

- Effectively communicate the results of risk assessment and use them to inform the highest levels of policy decision makers

Public awareness strategies

- Implement communication strategies to educate citizens and businesses about the hazards and threats facing the country, promoting the development of a "risk culture" and provide guidance on what they can do to prepare for the major risks

Tools for interpreting risk analysis

- Document and deliver hazard and risk information in an easily readable format, such as mapped hazard or risk information for a defined area, or as a risk matrix or risk curve showing possible events and their likelihood and expected impact

a) Internal and external communication

A dedicated structure or leadership position for government-wide risk assessment may be established to report results to the highest political levels. In the Netherlands for example, the Ministry of Security and Justice sends a findings report derived from the results of the risk assessment to the Lower House of Parliament on behalf of the Cabinet. It can also provide an interface with neighbouring countries, countries with which economic linkages are deep and relevant regional and international organisations in order to identify, assess and communicate cross-border risks and share the results of risk assessment.

Wide communication of risk assessment to the public results delivers significant benefits to policymakers and emergency planners at the national and sub-national levels of government. Risk assessment that is perceived to be objective and impartial helps to build and sustain public trust, which is crucial to acceptance of extraordinary measures during times of crisis. Transparency in the risk assessment process can also contribute to its wider public credibility.

Wide communication of risk assessment can also help in embedding risk reduction knowledge into governmental policies, spatial planning strategies, regulations and standards, such as regional and local planning, zoning, and building codes, which can have significant impacts on disaster risk reduction.

b) Public awareness strategies

Appropriate risk communication techniques will help to reach the targeted audiences. Information on hazard exposures and vulnerabilities can be communicated to the general public in a simplified way and be accompanied with practical illustrations of the actions that can be taken to reduce risk and of the expected benefits of such actions. The message will be more effective if they include specific information on risk reduction strategies that is realistic for local conditions. Despite inherent uncertainties that exist in the understanding and forecasting of hazards, stakeholders need clear, consistent and persistent messages to internalise basic information, change perceptions, and move

towards action. Messages need to put disaster risk into perspective, with a view to reducing the emotional impact of the threat posed by hazards.

The most systematic public education efforts have been built around widespread campaigns. These campaigns involve a series of messages and materials that are massively distributed through a wide variety of media channels, as well as sometimes cultural activities. They typically involve partnerships between government, civic organisations, mass media outlets, and the private sector. While multiple organisations and sectors can be encouraged to develop and disseminate materials, country experiences show that guidelines on important content help limit confusion and conflicting messages. Trusted organisations and sectors (e.g., regional and local authorities, non-profit associations, industry) have often collaborated, with the support or direct involvement of national governments, in developing standardised material that organisations can take and modify for their particular target audiences.

The insurance industry, as a key sector involved in financially managing disaster risks, can be usefully engaged in promoting and educating policymakers and individuals about disaster risks and financial protection. Some have used these opportunities to explain and promote better land use and construction standards that can help to reduce exposure and vulnerability. Others have partnered with civic and public organisations to promote public risk awareness and risk reduction education.

Mock evacuations and drills can be an engaging method of raising risk awareness across a wide cross-section of the population. Drills in schools are a basic way of sensitising children to risks. Practicing response skills regularly is significantly responsible for protective action during an emergency. Public inclusion in simulations and drills can also stimulate people to consider their own risk and preparedness.

In several countries, risk awareness, preparedness, and risk reduction information is made available on governmental websites. These websites focus on natural hazard information (including, where relevant, simplified hazard maps), the benefits of collective and individual disaster risk reduction actions, the availability and scope of disaster risk financing, risk-sharing, and risk-transfer tools, such as insurance, as well as on event response and emergency planning for post-event preparedness.

Clear and consistent messages to all stakeholders, including all levels of government, concerning the allocation of expected disaster costs and disaster prevention responsibilities can promote a shared understanding of roles and responsibilities and stimulate individual and collective actions to reduce vulnerability and exposure to the risk of physical and financial losses from hazards.[2]

c) Tools for interpreting risk analysis

Risk matrixes, risk maps and plotted risk curves are examples of tools that facilitate communication of results of risk assessments to policy makers and relevant stakeholders for different purposes. Risk matrixes, risk maps and plotted risk curves are examples of tools that facilitate communication of aggregate results to high level policy makers.

[2] See also OECD *Policy Handbook on Natural Hazard Awareness and Disaster Risk Reduction Education*, 2010.

Risk matrix

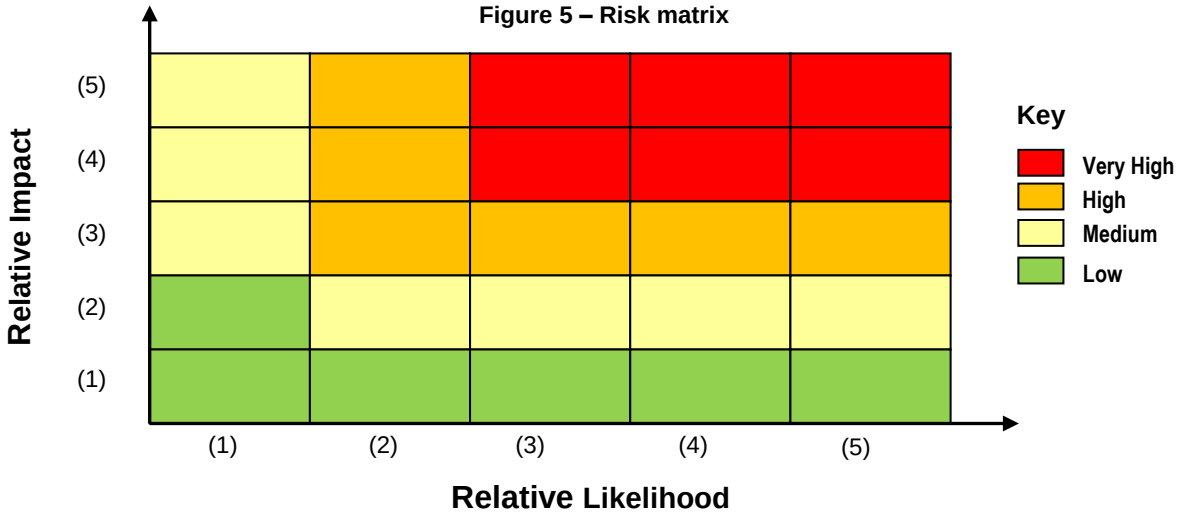
Several countries now use risk matrixes to visually represent the relative likelihood and impact of risk scenarios to high level policy makers as first step to consider their relative priority for risk treatment. A broader understanding of the risks faced at country level will enable the public to become more engaged in emergency preparedness and response, and calibrate its perception of risks which may strengthen demand and public support for risk financing strategies. Representation of the matrix can vary, for example as a plotted point on a two dimensional risk diagram with a colour-shaded background (see Figure 5).

Box 11: Risk matrices for policy decision making

In China, an industry standard entitled "Grading methods of natural disaster risk" was developed to facilitate communication of risk assessments results to policy makers and the general public, in which a risk matrix presents the likelihood and impacts of all natural-hazards facing the national territory.

In order to highlight the uncertainties surrounding risk assessment Canada and the Netherlands create variations of their consolidated risk matrix to visually display the confidence levels surrounding each of the plotted points representing the estimated level of risk. In the United Kingdom an abridged public version called a National Risk Register is made available to inform and educate citizens in a simplified manner.

Figure 5 – Risk matrix



Risk maps

Risk maps in digital form for national and sub-national levels are useful to communicate the spatial variation of risks. Mapped information is useful to inform decisions about land use strategies and urban planning that reduce exposures for example, or to guide the development of evacuation plans. Risk maps are also useful to evaluate the accumulation of exposures within a geographic area for risk transfer and risk financing purposes. The following types of maps can be prepared:

- Hazard maps showing the expected spatial distribution of major hazards and the range of potential physical impacts

- Hazards maps combining elements at risk – such as populations, infrastructures, and naturally protected areas – that can help to identify complex risks

- Maps showing the vulnerability of exposed elements to damage

Countries may use these maps as the basis for preparing risk maps that show the combination of likelihood and impact of a certain event, or for developing aggregated hazard maps to support a better understanding of multi-risk events. For example, countries have started to use location-based information tools to enable the mapping of critical infrastructures that have the potential to pollute local areas in combination with information on flood risk areas and population densities at the local and regional level. Hazard and risk maps are made more rigorous and complete if they are supported by guidelines that set out standards for their construction and for the underlying data collection process. Appropriate versions of these risk maps at different spatial scales could be made publicly available and distributed, including via online platforms.

Risk curves

Risk curves that for instance plot, for different hazard scenarios, the probability that a certain level of loss will be exceeded within a given year (exceedence probability), or that plot probable maximum loss (PML) against the range of possible hazard frequencies (less frequency implying greater PML), aid in planning for expected disaster impacts on national finances, the economy and the financial sector (particularly the insurance sector) provided the hazard or threat is amenable to quantitative analysis. Curves such as the exceedance probability curve help to inform decisions about the amount that would need to be set aside each year to fund future losses ("expected annual loss") and can help evaluate the relative costs and benefits of risk reduction and risk transfer strategies. The uncertainties surrounding the production of the risk estimates need to be explicitly considered in interpreting these curves. In China, a risk curve for earthquakes has been plotted on the basis of historical records, and expected annual losses due to earthquakes in the whole country. This analysis is available in the *Atlas of Natural Disaster Risk on China*.

4. POST-DISASTER IMPACT ANALYSIS

Impact assessment

- Conduct structured, consistent impact assessments for disaster events and re-evaluate risk assessment, including identifying any deficiencies in hazard, exposure, and vulnerability data and analysis and in risk governance

Quantification

- Collect and disseminate data on economic losses, insured and uninsured financial losses, and other disaster impacts in standardised formats and promote consistency and interoperability of national, sub-national, regional and global databases
- Collect and disseminate consistent data on post-disaster government spending
- Update data on hazards, exposures and vulnerabilities

a) Impact assessment

Current experiences show the critical importance to prepare post-disaster impact assessment following large-scale disaster events. A structured, well-planned impact assessment can be conducted, which collects data and information on the hazard event(s), government, industry, and civilian responses, and the various direct and indirect impacts, including loss of life, injuries, displaced persons, and damage to assets and economic activity, including economic, financial and insured losses.

This post-disaster loss assessment can provide qualitative and quantitative information to help identify the strengths and weaknesses of risk assessment, including possible deficiencies in underlying approaches, methodologies, data collection methods, and governance arrangements, as well as promote awareness of disasters risks. This impact assessment could be a component of a broader post-disaster evaluation report. Disasters provide an opportunity to take stock of country resilience and risk reduction efforts and consider initiatives that could limit exposures and vulnerabilities, such prevention infrastructure, improved building codes, and new land use planning and zoning policies, and improve preparedness capabilities and institutional capacities.

Box 12 Mexico: FONDEN's operating procedures for post-disaster damage assessment

In Mexico a 'Damage Assessment Committee' is convened after an event to identify damage to affected public infrastructure at the federal, state, and municipal levels and to determine the extent of losses. It is comprised of both federal and state representatives from affected agencies. Subcommittees are formed for each affected sector, such as housing, roads and bridges, hydraulic infrastructure, urban infrastructure, education, health, et cetera. Field work and site visits are then expeditiously conducted to assess the damage.

FONDEN has implemented geocoding and digital image capture to provide evidence of damage in affected sectors while improving the accuracy of post-disaster damage assessments. The use of geo-referencing also facilitates the expeditious collection and recording of data on disaster impacts. The approach allows for increased transparency and precision in the damage assessment process while reducing errors.

Guidelines and methodologies for post-disaster impact assessments will help to ensure consistency in reporting, both across the country and over time. In this context, the development of taxonomies, methodologies, and reporting templates for impact assessment on national and sub-national basis can be pursued, with appropriate distinctions between economic, financial, and insured losses. For example, the UN DesInventar approach helps to quantify such losses.

b) Quantification

Data collected on economic, insured and uninsured financial losses as well as other disaster impacts such as fatalities, injuries, and displaced persons can help improve understanding of disaster exposures and impacts and thereby help to quantify disaster risks. Standardised formats will facilitate comparability and permit the interoperability of national, sub-national, regional and global databases (see Table 9 for regional and global databases on losses and other damages).

The collection of data will be more complete if it includes extensive risk, i.e. frequently occurring, localised and less severe impacts, and not only large-scale disasters. It is also important to collect information on financial losses arising from damage to public assets. Reporting burdens arising from data collection efforts should be carefully considered, which may arise from the timing of requests and lack of well-established, pre-agreed formats. Data collected after the event can feed into the databases used for the assessment and quantification of risk in the pre-disaster phase, which is a pre-condition for sound risk financing and transfer strategies. Aggregate loss data collected from the insurance industry can be shared with the industry to improve risk assessments.

The collection of data on disaster-related government spending, with various breakdowns, will help to facilitate analysis and effectiveness of risk management policy. This will help to identify the use of public resources, including financial assistance used for reconstruction of infrastructure and housing, relocation of the population, support for living expenses and the purchase of household goods, credit provision to small and medium-sized enterprises, and compensation of losses in specific industries. There is scope to include assistance from civil society organisations that contribute not only to disaster risk reduction but also to disaster response, relief and reconstruction. Centralisation or harmonisation of various sets of data collected requires an in-depth cooperation between different governmental agencies and civil society, which often proves time-consuming. To overcome this difficulty, some countries such as Austria, Canada, New Zealand and Turkey have established a special entity to coordinate data collection from governments at the national level.

Table 9 - Historical loss databases

Initiative	Institution	Geographic scope	Status	Availability
GLIDE	Asian Disaster Reduction Centre (ADRC)	Global	Active	Open
DESINVENTAR	UNISDR	Global, various countries	Active	Open
EM-DAT	Catholic University of Louvain	Global	Active	Open
Sigma	Swiss Re	Global	Active	Commercial
NatCatSERVICE	Munich Re	Global	Active	Commercial
Property Claims Service (PCS)	Insurance Services Office, Inc.	North America	Active	Commercial

5. POLICY IMPLICATIONS OF RISK ASSESSMENT OUTCOMES

- Use the results of risk analysis to help in setting priorities and making decisions about the risks that are to be accepted, prevented, reduced or transferred

Risk assessment provides the basis for elaborating and assessing the full range of disaster risk management strategies aimed at enhancing disaster resilience. By identifying hazards and analysing vulnerabilities, impacts, self-protection capabilities and coping capacities across the population and the economy, risk assessment enables cost-effective and targeted DRM strategies tailored to local risk profiles and capacities.

