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Building Resilience

Integrating Climate and Disaster Risk into Development

The World Bank Group Experience

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Acknowledgments

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Foreword

Weather-related events hurt rich and poor countries alike. They can slam the brakes on economic growth and cripple markets. But how we fare after disaster strikes depends very much on where in the world we live, and how. The more vulnerable and less prepared our nations, communities and households are, the more we suffer. If we live in coastal or water scarce areas, on steep slopes, the more we are at risk. If our house is made of sturdy materials, the less we are likely to be affected. However, if we are poor or we live in a poor country, the more likely we are to lose our lives.

As the global climate continues to change, developing countries face mounting losses from severe floods, droughts and storms. By 2030, there could be 325 million people trapped in poverty and vulnerable to weather-related events in sub-Saharan Africa and South Asia. Large coastal cities, many of them in growing, middle-income nations, could face combined annual losses of US$1 trillion from such events by mid-century.

This report shows why building climate resilience is critical for the World Bank Group's goals to end extreme poverty and build shared prosperity—and why it should be front and center of the development agenda. Unless we help vulnerable and poor nations, regions and cities prepare and adapt to current and future climate and disaster risks, we could see decades of development progress rolled back. By focusing on the Bank's experience in climate and disaster resilient development, we hope that this report will also contribute to international discussions related to understanding loss and damage from climate change.

This report calls for the international development community to work across disciplines and sectors to build long-term resilience, reduce risk and avoid climbing future costs. It emphasizes the necessity of building and empowering institutions for the sustained effort needed for making development climate and disaster resilient. And by highlighting best practices, it shows how financial instruments and intervention programs, along with disaster preparedness expertise developed over decades, are already helping nations prepare for a more changeable world.

However, let us not fool ourselves that doing this will be easy. Resilience is effective, but it often requires a higher initial investment. Our experience shows it costs up to 50 percent more to design and build safer buildings and infrastructure after a disaster. State-of-the-art weather warning systems require new technology and highly trained staff. Relocating people from unsafe areas is expensive and can bring cultural and social disruptions, which can create new risks. We know that communities with strong social bonds are more resilient when disaster strikes as neighbors are the first responders and can help each other in the process of reconstruction.

At the World Bank Group, we believe that climate-related disasters can be reduced and investment costs curtailed. But this requires us to work across disciplines with different partners to make climate and disaster resilience part of our day-to-day development work.

The good news is, many of these interventions make sense for development and they help all of us—developing and developed nations alike—prepare for a warmer and more unpredictable world.

We know what to do. Our job now is to ramp up efforts to get ahead of disasters to save lives and protect livelihoods. We need to get beyond disasters and help countries and communities build resilience in the face of a rapidly warming world.

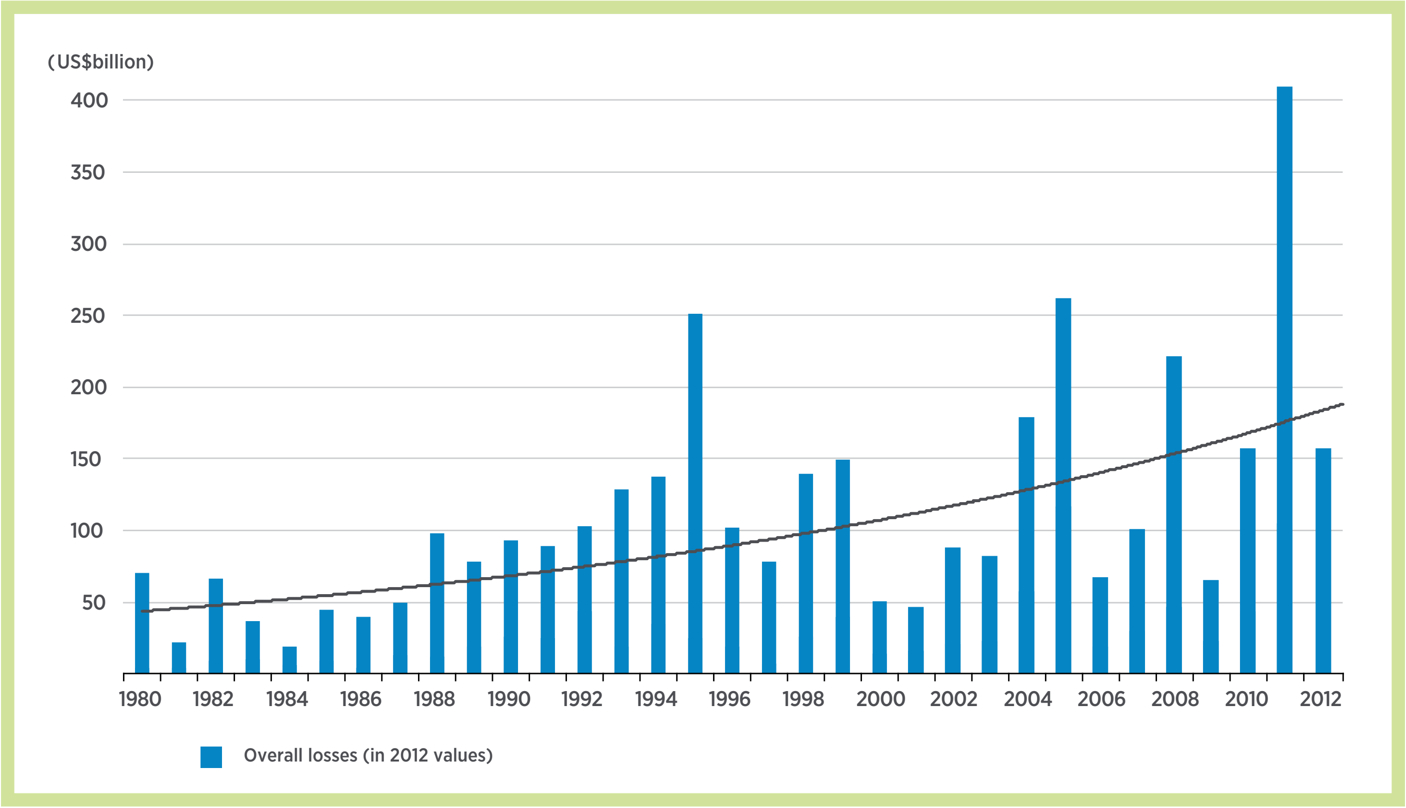
Rachel Kyte
Vice President
Sustainable Development Network
The World Bank Group