Risk assessment helps to:

i) identify the most significant hazards or threats

ii) identify the segments of the population and economy that are most likely to be impacted by disaster risks, the nature and scale of impacts, and underlying vulnerability factors;

iii) weigh the relative costs and benefits of alternative strategies to reduce these risks or mitigate their impacts; and

iv) establish priorities amongst these strategies and design these strategies to address systematically the relevant components of risk and the relevant affected segments of the population and economy.

DRM strategies include:

- **Anticipatory prevention and mitigation measures,** which reduce a country's stock of risk by avoiding or reducing exposure or impacts to known hazards and address underlying risk factors through such measures as land use planning, flood, landslide and avalanche protection, building standards, and early warning systems.

- **Emergency preparedness**, which involves developing emergency plans and generic response capacities amongst government actors, industry, civil society institutions and individuals to augment self-protection capabilities and coping capacities against all types of disaster scenarios.

- **Financial management**, involving similar preparedness efforts to mitigate the financial impacts of disasters, thereby strengthening financial resilience and enabling rapid response, recovery and reconstruction (see Section II of the framework).

Legal, regulatory and governance mechanisms that permit quick actions to save lives or minimise damages, allow rapid disbursement of funds, and accelerate international aid flows can be established to support these strategies.

Regarding the most significant hazards, the presentation of risk assessment results needs to make it clear to decision-makers whether these risks are acceptable in light of societal attitudes and preferences and current capacities to absorb these risks. If risks exceed acceptable levels due to their social, economic, environmental costs, clear options to reduce these risks or possibly transfer them need to be offered. To this end, countries may develop and implement a national risk mitigation plan that includes a "to do" list of risk reduction or transfer options, including a clear distribution of tasks and the list of entrusted institutions. An element of a national plan would be also to provide guidelines for the creation and management of risk reduction activities under localised disaster mitigation plans.

SECTION II – RISK FINANCING

Disasters can have widespread impacts, inflicting not only physical harm and damage to populations and assets, but also impairing economic activity, with potential cascading and global effects. These direct and indirect impacts generate losses for households, businesses, governments, and other segments of the economy insofar as income is lost and wealth destroyed, be it in the initial phase of a disaster or during recovery. These costs may be catastrophic, aggravating economic and social impacts. Finance Ministries need to understand these impacts and their relevance for financial and fiscal management strategies, for which they have central responsibility.

The financial impacts of disasters can be mitigated *ex ante* through pro-active financial management tools, most notably risk financing and risk transfer tools and compensation arrangements provided by the private sector or government, as a complement to physical risk reduction measures. These tools provide financial protection and may reduce costs by reprofiling risks across time so that they can be better managed or by transferring risks to those better able to absorb them. They reduce financial vulnerability, thus averting potentially devastating drops in welfare and ensuring that resources are available for rapid response, recovery and reconstruction, including important post-disaster investments in risk reduction.

The development of effective risk financing and risk transfer strategies at the country level by Finance Ministries and other relevant financial authorities requires a good understanding of risk exposures within the economy and risk-bearing capacities, which taken together reveal financial vulnerability. Financial vulnerability reflects the extent to which a financing gap might emerge as a result of a disaster, causing financial hardship or distress; as a measure of financial capacity, it provides a reference point for assessing the costs and benefits of ex ante financial tools and elaborating financial planning more broadly. While some may be able to cope with the financial impacts of disasters without having recourse to ex ante financial tools, others may clearly benefit from such tools despite their costs.

Risk financing and risk transfer strategies interact with physical risk reduction. In order to enable the functioning of risk financing and transfer markets, disaster risks must not only be properly assessed, but also reduced to levels that allow for cost-effective risk financing or risk transfer. In this regard, these markets, where they exist, may highlight critical risk reduction measures requiring governmental investment. They may also increase risk awareness and incentivise individual risk reduction measures – where such opportunities exist – through risk-based pricing or by means of adjustable loss-sharing mechanisms such as deductibles and co-insurance. A positive feedback loop in risk reduction may thus be created with risk financing and risk transfer markets.

Reliance may be placed on risk financing and risk transfer markets to manage the risks to private assets, with governments working to facilitate the operation of these markets and encouraging, where such markets are weakly developed, the development of tools and arrangements designed to protect financially vulnerable populations and sectors of the economy. For this reliance to be well-founded, the

availability, adequacy and efficiency of private markets need to be evaluated. This assessment needs to be focussed on identifying market failures, which may consider such factors as the insurability of disaster risks, the extent of asymmetric information and adverse incentives, consumer behaviour, and market features and structure.

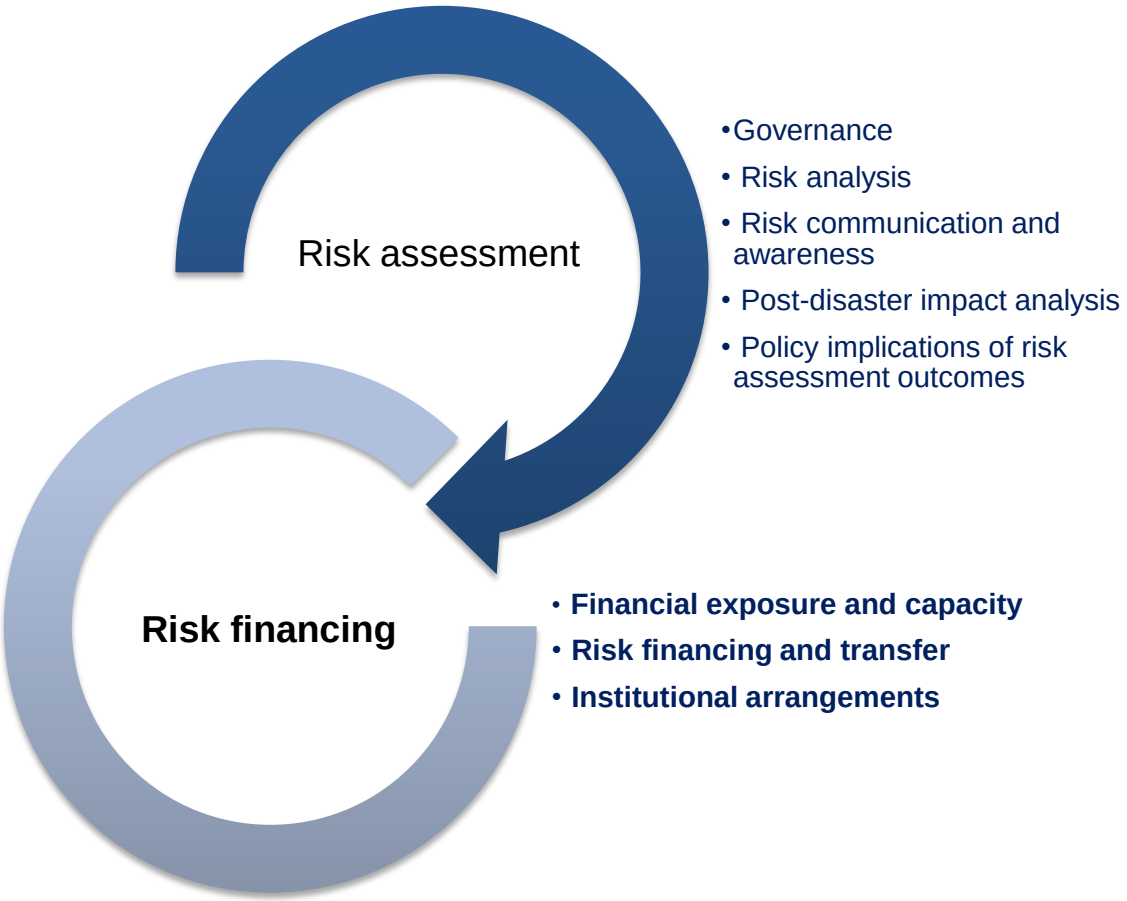
Governments may have disaster risk exposures and therefore need to assess carefully the potential role of risk financing and risk transfer in their fiscal management strategy. Governmental exposures are broader based, arising not only from human injuries and damage to public assets, but also from fiscal pressures arising from planned financial commitments, unplanned *ex post* financial assistance and potentially adverse changes in macroeconomic conditions, all of which directly affect Finance Ministries as managers of the government's overall fiscal framework. Governments may be expected to handle any peak risks, such as a once in a millennium earthquake, which would lie beyond the capacity of other economic agents to handle and likely absorb massive resources.

Governments are fortunately well placed to affect their own exposures and those of others through their central role in risk reduction and their ability to foster and influence, through their Finance Ministries, the development of risk financing and risk transfer markets, including insurance and capital markets. Indeed, governments and particularly their Ministers of Finance can clarify responsibilities for the coverage of losses, encouraging those exposed to disaster risks to reduce these risks where possible and obtain financial protection.

Institutional arrangements may be established or amended by Finance Ministries and relevant financial authorities to promote efficient risk financing and transfer capabilities within an economy as well as promote effective mechanisms for the provision of governmental financial assistance. Institutional arrangements may serve to ensure the general availability or affordability of financial tools, provide adequate compensation for identified segments of the population or economy that are financially vulnerable, strengthen rapidity in financial responses and provide greater certainty regarding the allocation of disaster costs. In addition to the critical decision of whether the government needs to play a role in promoting effective compensation mechanisms, a key decision for Finance ministries relates to the appropriate design of any institutional arrangements that may be established to this end.

As with other elements of DRM, effective risk financing and risk transfer strategies depend on the quality of risk assessment. Quantitative risk assessment may generate critical data sets enabling, through enhanced risk analysis, the development of risk financing and transfer markets and the promotion of more efficient risk pricing, thus potentially helping to expand financial coverage within the economy. As the quality and quantity of data increase, the breadth of financial options can be expected to increase. Risk assessment, through its analysis of exposures and vulnerabilities, and underlying drivers, can also be factored into financial strategies to ensure that adequate resources are available ex post for targeted investments in risk reduction measures and upgraded assets and infrastructure.

Yet risk financing and risk transfer markets, where they are well developed, can reinforce risk assessment and support other elements of DRM. Financial institutions active in these markets have strong incentives to perform their own risk assessments and, for this purpose, generate detailed and up-to-date data collection on hazards, exposures, and vulnerabilities, which they may – in the context of potential partnership with the private sector – decide to share with governments and support country risk assessments. These markets can also provide important signals regarding existing and emerging risks and their costs, which can help governments in identifying critical risk reduction measures, evaluating their costs and benefits, and measuring the extent to which disaster costs are being reduced through time.


Risk assessment
•Governance
• Risk analysis
• Risk communication and awareness
• Post-disaster impact analysis
• Policy implications of risk assessment outcomes
Risk financing
• Financial exposure and capacity
• Risk financing and transfer
• Institutional arrangements

1. FINANCIAL EXPOSURE AND CAPACITY

Risk exposure

- Use the risk assessment as the basis for assessing disaster-related financial exposures across the territory and facing the main segments of the economy, namely households, the corporate sector, the financial sector, and government

Risk-bearing capacity

- Assess the capacity of those exposed to disaster risks to absorb and recover from losses, from a short and long-term perspective, based on risk exposures and financial resources. This includes an assessment of:
  - The capacity and willingness of individuals and the corporate sector to assume disaster risk
  - The capacity of the financial sector to assume disaster risk, including the credit, insurance, market, operational, and other risks linked to disasters
  - The capacity of governments, at national and sub-national levels, to manage the public finance implications of fiscal risks arising from direct losses, contingent liabilities, and changes in macroeconomic conditions linked to disasters, including loss of revenues and increased expenditure
- Identify actual or potential gaps in financial capacity ("financing gap") and analyse how they might arise

a) Risk exposure

As a first step, those who are exposed to disaster risk and expected to sustain losses following a disaster need to be identified and their level of financial exposure assessed. In this analysis, the focus is on gross exposure; how these risks are reallocated by affected agents can be analysed separately (see "Risk financing and risk transfer" below). Country-risk assessment may provide the basis for this analysis; however, its results may need to be complemented and augmented by a more detailed, comprehensive analysis of financial impacts and affected parties.

In the first instance, it is useful to develop an understanding of who is expected to bear losses across the national territory and population, which can reveal concentrations in exposure. This information helps in identifying relevant critical prevention and mitigation measures and understanding the extent to which social solidarity in risk-sharing might be feasible in view of the distribution of exposures. At the same time, in order to grasp the potential economic and social disruptions caused by disasters, it is important to assess, in at least a general way, the financial exposures of the major segments of the economy, namely households, the corporate sector, the financial sector, and government. Specific sectors or populations may be investigated in view of economic, social, environmental and other considerations. Socioeconomic disparities are important to consider in this respect as they may be relevant for the targeting of financial assistance to the poorest segments of the population.

For households, the corporate sector, and the financial sector, disaster losses may arise from different types of impacts, such as: business (e.g., damaged factories, supply disruptions); financial (e.g., liquidity stress, counterparty credit deterioration, adverse market movements, claims payments for insurers); social (e.g., loss of livelihood or income due to injury or lost lives); and environmental (e.g., loss of natural resources or of the services they provide). These impacts may be direct, such as damage to property, or indirect, such as reduced income or increased expenses, and require analysis.

The banking sector merits special attention given its importance in the economy and the potential stresses that it may face, for instance due to damage to financial infrastructure or information systems, and deteriorating credit quality in loan portfolios due to worsened macroeconomic conditions. Similarly, the insurance sector requires close attention given its important role in risk transfer markets, where it may assume substantial disaster risk. Expected insured losses (or gross claims) linked to disasters provide an indication of the exposure of the insurance sector.

For governments, disaster risk exposure arises from a variety of sources. Losses may arise from damages to public property and infrastructure, pre-arranged financial assistance and guarantee or reinsurance schemes, post-disaster financial aid and changes in macroeconomic conditions, including possible lower economic growth or loss in tax revenues that may affect the fiscal position. These government contingent liabilities, which need to be assessed by Finance Ministries, may be explicit or implicit: expenditures that might arise from reconstruction of public assets and infrastructure or from pre-arranged financial commitments as a result of a disaster are explicit; by contrast, those expenditures that do not reflect any type of commitment or responsibility but which can nonetheless be expected to occur due to a perceived obligation are implicit. An assessment of the government's contingent liabilities could be one of the outcomes of a country-level risk assessment.

Unbundling disaster risk exposure by relevant major hazard can help in further understanding risk exposures. Each type of identified hazard (e.g., earthquake, flood, storm, terrorism, large-scale cyber-attack, hazardous industrial activity) may have different impacts across the territory and on each of the segments of the economy, with a different allocation of losses. For instance, households can generally be expected to have a greater exposure to natural hazards such as earthquakes and flooding in comparison with man-made risks such as terrorism and industrial accidents that are more likely to affect the corporate sector; the financial sector may, in particular, have a high exposure to terrorism risk. Unbundling disaster risk may also facilitate an understanding of the correlations among risks posed by hazards and whether affected parties might benefit from diversification in their risk exposures.

b) Risk-bearing capacity

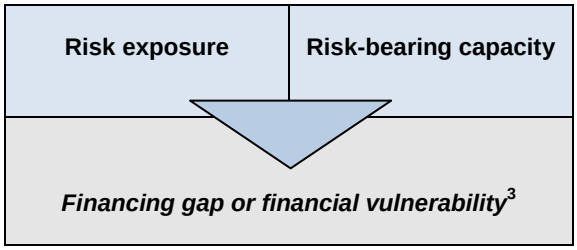
Risk-bearing capacity refers to the capacity of economic agents to absorb and recover from losses, based on own resources, income, and self-financing capabilities ("financial resources"). Self-financing capability refers to the ability to obtain external debt financing on favourable terms and conditions as a means to spread risks over time; in the case of corporations, including financial firms, it also refers to the ability to attract new capital, which can be used to absorb loss, while, for governments, it refers, in addition, to the ability to create sources of revenue. Measures of risk-bearing capacity include solvency, leverage, profitability, diversification, liquidity and repayment capacity.

Risk-bearing capacity is a key element of resilience against disaster shocks. Assessing risk-bearing capacity involves determining the extent to which economic agents can, given their disaster risk exposure, absorb and recover from disaster costs based on their financial resources, and thus avoid financial distress such as insolvency, i.e., their ability to manage the costs of disasters purely on an ex post basis in the short and long-term without pre-established risk financing or risk transfer arrangements.

In assessing risk-bearing capacity, consideration can be given to the expected nature and costs of reconstruction, which may involve returning damaged assets to their original state or investing in upgraded assets and infrastructure.

The extent to which economic agents are or might be unable to absorb and recover from losses for a defined level of disaster risk can be referred to as the "financing gap" (or "resource gap"). Absent risk financing and risk transfer instruments or further risk reduction measures, such gaps translate into financial vulnerability. The factors or conditions accounting for actual or potential financing gaps need to be identified and analysed. Similar to the analysis of risk exposures, the assessment of risk-bearing capacity can cover the major segments of the economy, and include analysis of those populations and sectors of the economy whose inability to absorb disaster risks might have important economic, social, environmental or other consequences. This assessment may also be spatially oriented, seeking to assess the capacity of regional and local economies to absorb risks.

Diagram 1: Simplified depiction of assessment of underlying financial capacity



Risk aversion is relevant for assessing financial capacity. Risk aversion, which reflects the extent to which an individual's welfare might be reduced by exposure to uncertainty, reflects preferences but is also affected by the level of resources or wealth. Individuals and those parts of the corporate sector with limited resources can in general be expected to be risk averse in their outlook, effectively limiting their capacity to accept risks. Large international corporations, the financial sector, and governments (or at least governments in large, well-diversified economies) are in comparison less likely to be risk averse.

The risk-bearing capacity of the household, corporate, and financial sectors can be assessed by reference to such factors as levels of wealth or assets, liabilities, income-generating capacities, diversification of income, ability to build up savings or retained earnings, and ability to secure external financing promptly on favourable terms and conditions, in comparison with the magnitude of the risk exposure. In-depth analysis is needed of the risk-bearing capacity of the financial sector, given its importance and the potential severity and complexity of the risks it may face, such as credit, insurance, market, liquidity and operational risks. This analysis may involve stress testing and an evaluation of procedures for crisis management, business continuity planning, claims management and failure resolution. Other sectors of the economy or populations (e.g., poor households) that are or may be financially vulnerable may also need to be closely analysed.

[3] The use of the term "financial vulnerability" here refers to the capacity of individuals, businesses and governments to withstand disaster losses *without the use of financial tools to mitigate impacts*, in contrast to the literature which incorporates the use of ex ante financial tools into the analysis of financing gaps. The intention is to bring greater clarity to underlying risk-bearing capacity and thus to highlight the role of risk financing and risk transfer tools in reducing financing gaps, a key step in the methodological framework (see " Risk Financing and Transfer" below). Conceptually, the approaches are the same.

Box 13: The importance of understanding disaster risk exposures and risk-bearing capacities within the economy – the case of Argentina and the agriculture sector

Argentina is a country where the agricultural sector plays an important role in the economy, with an important percentage of the population working in this sector. This economic dependence on farming makes the country vulnerable to weather-related hazards and climate change impacts on weather patterns. Of particular concern to Argentina are the potential economic impacts of adverse weather events on small and medium producers, who may not have the financial capacity to manage agricultural risks linked to weather patterns, particularly climate change.

Argentina has, at various levels of government, developed a range of financial instruments intended to offset the costs of disruptive weather events, such as grant subsidies for insurance as an instrument of social policy in rural areas (e.g., avoiding rural-urban migration, reducing producer vulnerabilities through financial protection of assets), tax exemptions for agricultural insurance, and reinsurance, although there are currently no national subsidy programs. A National Committee on Farming Emergencies and Disasters has been created whose main purpose is to manage the compensation of farmers affected by climate, weather, seismic, volcanic or biological events.

Source: *Improving the Assessment of Disaster Risks to Strengthen Financial Resilience*, Special Joint G20 Publication by the Government of Mexico and the World Bank (2012)

Assessing the risk-bearing capacity of governments requires a different and broader approach. Governments have in theory the ability to self-finance through existing budgetary resources (including through budget cuts and reallocations), post-disaster debt financing, taxation powers 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, 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).

The risk-bearing capacity of governments concerns not only national-level governments, but also sub-national levels, which can also be significantly affected by disasters. In general, local governments have more limited room to manoeuvre at the macroeconomic level, may face limitations in their ability to raise fiscal revenue and may thus face more adverse risk ratings than national governments. Finance Ministries are, given their responsibilities, best placed to assess governmental risk-bearing capacities.

By assessing risk-bearing capacities within the economy and the financial tools used to manage disaster risks (see "Risk Finance and Transfer" below), governments at the national and sub-national levels are better placed to evaluate their disaster-related implicit contingent liabilities, as this broad-based assessment of financial capacities to manage disaster risks serves to identify financially vulnerable populations, sectors of the economy, and regions that may demand post-disaster compensation or financing, and to provide an indication of expected disaster aid. These implicit contingent liabilities, as well as the government's explicit contingent liabilities, need to be factored into the assessment of the government's own risk-bearing capacity given its contingent liabilities.

Box 14: Linking federal disaster compensation to regional government financial capacities The cases of Australia and Canada	
Australia	Under Australia's *Natural Disaster Relief and Recovery Arrangements or NDRRA*, central government support for disaster relief and assistance (e.g., personal hardship and distress, restoration of essential public assets, concessional loans to small business) is scaled according to certain thresholds, which are calculated as a proportion of state or territory revenue. Linking the thresholds to regional government revenues helps to link the level of support to the financial capacity of regional governments to meet the costs of disasters within their own means.
Canada	Canada's *Disaster Financial Assistance Arrangements Program* (DFAA) is a cost-sharing reimbursement program between the federal government and Canadian provinces and territories, sharing in the costs of eligible provincial expenditures arising from natural disasters. Federal reimbursements are made on a progressive scale, with the thresholds defined by per capita eligible expenditures. 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 provincial economy and would exceed what the province or territory might reasonably be expected to bear on its own.
Source: *Improving the Assessment of Disaster Risks to Strengthen Financial Resilience*, Special Joint G20 Publication by the Government of Mexico and the World Bank (2012), Government of Canada, *2011-2012 Evaluation of the Disaster Financial Assistance Arrangements Program* (available at http://www.publicsafety.gc.ca/abt/dpr/eval/dfaap-eng.aspx)	

2. RISK FINANCING AND TRANSFER

- Evaluate the extent to which prevailing risk financing and risk transfer markets might enable disaster risk to be appropriately explicitly retained, transferred or reduced within the economy given financial capacities. In particular:
  - Understand the scope for risk retention and risk transfer and assess the benefits and costs of these financial tools, if available, in combination with possible further risk reduction to complement or substitute for these tools
  - Assess the availability, adequacy and efficiency of risk financing and risk transfer markets, with reference to such elements as penetration, coverage, pricing and speed of compensation
  - Assess the capacity of the financial sector, particularly the insurance sector, to offer risk financing and risk transfer instruments
- Identify those sectors or populations that are financially vulnerable and are unable, for economic or other reasons, to access financial tools and assess the extent to which the government may be expected to provide post-disaster aid
- Evaluate, within government, whether risk financing and risk transfer tools are to be used to bridge any identified actual or potential financing gap, taking into account the timing of any expected post-disaster government payouts
- Clarify the allocation of disaster costs so that all economic agents, including different levels of governments, assume responsibility for the risks they face and undertake actions to ensure that these risks are managed properly

Risk financing and risk transfer instruments, in combination with risk reduction measures, are capable of reducing financial vulnerability by addressing actual or potential financing gaps. These instruments may reduce the economic costs of disasters by enabling the reprofiling or the transfer of risks, improving government financial planning, and possibly providing incentives for risk reduction.

These instruments, generally involving the operation of insurance, banking and capital markets, need to be well understood to evaluate their cost-effectiveness in bridging identified financing gaps:

- ***Risk financing*** involves the retention of risks combined with the adoption of an explicit financing strategy to ensure that adequate funds are available to meet financial needs should a disaster occur. Such financing can be established internally through the accumulation of funds set aside for future use or obtained externally through pre-arranged credit facilities. The banking sector, capital markets and international lending institutions are sources of risk financing.
- ***Risk transfer*** involves the shifting of risks to others who, in exchange for a premium, provide compensation when a disaster occurs, ensuring that any financing gap that might emerge is partially or fully bridged. Risk transfer may be obtained through insurance policies or capital market instruments such as catastrophe bonds. The insurance and reinsurance sectors are the main sources of risk transfer, although capital markets provide

an alternative source. The payouts 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).

Where risk financing and risk transfer markets are domestically well-developed or can be accessed on a cross-border basis, those facing disaster risk need to evaluate whether, given their degree of financial vulnerability, to retain risks and fund them solely on an ex post basis within existing financial capacities or whether to manage risks ex ante through risk financing, risk transfer or additional risk reduction measures based on their costs and benefits.

If disaster risks are relatively minor in comparison with risk-bearing capacity, managing these risks solely on an ex-post basis may be a viable approach, allowing funds to be more productively invested elsewhere, supporting capital accumulation and thus augmenting financial capacity. However, if disaster risks are material, ex ante financial tools can provide valuable protection, helping to bridge financing gaps; alternatively, investment in risk reduction may yield benefits in terms of a reduced risk exposure. These measures require, however, an ex ante commitment of resources, with attendant opportunity costs given alternative uses of capital:

- Building up a dedicated pool of savings or ***reserves***, a source of risk financing obtained through internally generated funds which are set aside in a disaster fund and are drawn down in the event of a disaster, may prove valuable for those with relatively low disaster risk exposures, for instance for more frequent but lesser impact hazards.

- As disaster risk increases relative to risk-bearing capacity, accessing external sources of risk financing such as ***contingent credit facilities***, where loans are provided in the event of a disaster event, may be more efficient, 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.

- ***Insurance*** may provide beneficial protection for those facing larger disaster risks relative to risk-bearing capacity. Insurance permits risks to be transferred to undertakings, namely insurers and reinsurers, whose business is to pool and diversify risks. For households and other economic agents with limited expertise and resources and facing material disaster exposures, the purchase of insurance can – in those countries where insurance markets are well developed – provide simple and cost-effective financial protection. The same may apply to larger economic agents such as large corporations and governments. Alternative, simplified risk transfer tools such as micro-insurance and parametric insurance products may be deployed in countries where insurance markets are not well developed or broad-based.

- As the severity of the risks further increases and size of the risk bearer increases, enabling direct access to capital markets, additional risk transfer tools may become accessible, such as ***catastrophe-linked securities***, which involve risk transfer through capital markets. In a limited number of cases, countries have used catastrophe-linked securities to cover higher layers of risk in the context of structured disaster risk financing (e.g., a disaster fund) or risk transfer (e.g., an insurance scheme) mechanisms. Opportunity costs linked to ex ante financial tools may rise with the size of the risk bearer given that investment opportunities and investment management capacities may increase.

- Investment in ***risk reduction*** will yield both economic and social benefits, such as avoidance of loss of life and injury, as well as help to reduce overall country risk. Risk reduction measures can directly substitute for, or complement, financial tools. If disaster risks are large, then initial investments in risk reduction are likely to yield substantial benefits; however, there are likely to be diminishing returns as such investment increases. At the level of an individual household or small business, the scope for risk reduction may be limited compared to what might be achieved by a large corporation or government.

The advantages and limitations of ex ante financial tool are briefly described in Table 10 below. These tools may be combined and layered in order to optimise financial protection against disaster risk.

Table 10: Risk financial and risk transfer tools for disaster risk management

	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 countries concerned about credit ratings) • Can provide a structure for inter-agency coordination 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 for certain economic agents (e.g., households, small businesses), may be the only available ex ante financial tool for these agents	• 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 expected interval between 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
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 the return to investors 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	• Payment may not be immediately available and 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 possible unviable as the absolute size and level of uncertainty surrounding the occurrence of a risk event increase

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 they 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 • 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
Sources: OECD, Swiss Re, World Bank		

In sum, for ex ante financial tools and risk reduction measures, there is a trade-off between addressing potentially damaging financing gaps on the one hand and generating returns and growth through the alternative use of funds on the other, with each instrument or tool offering specific benefits and costs that need to be evaluated in the context of financial vulnerability and other contextual factors and specific individual and country circumstances.