November, 2013

Executive Summary

This report presents the World Bank's experience in climate and disaster resilient development, and contends that such development is essential to eliminating extreme poverty and achieving shared prosperity by 2030. The report recognizes, however, that such development requires additional start-up costs, which pay off in the long run if done correctly. Given this, the report argues for closer collaboration between the climate resilience and disaster risk management communities, and the incorporation of climate and disaster resilience into broader development processes. Selected case studies are used throughout this report to illustrate promising approaches, lessons learned and remaining challenges.

Figure A: Global disaster losses from 1980–2012



The bars indicate annual disaster losses. The line indicates the trend.

Source: © 2013 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE (as of January 2013)

The report aims to contribute to the loss and damage discussions under the United Nations Framework Convention on Climate Change, and is targeted at development practitioners and national policy makers who face the challenge of addressing a potential increase in disasters caused by gradual changes in climatic means and extremes.

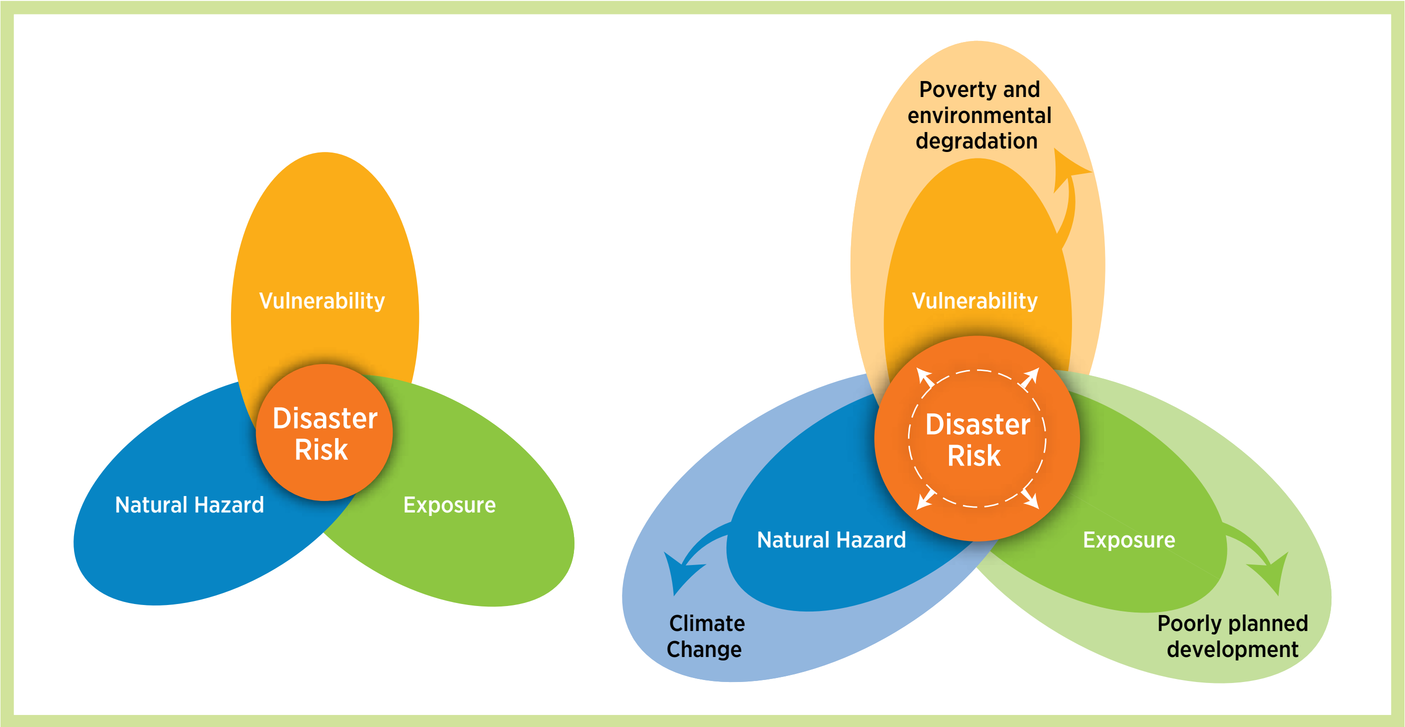
From 1980 to 2012, disaster-related losses amounted to US$3,800 billion worldwide (Figure A). Some 87% of these reported disasters (18,200 events), 74% of losses (US$2,800 billion) and 61% of lives lost (1.4 million in total) were caused by weather extremes (Munich Re 2013).