Considering the appropriate mixture of financial instruments is important for those participating in institutional arrangements designed to promote the functioning of disaster risk financing and risk transfer markets. In these schemes, there is a need to optimise financial strategies and ensure that financial commitments undertaken to those covered under the scheme are met (for more on institutional arrangements, see "Institutional Arrangements" below). Each potential party to the arrangement (e.g., insurers, entity managing the scheme, and the government and Finance Ministries in particular) needs to consider and financially manage their contingent liabilities under the scheme, which will be determined by the pre-agreed allocation of risks. Hence, a government participating in any arrangement will face different exposures and adopt a financial approach based on its financial commitments under the scheme.

In order for reliance to be placed on risk financing and risk transfer markets as a widespread mechanism for individuals, businesses and governments to obtain financial protection, the overall availability, adequacy and efficiency of these markets need to be evaluated. This evaluation needs to be focused on identifying potential market failures, which may include consideration of such factors as:

- **Insurability of disaster risk**: Disaster risks may be uninsurable or hard to insure due to the expected high frequency and/or high level of severity of, and high degree of correlation among, hazard events, which make risk-bearing problematic except for the largest of economic agents and markets. Other hazards, while more easily insurable, may lead to variability in risk protection over time in terms of pricing and coverage given potentially significant impacts on the earnings and capital of insurers. Risk reduction has the potential to increase insurability by reducing risks facing the insurance sector, although some peak risks, due their extreme nature, may never become insurable on reasonable economic terms. At the same time, changing hazards, exposures and vulnerabilities linked to an increasingly globalised economy, rapid urbanisation and climate change are affecting the frequency and/or impacts of disasters, impacting disaster

costs and potentially affecting insurability; as long as risk-adequate premiums can be generated, however, insurance markets are capable of covering disasters risks.

- **Asymmetric information, decision-making and behaviour of economic agents**: Information asymmetries in risk financing and risk transfer markets can create problems of moral hazard and adverse selection, which may lead to incomplete markets. Such problems can be expected to be more limited in retail catastrophe insurance markets given that insurers will typically have an informational advantage; however, such problems may arise in reinsurance and capital markets. Parametric covers can help reduce these risks and thereby stabilise the availability of insurance. In addition, retail consumers may lack the capacity to optimise financial strategies, exhibit myopic behaviour (e.g., systematic underestimation of risks) and face incentives that discourage risk transfer (e.g., expectation of aid), all of which may lead to inadequate demand for coverage.

- **Pricing, extent and continuity of coverage and speed of compensation**: More generally, the extent to which the insurance sector meets the needs of those who are financially vulnerable to disasters and are prepared to pay a premium for coverage at a level reflective of technical risks can be assessed. Any gaps in coverage, sustained excessive pricing disconnected from underlying risks or loss experience or other similar problems in a country where insurance markets and related data infrastructures are already well developed may be indicative of a market failure that may be examined. For instance, it is important to identify uninsured populations and sectors of the economy that are financially vulnerable and assess the reasons why they lack insurance. Measures may be taken to overcome these hurdles and make risk transfer mechanisms available and affordable (see section on "Institutional Arrangements").

Ideally, risk financing and transfer instruments will, in terms of their design and pricing, ensure adequate protection against financial vulnerability within the economy and across the national territory, promote market capacities to accept and absorb disaster risk, and offset any negative incentives. The pricing of these instruments is affected by uncertainties characterising the risk assessment process. The availability of reliable and consistent data on hazards, exposures and vulnerabilities is of fundamental importance to reduce these uncertainties and lower the cost of risk financing and transfer tools.

The strength of risk financing and risk transfer markets depends on a solid financial sector. Accordingly, banks and especially insurers need to have adequate levels of capital to absorb the costs of not only regularly recurring but also more remote but potentially large disasters. Insurers must also have the operational capacity to pay claims promptly in the event of a disaster. The financial capacity of the insurance sector to assume disaster risk depends critically on the insurability of this risk, as noted, which is linked to the nature of the hazard, the capacity of the insurance and reinsurance sectors and their need to generate earnings, and the functioning of insurance and capital markets.

In countries 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 such data that could permit more efficient pricing. In these contexts, financial vulnerabilities, which may be significant, might remain unaddressed, particularly for poorer segments of the population. Government thus need to identify those populations (e.g., poor households) or sectors that are financially vulnerable and lack access to financial tools and consider ways, through programs or arrangements (see section on "Institutional Arrangements") to ensure that basic compensation or post-disaster risk financing are made available to reduce economic and social hardship, for instance through

the development of innovative financial tools or through the establishment of government compensation programs or arrangements. Absent such arrangements, the government may be called upon to provide post-disaster financial assistance in an ad hoc manner, which could potentially increase outlays.

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 and in particular Finance Ministries to assess carefully the potential role of disaster risk financing and risk transfer instruments in their fiscal management strategy. This assessment will be made within a disciplined framework that is based on a sound risk assessment process and risk financing approach that seeks to identify any financing gaps. Table 11 outlines the two main approaches to financing disaster risks, which may be combined for an optimal mix: an ex post approach that relies on existing resources and powers (e.g., budget reallocation, debt financing, taxation) that can be leveraged after a disaster to meet costs; and an ex ante approach that relies on the use of financial mechanisms explicitly arranged or secured beforehand. An ex post financing approach does not preclude the establishment institutional arrangements that specify, ex ante, the government's financial commitments (see section on "Institutional arrangements").

Table 11: Approaches to financing government disaster risk

Examples of methods	
Ex ante financing	***Ex-post financing***
• Dedicated reserve fund • Contingent credit facility • Insurance • Catastrophe bond, other CAT-linked security / alternative risk transfer instrument	• Budget reallocation • Debt financing / borrowing • Taxation • Multilateral / international borrowing • International aid
Country examples	
Australia	Australia funds its financial commitments under the *Natural Disaster Relief and Recovery Arrangements* on a purely ex post basis. For Australia, the funding decision is deemed to be ultimately a question of cash management and a timing decision regarding the raising of debt finance. Funding an ex ante reserve is not viewed as costless. Since Australia is well placed to access financial markets, it can raise cash as and when needed to finance disaster recovery, an approach it believes is consistent with efficient balance sheet and cash management.
Colombia	Colombia has assessed its contingent liabilities and found that disasters caused by natural hazards are the second most important source. Colombia has typically managed the fiscal risk of disasters through ex post mechanisms and ex ante measures (e.g., contingent loan facility with the World Bank, public asset insurance). However, it has been determined that the government would not have the financial capacity to finance the cost of more extreme disasters. Accordingly, a new financial strategy has been developed to mitigate fiscal volatility generated by catastrophic events in Colombia. It suggests the need to develop risk transfer solutions for public buildings, key transport infrastructure and housing of financially vulnerable populations. Capital market and insurance instruments will be considered as well as government reserve funds similar to those used in Mexico.
Mexico	Mexico's strategy for financially managing its disaster costs relies principally on an ex ante financing approach through a risk retention vehicle (FONDEN) and a related reinsurance and catastrophe bond programme. Funds from FONDEN can be used for the rehabilitation and reconstruction of (i) public infrastructure at the three levels of government (federal, state, and municipal); (ii) low-incoming housing; and (iii) certain components of the natural environment (e.g., forestry, protected natural areas, rivers, and lagoons). The reinsurance and catastrophe bond programmes serve to augment the financial capacity of FONDEN, thereby limiting the financial exposure of Mexico's federal government to disaster risk.

Source: *Improving the Assessment of Disaster Risks to Strengthen Financial Resilience*, Special Joint G20 Publication by the Government of Mexico and the World Bank (2012)

If there are significant populations or sectors that are financially vulnerable and, for whatever reason, uninsured, 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.

In assessing risk financing needs, the government may usefully consider whether funds for rebuilding should in part be channelled to pre-identified risk reduction measures or the upgrading of assets and infrastructure to enhanced standards. The government is well placed to affect its own exposures not only due to its role in risk reduction strategies, but also given its ability to foster and influence the development of risk transfer markets, including insurance markets, which by promoting financial protection within the economy can serve to reduce the government's exposures. Finance Ministries are best positioned to promote the development of risk transfer markets and financial instruments given their policy and regulatory responsibilities for the financial sector.

Box 15: Measuring government financing gaps or financial vulnerability

Example: Disaster Deficit Index

The Deficit Disaster Index (DDI) measures the financial capacity of a government to manage the economic losses it might suffer as a result of a disaster, taking into consideration its own resources and any financial arrangements such as insurance. The DDI compares estimated losses arising from the "Maximum Considered Event" (MCE) to the government's "Economic Resilience" (ER), which describes internal and external resources available to cover economic losses. A ratio exceeding 1 means that the government is unable to cover losses, indicating financial vulnerability.

Several hazard severities or return periods are selected (e.g., 1 in 50, 100, and 500 year events) and, on this basis, losses are estimated for each given scenario. The loss metric chosen for the MCE is expected annual loss, i.e., the expected loss over a one-year period.

Losses are estimated using risk models, linking hazard intensity to the scale of damage to infrastructure and other assets and resulting loss. The resources available to government (ER) include budgetary reallocations, external credit, new taxes, internal credit, national and international aid and insurance.

Source: Inter-American Development Bank, *Indicators of Disaster Risk and Risk Management* (2010)

Clarifying the allocation of disaster costs can align incentives with risk reduction and thereby promote the financial management of disasters by governments. Those exposed to disaster risk and capable of mitigating it need to be aware of the costs that they are expected to bear and incentivised to reduce such risk. This communication on risk allocation can be included in risk communication and awareness strategies elaborated as a result of risk assessment; in addition, it may be announced by relevant government authorities such as Ministers of Finance with a strong policy and financial interest in the matter and may be made explicit in any institutional arrangements backed by the government (see section below). Several countries have achieved this result either by specifying, at least to certain extent, such allocation in the rules governing disaster funds and/or relief arrangements (e.g., Australia, Canada, Mexico) or by setting up and sometimes sponsoring disaster insurance schemes.

Such a communication on risk allocation will, if well understood and successfully internalised, serve to limit moral hazard and incentivise those facing risks to consider, as appropriate, relevant risk mitigation actions, be they physical risk reduction measures or the use of ex ante financial tools. At the extreme, the government may consider mandating the purchase of financial coverage (e.g., local

government authorities being mandated to purchase insurance to cover public assets), although such an approach may raise its own host of problems. Communication on risk allocation usefully includes cost allocation between the public and private sectors and among different levels of governments. Among governments, clarity is required regarding respective or shared responsibilities for post-disaster public investments in risk reduction measures (e.g., zoning, building codes, prevention infrastructure).

In addition to providing the resources necessary to fund post-disaster needs, risk financing and transfer markets can convey signals regarding disaster risks and incentivise cost-effective disaster risk reduction measures. Where competitive markets exist, pricing may provide important signals regarding existing and emerging risks and their costs, which can help governments in identifying critical risk reduction measures, evaluating their costs and benefits and measuring the extent to which disaster costs are being reduced through time, thus promoting effective implementation of DRM. These signals may be complemented by loss-sharing arrangements (e.g., deductibles, co-insurance in insurance policies) that, by ensuring some retention of risk at the individual level, may further incentivise feasible risk reduction actions.

3. INSTITUTIONAL ARRANGEMENTS

- Determine whether the government needs to play a role in providing risk financing or risk transfer of private losses, based on a full assessment of the need for such intervention, which should in particular address:
  - The reasons why the financial sector might be unable to provide needed risk financing and risk transfer instruments given the nature and scale of disaster risks and other contextual factors such as the state of development of the financial sector and the regulatory framework
  - The economic impacts, if any, of any lack of capacity in the financial sector to offer disaster risk financing and/or transfer instruments
  - The risk financing and risk transfer needs of financially vulnerable populations or sectors within the economy and the options to enhance risk financing and risk transfer or compensation mechanisms for these groups or sectors
  - The financial capacity of government to offer risk financing and transfer or compensation mechanisms and the potential costs of intervention and their distribution
- Assess, if a government role is needed in private risk transfer markets, the appropriate extent of risk sharing, which may help to determine the appropriate role of industry and government and layering strategies. Considerations include:
  - The scale of disaster risks, the extent to which the insurance and reinsurance sectors can accept such risks, and the point at which such risks should, in part or whole, be shifted to the government
  - Recognition of the potential adverse impacts of government intervention, including policyholder and insurer moral hazard and crowding out effects
  - The need for the government to balance risks and rewards given its acceptance of risk and the potential adverse impacts of intervention
  - Social values, such as social solidarity, and other nation-specific factors
- Review any government role in risk financing and transfer or compensation, and related institutional arrangements and possible risk-sharing strategies, on a regular basis

Institutional arrangements refer to the frameworks, systems, organisations, instruments, rules, and processes that may be established to promote the financial management of disaster risks. At a general level, governments, and Finance ministries in particular, need to ensure that the policy and legal framework supports and facilitates the operation of disaster risk financing and risk transfer markets. However, specific, ex ante institutional arrangements may, depending on country circumstances, be established to promote efficient risk financing and transfer capabilities within an economy as well as promote effective mechanisms for the provision of governmental financial assistance, targeting financially vulnerable populations and sectors of the economy.

Institutional arrangements for risk financing and risk transfer may be established by industry or government or, typically, by both. By contrast, arrangements designed to facilitate the provision of financial assistance are established by governments only. Institutional arrangements of both kinds may be supported by, or involve, policy, regulatory, and legal measures. Institutional arrangements, whose overarching objective is to strengthen financial resilience, may serve, among other purposes, to:

- Ensure the general availability or affordability of financial tools, for instance by deepening financial capacity for the assumption of disaster risks
- Provide adequate compensation for identified segments of the economy (e.g., households, business) or specific sectors or individuals within such segments
- Ensure prompt compensation in the event of a disaster and promote confidence in disaster response
- Provide greater certainty regarding the allocation of disaster risks within the economy

Special institutional arrangements, or the adaptation of existing governing regulatory frameworks, may be necessary to support private-sector development of products designed to provide needed financial tools for identified vulnerable populations or sectors of the economy, such as micro-insurance or parametric insurance products. These arrangements may be complemented by special subsidies or tax incentives, and may involve innovative distribution channels. Examples can be found in several countries, including Bolivia, Brazil, Colombia, China and India.

In addition to supporting the financing of disaster risks, institutional arrangements may bring other benefits. These arrangements may facilitate coordination with the private sector, ensuring that the powers and competencies of both government and industry can be most effectively leveraged for DRM, for instance in data collection, risk modelling and assessment, risk reduction and risk awareness. Institutional arrangements may also help, by promoting financial coverage of disaster risk, to clarify the allocation of disaster costs and thus enable better identification of the contingent liabilities facing government, an important component of the fiscal framework and public accounting,

Finance ministries have key decision-making responsibilities with regard to institutional arrangements involving the government in terms of: i) assessing the need for any arrangements; ii) designing these arrangements and, in this context, determining the appropriate type of financial commitment to provide, for instance ex post financial assistance or a financial guarantee, given the nature and objective of these arrangements (e.g., public scheme to support the disbursement of post-disaster aid, scheme to support private risk financing and transfer); iii) ensuring clarification of responsibilities and financial commitments to ensure that incentives are aligned, policy objectives are met, and unwanted risks to the fiscal framework are minimised; and iv) ensuring that ex ante public arrangements for disaster aid and private financial mechanisms are well-coordinated and complementary.

The involvement of the government in disaster risk financing and, in particular, risk transfer needs to be carefully evaluated. Some key elements for consideration in this respect include:

- Whether impediments to insurability might apply (e.g., high correlation of losses and inability to diversify or spread risks, high level of severity and/or frequency, ill-defined or dynamic hazard), thus impairing the functioning of domestic and international insurance markets

- The systemic implications of a lack of insurance availability, in particular:
  - Whether the banking sector and capital markets might be unable, following a disaster, to provide normal and disaster-related financing given possible disaster-related losses or exposures
  - The impact of any lack of disaster risk financing and risk transfer on the corporate sector (including key economic infrastructures and facilities) and its ability to continue operations and secure, both in normal times and following a disaster, needed financing and investment
- Whether financially vulnerable populations or sectors within the economy require protection for compelling economic, social, or other reasons
- The financial capacity of government to provide risk financing and transfer mechanisms
- The potential costs and adverse impacts of government intervention created by the possible imposition of any government-backed scheme and the distribution of direct costs within the economy, which may directly impact households and businesses

Where negative impacts and disruptions arising from the lack of insurance are expected to be high, for instance in the banking sector or major business segments of the economy, and the degree of insurability and level of post-event financing expected to be low, the direct, ex ante involvement of the government in enabling or providing disaster risk financing and, especially, risk transfer may need to be considered. Table 12 below provides some country examples of the motivations that led to the creation of government-backed schemes for terrorism risk insurance.

Table 12: Rationale for terrorism insurance schemes

Country examples

Australia	The lack of affordable terrorism insurance after 11 September forced Australian commercial property owners, banks, pension funds and fund managers to retain terrorism risk. There was a concern that the lack of terrorism insurance for commercial property and infrastructure would reduce financing and investment in the commercial property sector, with consequent wider negative economic impacts. It was believed that this uncertainty might delay commercial property investment projects and affect investment management portfolio decisions, with adverse consequences for the sector and broader economy. A terrorism insurance scheme was established in 2003 for commercial property and related business interruption losses and public liability claims.
US	The objective of the US *Terrorism Risk Insurance Act* (TRIA) was to ensure the availability of terrorism coverage following the events of September 2011. At the time of passage in 2002, it was considered that the lack of terrorism insurance was having major economic impacts, with cancelled or delayed construction projects, downgraded ratings for mortgage-backed securities, and other economic impacts linked to the inability of firms to obtain coverage of terrorism risks. Concerns had been voiced about specific impacts on commercial real estate, construction, banking, transportation and utilities.

Sources: Government of Australia, *Terrorism Insurance Act Review* (2012), Brown, Cummins, Lewis and Wei, *An Empirical Analysis of the Economic Impact of Federal Terrorism Insurance* (Journal of Monetary Economics, 2004)

There may be a case, on separate grounds, for government intervention to address identified vulnerable populations or sectors for social or economic development reasons. In these cases, the options for enhancing risk financing or risk transfer arrangements for these groups or sectors need to be considered, which could include subsidies for the purchase of insurance, the promotion of mutuality arrangements (e.g., within specific identifiable groups of populations, such as farmers) and, in emerging markets and developing countries, micro-insurance and other types of simplified products.

For any intervention in insurance markets, an assessment of its expected costs and adverse impacts needs to be undertaken, including the 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. Decision-making regarding governmental intervention is likely to include other relevant factors and analytical approaches, and is made more complex by the specificities and dynamics of national circumstances.

The government may also directly provide compensation and recovery financing to populations and sectors of the economy to address financial vulnerabilities and ensure basic response, recovery and reconstruction. Government compensation arrangements, which can for instance cover basic living expenses and losses linked to property damage, effectively transfer risks to the government. These schemes are designed in such a way as 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 governmental appropriations and possibly leveraging international risk financing and risk transfer markets to augment financial capacity; alternatively, they may be funded ex post, with appropriations made upon the occurrence of a disaster.

Compared with ad hoc post-disaster financial assistance, ex ante governmental compensation arrangements have important advantages in terms of efficiency and clarification of disaster assistance, helping to ensure prompt assistance and reduce moral hazard and variability in unplanned post-disaster assistance. Ad hoc ex post fiscal measures may be ill-planned, untimely, and overly discretionary, potentially leading to higher-than-expected assistance and discontent over possible inequities in compensation. The budget-making process can have an important influence on outcomes and introduce complications. Also, in the absence of well-defined parameters surrounding this assistance, individuals and businesses may come to develop strong expectations of post-disaster aid, thereby affecting incentives for self-protection and reducing demand for other sources of financial coverage such as insurance.

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 of severely affected individuals and businesses, thereby strengthening incentives for financial self-protection, promoting confidence in solidarity mechanisms and limiting economic and social hardship, while helping to clarify and limit the government’s contingent liabilities. In order to avoid double payments, government schemes will typically exclude compensation of already insured property; moreover, to prevent moral hazard, such schemes may not provide compensation in the event that insurance could ordinarily have been purchased to provide coverage. Well-designed governmental schemes may thus help to reduce moral hazard and avoid the crowding-out of private insurance markets, thus complementing these markets.

In countries where insurance markets are less developed, 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 affordability of insurance products given country incomes. In this context, governments face important challenges: how to reduce financial vulnerabilities in a fiscally sustainable manner, while avoiding the building up of expectations of compensation which may become ingrained and inhibit the growth of nascent insurance markets. Consideration of institutional arrangements and possible fiscal measures that enhance the availability and affordability of private risk financing markets and tools may thus need to be considered until the economy becomes more advanced and insurance markets more developed. Any government financial mechanisms in these countries may have to be limited in nature given possibly limited public resources, requiring for instance a focus on the provision of immediate assistance or relief. Overall, there is a need for a rigorous balancing of the respective roles of government and market-based or insurance-based solutions in promoting financial resilience, depending on the maturity of insurance markets and on the nature of financial vulnerabilities within the country and economy.

Where intervention is envisaged in insurance markets, the government and in particular its Finance Ministry needs to assess how risks are to be shared and pooled within the economy, which can then provide a basis, amongst other possible factors such as social values of solidarity, for determining the appropriate role of industry and government and layering strategies, key elements in the design of any institutional arrangement intended to support insurance markets. For this purpose, the Finance Ministry needs to consider the scale of disaster risks based a proper risk assessment and the extent to which the insurance sector can assume and pool these risks within competitive markets. Industry may, to this end and within the limits established by applicable competition laws, establish sectoral pooling or mutuality arrangements as mechanisms to spread risks more widely.

Should the nature or scale of such risks exceed private sector capacity, some degree of risk-sharing with the government may be envisaged. Typically, a layering or co-insurance strategy is adopted so that the government assumes only a portion of the risk, thus limiting its exposure, with the industry bearing a level of risk that is reasonably within its financial capacity. At the extreme, where disaster risks are considerable for the entire country, the government may decide to offer disaster risk coverage directly, for instance to households, who are financially more vulnerable than other segments of the economy. This direct provision of disaster insurance may be carried out through a separately established entity, with mandated objectives and accountability mechanisms established to ensure that risks are effectively managed within the entity and that the government’s fiscal risk is minimised. Table 14 provides an example of how the dividing line in risk-sharing was determined; in this country example, the threshold for the government guarantee is subject to revision based on evolving market conditions.

Box 16: Determining the boundary between industry risk retention and the state guarantee: the case of Denmark for NBCR risks

In Denmark, coverage for nuclear, biological, chemical or radioactive (NBCR) terrorism risks is deemed to be essential. In establishing the Danish terrorism insurance scheme, it was determined that there was a market failure in the market for NBCR coverage since there was inadequate global reinsurance capacity for these risks, limiting Danish insurer capacity to offer NBCR coverage domestically. The Danish state acts as a reinsurer.

The risk retained by the insurance industry is based on its capital base and the availability of global NBCR reinsurance. This threshold is reviewed every year. The Danish state then provides a guarantee for the next DKK 15 billion of losses that exceed this threshold. Insurers pay a fee for this guarantee, which varies according to the level of the threshold.

In order to determine the level of NBCR risk that should be retained by the non-life insurance sector, the Danish authorities test the effects of exposing the sector to specified terrorism scenarios, distributing the effects across insurers in accordance with their share of industry gross premiums. The loss for each insurer is deducted from its capital base. The reduced capital base is compared with solvency requirements: some insurers might meet requirements, others might not but still have positive capital, while some might be left with no equity capital.

The threshold is set a level that is low enough to avoid a total collapse of the industry, but high enough so that some non-life insurers might risk bankruptcy. If enhanced reinsurance capacity becomes available, the risk retained by the industry increases and the threshold rises. At some point, it could become uneconomical for insurers to rely on the state guarantee given the fee. It is thus argued that the scheme has an inbuilt review mechanism that ensures that the state does not replace private market capacity.

Source: State Aid Notice 637/2009 – Denmark, *Danish Terror Insurance Scheme 2009* (available on http://ec.europa.eu)

In intervening, the government needs to recognise potential adverse impacts, which include possible policyholder and insurer moral hazard and crowding out effects. More ample and affordable provision of disaster insurance, while beneficial, may reduce incentives, at the policyholder level, to mitigate risks, although such moral hazard effects may in fact be limited if the scope for risk reduction at the individual level is limited. Government assumption of some level of disaster risk may incentivise the insurance sector to weaken underwriting standards and take on more risk. Controls such as industry retentions within a risk-sharing arrangement between industry and government may help to mitigate any potential moral hazard effects. Yet government involvement may extend beyond what is necessary for the operation of stable markets, thus crowding out insurance market activity.

These considerations highlight the need for the government and its Finance Ministry in particular to balance risks and rewards given its assumption of risk and the potential adverse impacts of intervention, which requires appropriate policy design and controls. Governments that assume disaster risk either directly or as part of a risk-sharing arrangement with the insurance industry or capital markets should see clear benefits, be it in the form of the achievement of stated policy objectives (e.g., reducing financial vulnerability) and/or in the form of financial benefits flowing to the government in proportion to the risks assumed including, for instance, through the receipt of a fee for the provision of the government guarantee: the greater the risk borne by government, the greater the need for benefits to flow in support of government objectives and interests. In short, any risk-sharing arrangement between the government and the private sector needs to involve a proportionate sharing of risks and benefits; otherwise, there may be adverse incentives and impacts.

These design considerations are relevant in considering the various possible forms of institutional arrangements that could be adopted if the government decides to intervene in insurance markets, in those countries where such markets are well-developed. Table 13 outlines key practical decision-making steps that a Finance Ministry can consider in designing a national institutional arrangement, particularly for any scheme linked to intervention in insurance markets.

As a first step, there first needs to be a determination of the scope of hazards to be covered by the scheme and the type of coverage (e.g., residential, commercial, public assets, business interruption). This determination will be linked to the nature and scale of risk exposures linked to each of the hazards, risk-bearing capacities, the implications of any financial vulnerabilities for the wider economy and social welfare, and broader considerations such as the state of development of insurance markets and the types of disasters the insurance industry is capable of handling efficiently.

As a second step, the government needs to determine the type of coverage to be provided under the scheme. Existing institutional arrangements currently cover different types of perils (see Table 14). Some of them have a broad scope of application, providing coverage for a wide range of disaster risks, while others focus instead on single perils - such as earthquake, flood or terrorism - or categories of perils - such as geological or hydro-meteorological hazards. Separate institutional schemes have been set up in a number of countries to cover different types of disasters. While multi-peril disaster insurance schemes allow for broader coverage, they also raise complex issues related to underwriting and pricing, as setting premium rates adequate to cover all the expected costs of disaster losses caused by different perils requires sophisticated determinations. In some countries, multi-peril coverage has been introduced to achieve a higher level of risk pooling and some degree of cross-subsidisation. On the other hand, countries with very high exposures to one main peril - such as earthquake - have often chosen to focus on a single-peril approach.

Table 13: Key elements of national institutional arrangements

1) Hazards covered	• Single • Pre-selected group • All
2) Scope of coverage	• Residential property • Commercial property • Public assets • Business interruption
3) Role of government	***a) Role in direct compensation***
	• Pre-specified financial assistance arrangements and programmes provided directly by the government
	b) Role in insurance markets
	• Backstop liquidity provider • Reinsurer • Direct insurer • Guarantor
	…key features of policies under schemes for insurance markets
	i) Extent of compulsion
	• Mandatory offer • Mandatory extension • Mandatory purchase
	ii) Pricing
	• Flat • Risk-based

The institutional disaster insurance solutions currently adopted differ in terms of type of losses covered (see Table 15). While the vast majority of schemes provide coverage for property damage, the type of properties concerned may vary significantly (e.g., commercial, industrial, residential, agricultural, infrastructures). Natural hazards are generally likely to impose catastrophic costs on households (e.g., loss of or severe damage to home), with the result that residential property is generally covered by disaster insurance schemes. The commercial sector is, by comparison, more likely able to retain these risks or better placed to negotiate coverage. Consequently, institutional schemes covering one or more natural hazards therefore typically apply to residential property only. By contrast, certain man-made threats such as terrorism are more likely to affect the commercial sector, particularly key systems or nodal points (e.g., energy, transport, telecommunications). Accordingly, terrorism insurance schemes typically tend to cover commercial property and other related risks such as business interruption, although some schemes provide coverage for the household segment.