Development patterns, particularly population growth in high-risk areas and environmental degradation, continue to be the most important drivers of disaster risk (IPCC 2012). However, since the 1960s, human-induced climate change has been increasingly contributing to extreme events in the form of rising temperatures (such as warmer spells and heat waves), changing precipitation patterns (e.g., flash floods) and sea storms (IPCC 2013). For example, land areas affected by heat waves are expected to double by 2020 (World Bank 2013a).

Attributing causality of disasters to climate change remains intrinsically difficult due to the uncertainties, and complex and dynamic interactions between development patterns, the environment and the climate (all of which contribute to disaster risk). While attribution of specific weather events to climate change is highly challenging, attributing disasters (the resulting impact) to a specific driver—climate, development or environmental change—is even more difficult, given the complexity of these interactions (Figure B).

Weather-related disasters affect both developed and developing countries, with particularly high disaster impacts in rapidly growing middle-income countries, due to growing asset values in at-risk areas. The largest coastal cities, for example, could experience combined losses of US$1 trillion by mid-century (Hallegatte et al. 2013).

Figure B: The role of natural hazards, exposure and vulnerability in disaster risk



Disaster risk is determined by the occurrence of a natural hazard (e.g., a cyclone), which may impact exposed populations and assets (e.g., houses located in the cyclone path). Vulnerability is the characteristic of the population or asset making it particularly susceptible to damaging effects (e.g., fragility of housing construction). Poorly planned development, poverty, environmental degradation and climate change are all drivers that can increase the magnitude of this interaction, leading to larger disasters.

Source: Adapted from IPCC, 2012.

However, low-income and lower middle-income countries have the least capacity to cope and, in general, suffer the highest human toll, accounting for 85% of all disaster fatalities (Munich Re 2010).

Building climate resilience is essential to the global goals of ending extreme poverty and promoting shared prosperity

While many uncertainties persist, one thing is clear: climate-related impacts will continue to grow due to both development and climate drivers (IPCC 2013), and impacts will be felt most acutely by the poor. Unless measures are taken to reduce risks, climate change is likely to undermine poverty goals and exacerbate inequality for decades to come.

Climate change will have the greatest impact on the poorest and most marginalized populations, who commonly live in the highest-risk areas (for example, 72% of the African urban population live in informal settlements). They are also the ones with the least ability to recover from recurrent, low-intensity events, which can have crippling and cumulative effects on livelihoods. The impacts of climate change on poverty are expected to be regressive and differential, affecting most significantly the urban poor (net food consumers) and highly vulnerable countries in sub-Saharan Africa and South Asia, where the number of exposed poor may reach 325 million by 2030 (Shepherd et al. 2013). Many of these countries are also those with the least capacity to prepare for, and absorb, the effects of climate events.

Climate change is already exacerbating inequality; at the subnational level, impacts tend to be most severe in already impoverished areas. As climate effects can undermine hard-earned development gains, potentially trapping the most vulnerable into poverty, their impacts need to be minimized by reducing the magnitude of the hazard (which requires a global solution, namely reducing greenhouse gas emissions), diminishing exposure (by protecting and/or assisting the poor to live in safer areas) or decreasing the vulnerability of the poor to climate shocks. Social protection programs are an important part of such a strategy, but must be complemented by policies that directly help the poor become more resilient.