Table 14: Scope of coverage under disaster compensation and insurance schemes (*country examples*)

Natural hazards	Man-made accidents	Both
Disaster insurance scheme		
Belgium (earthquake, flood, storm, landslide and ground subsidence – *disaster insurance program*) **California** (earthquake – *California Earthquake Authority*) **Denmark** (storm surge – *Danish Storm Council*) **France** (natural perils, technological accidents, terrorism – *under three different insurance programs*) **Japan** (earthquakes, volcanic eruptions and resulting tsunami - *JER*) **New Zealand** (earthquake, natural landslip, volcanic eruption, hydrothermal activity, tsunami + storm and flood for residential properties – *Earthquake Commission*) **Norway** (landslide, avalanche, storm, flood, earthquake and volcanic eruption – *Natural Perils Pool*) **Switzerland** (flood, inundation, windstorm, hail, avalanche, snow pressure, rock and stone fall, landslide - *Cantonal Public Insurance Companies + private insurance companies*) **Turkey** (earthquake – *Turkish Catastrophe Insurance Pool*) **United States** (earthquake – California Earthquake Authority, flood – *National Flood Insurance Program*)	**Australia** (terrorism - *Australian Reinsurance Pool Corporation*) **Belgium** (terrorism - *Terrorism Reinsurance and Insurance Pool*) **Denmark** (terrorism – *Terrorism Insurance Pool for Non-Life Insurance*) **France** (terrorism and technological accidents – *under two different insurance programs*) **Germany** (terrorism – *Extremus AG*) **Netherlands** (terrorism - *NHT*) **South Africa** (riots, strikes, political unrest, terrorist attacks, civil commotion, public disorder and labour disturbances – *SASRIA Limited*) **United Kingdom** (terrorism - *Pool Re*) **United States** (terrorism – *TRIA*)	**Spain** *(*all extraordinary risks, including natural perils and terrorism - *Consorcio de compensacion de seguros)*
Government compensation arrangements		
Australia (bushfire, earthquake, flood, storm, cyclone, storm surge, landslide, tsunami, meteorite strike, tornado (excluding drought, frost, and heat wave) - *Natural Disaster Relief and Recovery Arrangements or NDRRA*) **Canada** (natural perils - *Disaster Financial Assistance Arrangements or DFAA*) **European Union** (natural perils – *EU Solidarity Fund*) **Hungary** (flood - *Wesselényi Miklós Compensation Fund for Flood and Inland Waters Protection*) **Mexico** (earthquake, volcanic eruption, avalanche, tidal wave, landslide, atypical drought, cyclone, extreme rains, snowfall and hailstorm, atypical floods, tornado, forest fires – *FONDEN*) **Netherlands** (earthquake, freshwater floods – *Calamities Compensation Act*) **Norway** (natural perils – *National Fund for Natural Damage Assistance*)		

Table 15: Scope of coverage under disaster insurance schemes

Country examples

Residential property damage	Commercial property damage	Infrastructure	Business interruption
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*) **Netherlands** (terrorism - *NHT*) **New Zealand** (natural perils - *Earthquake Commission or EQC*) **Norway** (natural perils –*Natural Perils Pool*) **Spain** (all extraordinary risks – *Consorcio*) **Turkey** (earthquake – *Turkish Catastrophe Insurance Pool*) **United States** (flood – *National Flood Insurance Program*)	**Australia** (terrorism - *ARPC*) **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*) **Norway** (natural perils – *Natural Perils Pool*) **Spain** (all extraordinary risks – *Consorcio*) **United Kingdom** (terrorism - *Pool Re*) **United States** (terrorism – *Terrorism Risk Insurance Program*)	**Iceland** (natural perils - *Iceland Catastrophe Insurance*)	**Australia** (terrorism - *ARPC*) **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*) **Spain** (all extraordinary risks – *Consorcio*) **United Kingdom** (terrorism - *Pool Re*) **United States** (terrorism – *Terrorism Risk Insurance Program*)

As a third step, the appropriate role for the government in the scheme needs to be determined. The role of the government in any financial scheme will be governed by the nature of the scheme, policy objectives, and an assessment of the extent to which the government should assume the costs of disaster risks to be covered by the scheme. For pure compensation schemes, the government will directly assume responsibility for the financial liabilities specified by scheme (possibly co-shared with other levels of government), which must be funded either on an ex ante basis through reserves and other financial tools or on an ex post basis through budget reallocations, debt financing, and the like. Existing institutional arrangements for disaster insurance involve the government assuming different types of roles:

- **Backstop liquidity provider**: The government provides liquidity, through a pre-arranged loan facility, to insurers to relieve funding pressures and enable them to make payments on a potentially large number of claims linked to a catastrophic event. This arrangement can take the form of liquidity facilities provided to an entity established to reinsure disaster-related liabilities. Under this approach, insurance companies retain the ultimate risk, but the government provides risk financing to address immediate short-term liquidity needs or help to smooth catastrophe losses over time.

- **Reinsurer**: The government or a special entity established by the government assumes some or all of the liabilities assumed by insurers in connection with disaster risks, and then possibly cedes some or all these risks to global reinsurance markets. This arrangement is aimed at removing industry exposure to peak risks. It may be justified if insurers can retain a portion of the risk, but there is not enough reinsurance capacity on the private market to provide the required risk transfer arrangements. It may also be part of a broader institutional arrangement in which there is mandatory offer, purchase, or extension of disaster risk coverage, and thus may be aimed at protecting insurer sector solvency.

- **Direct insurer**: Alternatively, the government or a special entity established by the government in some countries directly provides disaster insurance. Some or all of these risks may be ceded to global reinsurance markets. This approach may be a response to a situation where the private insurance sector is unwilling or unable to provide any coverage of disaster risks. While there is no risk sharing with the insurance industry, private-sector operational capacity is often used to perform such functions as marketing, premium collection and claims handling on behalf of the government.

- **Guarantor:** Where institutional arrangements exist, governments often explicitly guarantee some or all of the liabilities assumed in connection with disaster risks. Such a guarantee might arise in connection with a special purpose entity, pool or fund created to cover catastrophic risks to ensure that it will meet all its obligations. Thus, the role of guarantor can be combined with other risk financing or risk transfer functions provided by the government. The guarantee may be capped, with a threshold after which losses may be recouped against, for instance, policyholders (e.g., special premium surcharge, reduction in claims).

See Table 16 below for an overview of the advantages and disadvantage of each of the main approaches (liquidity provider, direct insurer, reinsurer) and Table 17 for country examples.

Table 16: Schemes designed to support disaster insurance

	Advantages	***Limitations***
Backstop liquidity provider	• Appropriate where risks are more easily managed by the industry	• Depending on pricing, terms and conditions, may crowd out capital market solutions
Reinsurer	• May be implemented easily and quickly • Seeks to maintain, to the greatest extent possible, industry involvement and may help to limit fiscal exposure • With industry retaining the first layer of loss, aligns incentives of insurance industry with the reinsurance provider • Able to fine-tune risk-sharing and, should circumstances warrant, gradually withdraw government support	• Depending on the extent of compulsion, pricing, terms, and conditions of the reinsurance, may crowd out reinsurance market capacity and inhibit the development of capital market solutions
Direct insurer	• Promotes widespread financial coverage • Able to introduce social objectives into coverage should there be a need	• May discourage adaptation and innovation in insurance markets in the long run • May be difficult for the government to limit fiscal liability or to exit without disruption

The examples in Table 17 show that countries with similar major disaster risks (e.g., Japan, New Zealand for earthquake risk) may nonetheless adopt different institutional approaches, with different forms of government financial commitments and laying strategies. Yet countries facing similar disaster risk profiles with similar levels of insurance penetration will likely similar decisions regarding the optimal level of risk-sharing with the insurance industry, involving an assessment of the extent to which the government should accept disaster risk as an explicit contingent liability and how best to limit remaining implicit contingent liabilities, while taking into consideration possible benefits and adverse impacts of various alternative approaches. The examples also highlight, despite the different approaches to the role of government, the reliance placed by government, where insurance markets are developed, on the insurance sector and its methods and operational capacities to fulfil certain operations (e.g., direct insurance within a layering strategy, claims management), suggesting that some form of partnership with the insurance industry is needed to maximise the capacity of the insurance sector and achieve policy objectives efficiently.

Table 17: Roles of government in disaster insurance schemes ***Country examples***
Backstop liquidity provider
United Kingdom (*Pool Re*)
Reinsurer
Australia (*Australian Reinsurance Pool Corporation or ARPC*)
Belgium (*Caisse nationale des calamites* + participation in *Terrorism Reinsurance and Insurance Pool*)
Denmark (participation in *Terrorism Insurance Pool for Non-Life Insurance*)
France (*Caisse Centrale de Réassurance or CCR*)
Japan (*Japan Earthquake Reinsurance Co., Ltd. or JER*)
Germany (participation in Extremus AG)
Netherlands (participation in *Nederlandse Herverzekeringsmaatschappij voor Terrorismeschaden or NHT*)
United States (participation in *Terrorism Risk Insurance Program*)
Direct Insurer
Iceland (*Iceland Catastrophe Insurance or ICI*)
New Zealand (*Earthquake Commission or EQC*)
South Africa (*SASRIA Limited*)
Spain (*Consorcio de compensacion de seguros*)
Turkey *(Turkish Catastrophe Insurance Pool)*
United States (*California Earthquake Authority*, *National Flood Insurance Program or NFIP*)
Guarantor
Australia (*Australian Reinsurance Pool Corporation or ARPC*)
Denmark (storm surge - *Danish Storm Council*)
France (*Caisse Centrale de Réassurance or CCR*)
New Zealand (*Earthquake Commission or EQC*)
Spain (*Consorcio de compensacion de seguros*)
United States (*National Flood Insurance Program or NFIP*)

Where a decision has been made to establish a national disaster insurance scheme, the nature and degree of compulsion needs to be decided. Some element of compulsion is generally a part of any disaster insurance scheme involving a government financial commitment; it provides the mechanism by which coverage is promoted and policy objectives are met, namely adequate financial protection, ensuring that the risks linked to the financial commitment yields appropriate benefits. The nature and extent of compulsion varies across schemes (see Table 18).

Table 18: Mandatory nature of coverage under disaster insurance schemes

Country examples

Mandatory offer	Mandatory purchase	Mandatory extension
California (earthquake) **Japan** (earthquakes, volcanic eruptions and resulting tsunami) **United States** (earthquake (California), terrorism)	**Turkey** (earthquake) **Iceland** (earthquake, volcanic eruption, snow avalanches, landslides and floods) **Switzerland** (natural perils, excluding earthquake - *Cantonal Public Insurance Companies for Buildings in 19 cantons + private insurance in 3 cantons)*	**Australia** (terrorism) **Belgium** *(*natural perils and terrorism – *under two different insurance programs)* **Denmark** (storm surge) **France** (natural perils, technological accidents, terrorism – *under three different insurance programs)* **New Zealand** (earthquake, natural landslip, volcanic eruption, hydrothermal activity, tsunami + storm and flood for residential properties) **Norway** (natural perils) **Spain** (all extraordinary risks)

While some countries have made the purchase of disaster insurance coverage mandatory, others have required insurance companies to make disaster insurance available by introducing a mandatory offer of coverage that can be declined by the policyholder. The effectiveness of enforcement mechanisms to ensure compliance with the mandatory purchase requirement is a key component of this policy. In a number of countries, moreover, fire or other first party insurance policies are marketed on a voluntary basis, but insurance companies are required by law to include coverage for disaster risks in such policies. An overview of the main advantages and drawbacks of a compulsory approach within a disaster scheme is provided in Table 19.

Table 19: Compulsory versus mandatory insurance schemes

	Advantages	***Limitations***
Mandatory purchase	• Promotes the expansion of disaster insurance coverage, which should help to reduce insurance costs overall • Eliminates the risk of self-selection (i.e., those who perceive themselves to not be at risk may not purchase insurance, possibly increasing risks in the pool) • Addresses potential behavioural biases, which may otherwise lead to inadequate coverage • Serves to clarify the allocation of disaster costs and reduces the government's implicit contingent liabilities	• May be unpopular and perceived as a tax • May run contrary to the culture of the country and constitutional constraints (e.g., limit to private autonomy) • Enforcement of purchases may be difficult • Given the captive market, insurance sector may seek to build strong profit margins into premium rates; at the other extreme, inadequate pricing may lead to underwriting losses and drain capital from the industry • Mandated pricing may become overly influenced by other policy objectives
Mandatory offer	• Promotes the expansion of disaster insurance coverage, so that businesses and individuals who are willing to purchase financial protection can do so • Aligned with country settings where mandatory purchase could pose problems for cultural and other reasons	• May lead to self-selection: those who perceive themselves to not be at risk may not purchase insurance, possibly increasing risks in the pool and leading to sub-optimal take-up rates; low risk awareness or cognitive biases may aggravate this effect • Inappropriate pricing may lead to underwriting If the penetration rate remains very low, there may be inadequate risk pooling
Mandatory extension *i.e., mandatory inclusion of disaster coverage in basic voluntary property insurance policies*	• Can be effective if the penetration rate of the underlying basic policies is relatively high, so that they are used as a vehicle to spread disaster insurance coverage • Compared with the mandatory purchase of disaster insurance, this option entails a lower degree of compulsion and may be less unpopular	• May have negative effects on the market for the basic property policy to which the mandatory disaster extension applies • Tying different products together (e.g., fire and flood insurance) may distort competition as policyholders would be forced to choose the same insurer for coverage of both risks

Similarly, the pricing mechanism within a national disaster insurance scheme needs to be addressed. The pricing mechanism within any related formalised risk-sharing arrangement between government and industry is important as it can affect the success of the scheme in meeting policy objectives and influence the balance of risks and rewards for government and industry. Risk-based pricing incorporates risk differentials across the territory reflecting the technical risks (e.g., nature and scale of the hazard, vulnerability factors) and incentives to encourage risk reduction (e.g., price reductions for installation of storm shutters, wind resistant glass). Flat-rate pricing is based on a fixed percentage of the base premium or a percentage of the amount to which the property is insured, without specific risk differentials.

While some schemes apply a risk-based pricing mechanism, others adopt flat pricing (see Table 20). As can be seen in Table 20, risk-based pricing appears to be universally applied in terrorism risk insurance schemes, unlike natural disaster insurance schemes where either approach may be used. If affordable, risk-based pricing may promote coverage against damage by ensuring a risk-adequate premium, tailored to the risks facing individuals and businesses. Risk-based pricing may also provide

signals to individuals regarding the hazards they face, thus encouraging the adoption of mitigation measures that may lie within their capacity to address and promoting a culture of risk reduction. It may also encourage local authorities to undertake critical risk reduction investments and encourage spatial planning that is responsive to disaster risks, both of which should help to lower disaster costs and make insurance more affordable. Flat-rated pricing may, however, provide greater assurance of general affordability of disaster insurance as the cost of insurance is cross-subsidised across the entire insured pool, which may enhance penetration. It may also reinforce national solidarity.

However, under flat-rate pricing, any risk incentives offered by risk-based pricing are diminished at the level of the individual or business covered by insurance. Decision-making at the individual, business and local (or national) government level will not benefit from the cost signals provided by insurance markets on critical risks, leading to decisions that are likely to increase risk rather than reduce it, such as overbuilding in hazard-prone areas. Flat-based pricing may also be regarded as burdensome if not unfair by those at low risk.

In order to strengthen risk reduction incentives under a scheme with flat-rate pricing, risk differentials may be introduced through differential deductibles. For instance, in France, deductibles vary with the implementation of regional prevention measures: insofar as prevention measures have not been implemented, deductibles increase in line with the number of disasters in the region that have been declared in the last five years, for instance quadrupling if five or more disasters have been declared for the region. Alternatively, flat-based pricing may apply to a basic level of coverage as a means to ensure broad-based coverage of disaster insurance, with coverage above this level provided under competitive market conditions where rates may be risk-based, as is the case in New Zealand. Another approach can involve, as is the case in Denmark, the scheme refusing to provide indemnification in cases where the damaged building was built in an area known in advance to contain serious risk, failed to observe building standards, was built based on an inappropriate design or using inappropriate materials, or was poorly maintained.

A risk-based pricing scheme may be difficult to implement since it requires insurers to invest in costly risk assessment to differentiate customers properly. Many countries have opted for a more pragmatic and simplified approach to risk-based pricing, using broad gradations of risk by selecting risk indicators (e.g., prior claims) or risk determinants (e.g., location, construction type or the adoption of mitigation measures) to enhance implementation efficiency. However, other countries have opted for more granular risk classifications. Table 21 provides further consideration of the advantages and disadvantages of risk-based pricing.

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Table 20: Pricing mechanisms used by disaster insurance schemes (country examples)	
Risk-based pricing	
Australia (terrorism - *ARPC*)	Reinsurance premium levels between 2% and 12% (depending on risk and location) of underlying commercial property insurance premia have been mandated from October 1, 2003. Reinsurance rates may be increased up to three times after an event. Direct insurers are free to set premia to be paid by insureds.
France (terrorism – *GAREAT*)	Direct insurers set the rates to be applied on original policies. Pool members cede the following rates (expressed as % of property insurance premia) to GAREAT: **Large Risks section** - Insured value between EUR 20 million and < EUR 50 million: 12% / Insured value ≥ EUR 50 million: 18% / Nuclear: 24 % **Small and medium sized risk section** - Insured values below EUR 6 million: Motor:0.10% / Personal lines:0.80% / Professional risks:1.20% / Agricultural:0.60% / Hulls light aircraft < EUR 1 million:2.5% / Pleasure craft Hulls <EUR 1 million 1.25% - Insured value between EUR 6 million and < EUR 20 million: Motor, Personal Lines, Professional risk, agricultural: 4%
Germany (terrorism – *Extremus AG*)	Ratings are between 0.075‰ and 0.45‰ of the sum insured. Pricing depends on location (3 tariff zones) and specification (8 risk categories requiring a surcharge) of risks.
Japan (earthquake - *JER*)	Premium rates are calculated by the Non-Life Insurance Rating Organization of Japan (NLIRO). Rates depend on building location (several risk zones) and construction material (wood or non-wood); special discounts are applied according to construction age, seismic isolation and/or the installation of particular quake-resistance structures.
Turkey (earthquake - *TCIP*)	The TCIP has a simple pricing matrix: pricing accounts for seismicity, total floor area, and the type and quality of construction. Prices range from 0.44‰ to 5.5‰. The earthquake map used by TCIP divides Turkey into 5 different risk zones whereas the tariff divides buildings into 3 categories according to their construction types.
United Kingdom (terrorism – *Pool Re*)	Reinsurance is provided to members at rates stipulated in the Underwriting Manual. The material damage rates are related to geographic zones by postcode within the United Kingdom; in broad terms these are grouped in Central and Inner London, other city centres, and the rest of England together with Scotland and Wales. There is a single rate for business interruption, which is not allocated to particular zones. Rates are applied to the full value at risk. Members are free to set the premia for their underlying policies.
United States (terrorism – *Terrorism Risk Insurance Program*)	Direct policy premia subject to state law (with exception for premia charged prior to 31 December 2003). No initial premium for government reinsurance backstop, but amounts paid to insurers are subject to mandatory and discretionary recoupment via surcharge on policyholders as set by the Secretary of the Treasury.

Flat-based pricing	
Denmark (storm surge – *Danish Storm Council*)	The single premium consists of an annual charge of DKK20, added to the premiums for all fire policies.
France (natural perils - *CatNAT*)	By law the premium for the CatNAT guarantee has been established as a supplemental premium to the premium of the basic insurance policy. The rate is determined by a flat pricing mechanism. At present, the rate is set at 12% of the premium for property other than motor vehicles and at 6% of the premium for fire and theft of motor vehicles.
Iceland (natural perils - *Iceland Catastrophe Insurance*)	Single rate for the entire national territory, for every type of risk, without differentiation. Buildings and contents: 0.25 ‰; infrastructures: 0.20 ‰
New Zealand (earthquake - EQC)	Standard premium of 15 cents per NZD100 sum insured.
Norway (natural perils – *Natural Perils Pool*)	An additional premium is applied at a rate of 0.11‰ of the sum insured in the base policy, without distinction of geographical zone, class of risk or type of property
Spain (all extraordinary risks – *Consorcio de compensacion de seguros*)	The tariff is applied uniformly across the territory to the sum insured established in the ordinary policy. Houses and condominiums: 0.08 ‰ / Offices: 0.12 ‰ / Shopping and commercial centres: 0.18 ‰ / Industrial risks: 0.21 ‰ / Cars: fixed amount (depending on the class) / Civil works: different rates (0.28‰ to 1.63 ‰) / Life and accidents: 0.005 ‰) / Business interruption: several rates (0.005‰ to 0.25‰).

Table 21: Approaches to pricing in schemes

	Advantages	***Limitations***
Risk-based pricing	• Ensures the adequacy of premiums to enable insurers to meet the expected costs of disasters • Provides incentives for risk prevention and mitigation for those exposed to risk to the extent that such measures are within their reach • Signals risks to individuals and businesses, and provides incentives for disaster risks to be factored into decision-making • Helps authorities identify areas of high risk, thus helping to prioritise physical reduction measures and measure the reduction of risks through time • Encourages authorities to consider disaster costs in local decision-making e.g., land use planning, zoning, etc., in order to reduce premium levels	• May require costly insurer investment in location-by-location risk assessments • May result in insurance becoming prohibitively expensive in high-risk zones, particularly for poorer households, leading to lack of adequate coverage in these zones, unless addressed by government subsidies • May not be effective in promoting risk reduction given that the scope for individual actions to reduce risks and thus influence the level of premiums may be limited. Physical risk reduction may be more effective if undertaken at a local, regional or national level (or by a large commercial enterprise), whose actions may have a greater impact on rates.
Flat-based pricing	• Allows solidarity at the national level • Eliminates the need for risk assessments for the purpose of premium-setting, thus reducing costs • If priced properly, may provide an effective mechanism to broaden the pool of risks, helping to lower premiums overall, while at the same time enabling cross-subsidisation across the insured pool to ensure maximum insurance coverage	• Unless the purchase of insurance is mandatory, may lead to self-selection: those who perceive themselves to not be at risk may not purchase insurance, possibly increasing risks in the pool • Inappropriate pricing may lead to underwriting losses, lowering insurer returns and putting them at risk, which may inhibit capital provision • Reduces incentives to adopt cost-effective risk reduction measures (moral hazard). Deductibles may, however, mitigate this impact, particularly if they are made variable, reflecting risks • Reduces incentives for governments to consider risks in local decision-making, e.g., land use planning, zoning, etc, and reduces the ability of markets to identify risk zones and measure costs • Cross-subsidisation may be achievable within each differently rated class of policyholders

Governmental intervention in disaster risk financing and risk transfer may be considered at the national level but could involve a partnership among governments at the sub-national or international level, in possible collaboration with sub-national or international institutions and the financial sector (see Table 22).

Table 22: Examples of regional schemes to promote risk financing and risk transfer

Scheme	Purpose and coverage	Nature of scheme
Caribbean Catastrophe Risk Insurance Facility (CCRIF)	Reduce fiscal impacts of disasters (hurricanes, earthquakes, excess rainfall)	CCRIF is a country risk pooling facility owned and operated by participating Caribbean governments. In return for premiums, the pool provides a payout when a policy is triggered. Policies are based on parametric triggers (in this case, modelled government loss) and are designed to provide governments with the funds needed to manage the immediate aftermath of a disaster. Coverage limits are determined by governments, but no country can purchase coverage in excess of USD100 million per hazard. Payments are made on a sliding scale relative to scale of the loss. The pool's capacity is augmented by the purchase of reinsurance and a catastrophe swap with the World Bank. The World Bank provides oversight of the CCRIF and manages a trust fund, used to support the CCRIF, on behalf of foreign donors.
Southeastern Europe and the Caucasus Catastrophe Risk Insurance Facility (SEEC CRIF)	Increase access to disaster insurance coverage for homeowners, SMEs, farmers, utilities, and government agencies , reduce government contingent liabilities (earthquake and fire following, flood, hail, and extreme temperature and precipitation such as drought and freeze)	Parametric and indemnity products are provided through Europa Re, a multilateral, Swiss-based government-owned organisation specialised in regional reinsurance mandated to provide reinsurance and pricing, underwriting, risk management and claims settlement services to private insurance companies in member states. These services are intended to allow local insurers to focus on product sales and increase catastrophe insurance protection. Government participation in Europa Re is supposed to be wound down after 5 years and placed on a self-sustaining basis.
Pacific Disaster Risk Insurance Pilot Program	Reduce fiscal impacts of disasters (tropical cyclones, earthquakes)	Parametric insurance policies will be developed with participating Pacific Island governments and pooled. Premium subsidies will be made available to low-income governments. The capacity of the pool to make claims will be enhanced through reinsurance. The World Bank is to provide technical assistance in designing country-specific policies.
Sources: The Caribbean Catastrophe Risk Insurance Facility (www.ccrif.org), Pacific Disaster Net (www.pacificdisaster.net), Europa Re (www.europa-re.eberlesystems.ch), Global Facility for Disaster Reduction and Recovery (www.gfdrr.org), World Bank (www.worldbank.org)		

When considering or reviewing the government's role in risk financing or risk transfer and related institutional arrangements, it is useful to undertake a comparative assessment of institutional approaches to disaster risk financing and transfer, drawing on other countries' experiences and good practices, seeking to understand what strategies might work well and which might be unsustainable or otherwise unsuitable to local conditions, and modifying approaches as warranted. Information-sharing and expert opinions from relevant countries are beneficial in this context, as well as relevant reports and analyses conducted on country approaches. If institutional arrangements are for any reason established, the government should conduct a regular review of these arrangements to ensure their continued suitability in light of conditions in risk financing and risk transfer markets and prevailing policy objectives.

CONCLUDING REMARKS

With disasters presenting a broad range of social and economic impacts, causing damages to lives, buildings and infrastructure and disrupting activities, ensuring that the economy has the resources necessary to recover, rebuild and resume economic growth is critical to effective disaster risk management.

Achieving financial resilience depends on the development of financial strategies that rely on country risk assessment and financing tools, which are the focus of this methodological framework. Identifying and accurately evaluating natural and man-made disaster risks is necessary to comprehend the scale of expected losses and anticipate post-disaster financial needs. This is the starting point for identifying financial vulnerabilities within the economy and the appropriate roles of risk financing and risk transfer tools and government compensation mechanisms in addressing these vulnerabilities. More generally, risk assessment enables an estimation of the likelihood and potential impacts of disasters and the identification of their underlying physical and societal drivers. It also leads to the identification and evaluation of cost-effective risk reduction measures and early warning and emergency management capabilities that can directly reduce disaster costs.

Finance Ministries have a key role in ensuring an effective approach to the financial management of disaster risks – promoting the role of risk financing markets where feasible, ensuring the proper design of any market interventions, considering the development of public financial aid arrangements and programs as a complement to any private compensation mechanisms and engaging in sound fiscal management of government contingent liabilities. Being centrally placed to affect the financial sector, budget making and the provision of financial guarantees, Finance Ministries have the responsibility to ensure that financial strategies for DRM are well integrated, efficient and effective. At a time when many countries are facing severe financial constraints, identifying the source of potential contingent liabilities and providing ex ante frameworks for managing them contributes to more robust public finances in the long term. Finance Ministries also have an important stake in ensuring the quality and policy relevance of country risk assessments and strengthening their own input into the risk assessment process as a means to ensure the development of cost-effective DRM strategies and financial strategies.

This methodological framework provides for a flexible, open-ended framework that encapsulates the key issues from a broad, economy-wide perspective and is capable of addressing differences in country circumstances. Yet it also provides substantive and voluntary guidance for decision-making, in particular by financial authorities, with concrete examples as illustrations. The activities outlined in this framework are complex, difficult and resource-intensive, requiring pragmatic approaches and strategies that recognise financial constraints and the inherent unpredictability of disasters. The framework is however not exhaustive and further work may be considered.

In this respect, establishing a solid evidence base through the collection of data on hazards, exposures, vulnerabilities and losses is crucial to disaster risk assessment and risk financing and DRM strategies overall and requires national, regional and global databases capable of pooling data from diverse sources, helping to enrich risk assessment and enabling the development of more cost-effective, innovative risk financing tools.

The measures covered in the framework also need to be coordinated with risk prevention and mitigation measures, for which risk assessment provides an underpinning, and which can be influenced by financing mechanisms. Strengthening risk prevention and mitigation measures further is also key to improving resilience to natural and man-made risks. Broadening the analysis in this dimension would help to strengthen the underpinning for country approaches towards disaster risk management and its financial implications for Ministries of Finance.

Further work may also include the development of more detailed guidelines, consistent with the framework. This may for instance include further understanding of the contingent liabilities and budgeting mechanisms that help frame public policy responses to disaster risks and issues related to disasters affecting financial infrastructure and systems with a focus on their sustainability and business continuity.

Follow-up work could also include consideration of financing mechanisms designed to enable sustained prevention and mitigation investments (e.g., mitigation funds, development programs), which would complement the focus in this framework on financially managing disaster losses. It could also include the development of guidance and case studies for governments in developing countries that may be operating in extremely resource-scarce environments, in which people may be highly vulnerable to disasters and lack access to needed resources and financial tools to mitigate disaster impacts; in this context, consideration could for instance be given to the institutional capacities needed to support risk assessment and the elaboration of financial strategies and the role of civil society organisations in these respects.

ANNEXES

I. SELF-ASSESSMENT GUIDING TOOL

II. TERMINOLOGY

I –SELF-ASSESSMENT GUIDING TOOL

This list of issues is to help countries who would wish to self-assess their risk assessment and financing strategies and in particular their position against the key elements and capacities identified and presented in the methodological framework for disaster risk management focusing on risk assessment and risk financing strategies. Periodic self-assessment exercises are encouraged as an effective tool for countries to review, monitor and improve the quality of DRM strategies.

A. RISK ASSESSMENT	
1. GOVERNANCE	
ISSUE	**ANSWER**
a. Do we conduct an *all-hazards risk assessment* for potential disasters at central level? If not, what is the scope of our national risk assessment(s)?	
b. What are the declared objectives of our government-sponsored disaster risk assessment(s)?	
c. Are highest-level policymakers, including the Ministry of Finance/Treasury, provided with a comprehensive view of *disaster risks* to vital interests and of their possible impacts and interrelationships?	
d. For what purposes are the results of disaster risk assessment(s) used?	
e. Do we have official or otherwise commonly accepted definitions of terminology used in risk assessments, e.g. "*risk*", "*hazard*", "*disaster*", and/or "*disaster risk*"? What are they? Are such definitions used consistently throughout DRM policies?	
f. Is there an agreed methodology for the risk assessment? Has this methodology been disclosed, and to whom?	
g. Are the sources of data and information used in risk assessment identified and documented? To what extent is any of this information made accessible to the public?	
h. Have potential biases in the sources of information and expert opinion been identified and addressed?	
i. Are the limitations of data and information used in risk assessment identified and documented?	
j. What *reporting mechanisms* have been established to ensure that the results of the risk assessment are communicated internally and, as appropriate, externally?	
k. What *accountability mechanisms* are in place to ensure that risk assessments are of the highest possible quality? Is there an authority responsible for overseeing the risk assessment process and its outcomes?	

l. Who are the *key stakeholders* in disaster risk assessment in our country and how are they involved in the process?	
m. Which governmental authority has lead responsibility for *all-hazards disaster risk assessments* in our country?	
n. If more than one authority or entity, is responsible for *disaster risk assessment*, how is coordination ensured?	
o. Are *disaster risk assessments* conducted by governmental bodies or contracted to external third parties?	
p. To what extent is coordination undertaken with sub-national levels of government and/or in cooperation with other countries or supra-national authorities? How are these efforts coordinated and for which components of the risk assessment?	
q. According to what procedure and how frequently is the *budget for risk assessment activities* determined or reviewed in our country? Are resources for disaster risk assessment made available on a long term or recurring basis? How is their adequacy evaluated and by which authority?	

2. RISK ANALYSIS	
ISSUE	**ANSWER**
a. What is the process for collecting, storing and updating the data on *hazards* (natural and man-made) that are used in disaster risk assessment?	
b. What are the most relevant *hazards* (natural and human made) to our country's vital interests? How are these hazards spatially distributed?	
c. What tools and procedures do we employ to assess the expected *frequency and severity* of hazards (natural and man-made hazards)? Can we assess the *probability of occurrence* of a hazard of a given magnitude at a given location within our country in each year?	
d. Do we take into account the interactive and cumulative effects of multiple hazards in the disaster scenarios affecting our country's vital interests? (e.g., by analysing a scenario characterised by at least two hazards, natural or man-made, in combination or sequence)	
e. If yes, how do we quantify the expected consequences in terms of casualties and economic and financial losses? With what degree of confidence?	
f. What are the main *sources of vulnerability* within our country? These may be categorised along the following dimensions: (i) physical (ii) human and social (iii) economic and financial (iv) environmental (v) institutional What are the *main trends or factors* influencing vulnerability?	
g. What is the process for collecting, storing and updating data on *exposures* and *vulnerabilities* to hazards (natural and man-made) in our country?	

h. Do we keep track of public expenditures on disaster risk reduction investments? How is data collected across government ministries? Is this data disclosed to the public?	
i. Do we have a complete and updated geocoded inventory of: (i) public assets exposed to hazards? (ii) critical infrastructures exposed to hazards? (iii) infrastructures that reduce exposure and/or vulnerability across the national territory (e.g., flood defences, early warning systems, lifelines)? (iv) private assets exposed to hazards?	
j. Do we have reliable and updated geocoded information on: (i) the type, number and size of business activities exposed to hazards? (ii) the size of population exposed to hazards?	
k. What are the technical tools, procedures and methodologies (if any) that we employ to translate expected *physical losses* into *financial terms*?	
l. Are data generated on the *average annual cost* (based on historical losses) of disaster risks (for each type of hazard and in aggregate) for our country?	
m. Are data available to quantify the expected economic and financial consequences of a given disaster event suffered by our country? And its impact on *public finances*?	
n. How are the results of the risk assessment process documented?	
o. How do we identify, assess and document the *level of uncertainty* and, therefore, the degree of confidence, in disaster risk assessment?	
p. How are disaster risk assessment activities reviewed, monitored and validated in our country?	
q. Who is responsible for the identification and monitoring of *emerging risks* (all-hazards) facing our country? What is the nature of this forward-looking monitoring (e.g., time horizon)? What is the process in place to perform this task? Does it involve a separate risk assessment process or is it combined with the general disaster risk assessment process?	
3. RISK COMMUNICATION AND AWARENESS	
ISSUE	**ANSWER**
a. Is the outcome of disaster risk assessment communicated to *decision-makers* in the public and private sectors? In what form?	
b. Is the outcome of disaster risk assessment communicated to the *general public*? In what form?	
c. Are hazard and/or risk maps available for all relevant hazards and for the entire territory of our country? To what extent, if any, are they publicly accessible and disseminated?	
d. What strategy is in place to educate citizens and businesses about the hazards and threats facing our country and provide guidance on what they can do to prepare for the major risks?	

4. POST-DISASTER IMPACT ANALYSIS AND QUANTIFICATION	
ISSUE	**ANSWER**
a. Do we conduct *post-disaster impact assessments*? Do we compile post-disaster evaluation reports according to a consistent methodology? Are such reports publicly disseminated?	
b. Who is responsible for collecting, storing and updating data on *disaster losses* and *fatalities, injuries and displaced persons*? What process is followed?	
c. Are data readily available to quantify public expenditure (from either central, regional and local governments) disbursed to pay for *disaster losses* in the past year? And over the past ten and fifteen years - both on a yearly and aggregate basis?	
d. Is there a breakdown available of such public expenditure by type of hazard (natural and man-made) and by type of disaster losses paid for (e.g., damages to public buildings and infrastructures, damages to private assets, essential goods, business interruption losses, etc.)?	
e. Are data available to quantify the financial value of *disaster losses* sustained during the past year? And over the past ten and fifteen years - both on a yearly and aggregate basis?	
f. Are there data available to assess *disaster losses* with a breakdown by major segment of the economy, namely: (i) governments (central, regional and local) (ii) households (iii) the corporate sector (iv) the financial sector?	
g. What procedures are in place to incorporate the outcome of *post-disaster impact assessments* in future potential *disaster risk assessments*?	
5. POLICY IMPLICATIONS OF RISK ASSESSMENT OUTCOMES	
ISSUE	**ANSWER**
a. How are the results of *disaster risk assessments* used in decisions concerning allocation of resources for: (i) Emergency preparedness? (ii) Disaster prevention and mitigation measures? (iii) Disaster risk financing and risk transfer tools?	
b. To what extent does knowledge about the expected distribution of disaster impacts within the population and economy affect the implementation of measures a.(i) to a.(iii)?	

B. RISK FINANCING	
1. FINANCIAL EXPOSURE AND CAPACITY	
ISSUE	**ANSWER**
a. Based on the risk assessment, to what extent are: (i) national, regional and local authorities (ii) households (iii) the corporate sector (iv) the financial sector exposed to disaster risks and related *financial losses*? What risks pose the most relevant financial threats to key categories of stakeholders (i) to (iv)?	
b. What is the short-term and long-term *risk-bearing capacity* of those stakeholders who are expected to sustain a portion of disaster risks and related *financial burden*? What elements did we include in our assessment of risk-bearing capacities?	
c. What are, if any, the main *financing gaps* in our country? Who are the most financially vulnerable components of our economy and society? Are there relevant geographic differences?	
d. Has our government conducted a full assessment of its disaster risk exposures and risk-bearing capacity? Has it reported its explicit contingent liabilities linked to disasters and estimated its implicit contingent liabilities?	
2. RISK FINANCING AND TRANSFER	
ISSUE	**ANSWER**
a. What are the *disaster risk financing* and *transfer* tools currently available in our country to those stakeholders who are expected to absorb (in full or in part) the *financial consequences* of disasters?	
b. Are there significant differences in the availability of such tools for key categories of stakeholders (e.g., residential property owners, corporations, public sector entities)?	
c. Are disaster risk financing and risk transfer markets – to the extent that they are operating in our country – meeting the needs of financially vulnerable populations and segments of the economy?	
d. How is the pricing of such available *disaster risk financing* and *transfer* tools structured? To what extent it is based on risk?	
e. What efforts, if any, are or have been made by the public sector to facilitate develop *risk financing and risk transfer markets* (including insurance markets) and promote access to *disaster risk financing* and *transfer* tools for stakeholders who are expected to face a *financing gap* and thus are likely unable to absorb (in full or in part) the *financial consequences* of disasters?	
f. Have we considered the potential social, economic and *financial impacts* of the inability of such stakeholders to withstand disaster losses?	
e. Have we assessed the advantages and disadvantages of introducing some degree of *compulsion* in the use of disaster risk financing or risk transfer tools by law or regulation?	

g. Have we evaluated the costs and benefits of the different *risk financing* and *risk transfer* tools available to cover any important *financing gaps* within our country and to protect the public budget? What tools were considered? What methodology was employed?	
f. Have we compared the cost of *disaster risk financing* and *transfer* tools with the cost of *disaster risk reduction* and *mitigation* measures? Can we provide an example?	
g. Is there a clear understanding of the expected *allocation* of disaster costs between the public and the private sectors and within the public sector (e.g., different levels of government)? If so, how has such a policy or allocation been communicated?	
3. INSTITUTIONAL ARRANGEMENTS	
ISSUE	**ANSWER**
a. Do we have or have we assessed the need for setting up special institutional arrangements (or changing existing arrangements) to facilitate or improve coverage of *disaster risks* in our country? What was the outcome of our evaluation?	
b. If institutional arrangements have been established, what is their *form*? What was the *rationale* behind the decision made concerning such institutional arrangements and their structure or approach? Did we communicate such rationale to the stakeholders?	
c. What specific role, if any, are *financial sector* participants expected to play?	
d. Do we regularly assess the financial and operational capacity of *financial sector* participants to withstand a disaster event and their ability perform the specific tasks assigned within a given institutional arrangement, if any? What are the technical tools and procedures employed to perform such assessment?	
e. How often and according to what procedure do we reassess governmental decisions concerning *disaster risk financing* and *transfer* tools and related institutional arrangements?	
f. Do we have arrangements for specific sectors (such as finance, telecommunications energy etc? If we have them, are they efficient? If we do not, did we consider such arrangements?	

II - TERMINOLOGY

Coping capacity: *"The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters….Comment: The capacity to cope requires continuing awareness, resources and good management, both in normal times as well as during crises or adverse conditions. Coping capacities contribute to the reduction of disaster risks."* UN ISDR Terminology on Disaster Risk Reduction (DRR)

Disaster: "*A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources….Comment: Disasters are often described as a result of the combination of: the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, social and economic disruption and environmental degradation*." UN ISDR Terminology on Disaster Risk Reduction

Disaster risk financing: The strategies and instruments used to manage the financial impact of disasters, ensuring adequate capacity to manage and mitigate the costs of disaster risk, thereby reducing the financial burden and economic costs of disasters and enabling rapid recovery in economic activity.

Hazard: "*A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage*….Comment: … *In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis.*" UN ISDR Terminology on DRR

Exposure: "*People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses."* UN ISDR Terminology on DRR

Risk: "*The combination of the probability of an event and its negative consequences. ISO/IEC Guide 73.*

Risk assessment: "*A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend."* UN ISDR Terminology on DRR

Risk-bearing capacity: The capacity of economic agents to absorb and recover from losses, based on own resources, income, and self-financing capabilities.

Scenario: "*Assumption of possible events or sequences of events and their effects on subjects of protection."*

Vulnerability: "*The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard*." UN ISDR Terminology on DRR

Disaster Risk Assessment and Risk Financing

A G20 / OECD METHODOLOGICAL FRAMEWORK