The common goal should be climate and disaster resilient development, while recognizing that it comes at a cost

Risk reduction and better preparedness to deal with climate and disaster impacts can substantially decrease the cost of disasters. From India to Bangladesh to Madagascar, early warning systems, better preparedness and improved safety codes have proven to be cost effective, save human lives, and protect public and private investments. Climate and disaster resilient development, therefore, makes sense both from a poverty alleviation, as well as from an economic, perspective.

Yet despite its cost effectiveness over the long term, climate and disaster resilient development can require substantial start-up costs. Safer structures require design changes that typically cost 10 to 50% more to build—and even more if transport or water networks need to be relocated (GFDRR 2010). In addition, improved hydro-meteorological systems require new technology and training, risk assessments may require geospatial, scientific and engineering information often at high resolution, and even after risk reduction plans have been implemented, disasters can cause residual costs, making it imperative to reinforce coping strategies.

This report maintains that both developed and developing countries have a common interest in promoting climate and disaster resilient development. While interventions are needed that already make sense under sustainable development, they are now more urgent than ever due to climate change. As such, climate and disaster resilience should form an integral part of national strategies and development assistance, particularly in the most vulnerable and least developed countries.

Given the close interactions between climate change and local drivers of vulnerability, it is important to ultimately strengthen all aspects of climate and disaster resilient development, including coordinating institutions, risk identification and reduction, preparedness, financial and social protection, and resilient reconstruction. Addressing only selected aspects of this framework risks leaving others exposed, and even creating perverse incentives, such as what happens when funding is allocated primarily to disaster response, leaving proactive risk management underfunded.

Much is already known regarding how to build resilience to weather-related disasters, but better integration between climate resilience approaches and disaster risk management is required

Although the approaches used for climate resilience and disaster risk management originated from different disciplines, the two communities of practice are increasingly converging. Much of this convergence is happening on the ground; yet institutional resistance towards integration at national and international levels continues. To prevent fragmentation of scarce local capacity and global resources, the two disciplines must be progressively harmonized into a common agenda.

The World Bank and many other development partners have accumulated a wealth of global expertise in climate and disaster resilient development. Good practices are emerging in both processes, such as institutional frameworks and iterative feedback, as well as instruments and tools, including climate and disaster risk assessment, risk reduction, strengthened preparedness, social and financial protection, and resilient reconstruction. Many of these are described through case studies in this report.

In order to deal with climate and development uncertainties, national stakeholders need sustained and flexible programs, which require clear institutional frameworks and predictable, long-term financing (over at least a decade). The fact that climate affects most sectors introduces an added complexity in many countries where governance systems are structured along sectoral lines. Emerging experience suggests that to be effective, institutional coordination across various ministries should be set at the highest possible level.

In climate and disaster resilient development, the process of strengthening risk management—through better information, timely financing, contingency funds, and enabling policies and planning—can sometimes be more important than the actual achievement of discrete activities (such as building a protection dyke). Often, the activities—and in some cases the actual disaster—serve as a forum to catalyze better climate and disaster resilience decisions. The presence of uncertainties also requires a robust feedback system to determine which approaches succeed, which ones fail and why. The paucity of short-term results, together with slow initial disbursements, may at first deter some donors accustomed to more conventional and risk averse investments; however, it is important that they recognize that this is how climate and disaster resilient development works. An increasing number of countries, such as Colombia, the Philippines, India, Mexico and Samoa, have piloted climate and disaster resilient planning, and evidence shows this has helped them curb climate-related impacts. These countries' experiences are documented in case studies in this report.

Despite progress made, many challenges remain. Long-term projections of climate and development scenarios continue to be highly uncertain, which is often cited as a cause for policy inaction. A robust, iterative decision-making framework is a potential course of action, but data for informed decision making continue to be limited, as are opportunities for engagement with countries at key development planning stages (for example, when national development plans are being prepared). The most important challenges, however, continue to be institutional. The international community should lead by example by further promoting approaches that progressively link climate and disaster resilience to broader development paths, and funding them appropriately.

Abbreviations

CDD	Community-driven development
CAPRA	Central America Probabilistic Risk Assessment
CARICOM	Caribbean Community and Common Market
CAT-DDO	Catastrophe Deferred Drawdown Option
CCKP	Climate Change Knowledge Portal
CCRIF	Caribbean Catastrophe Risk and Insurance Facility
CIF	Climate Investment Funds
CERC	Contingent emergency response components
COP	Conference of the Parties
CRW	Crisis Response Window
DaLA	Damage and Loss Assessment
DPL	Development Policy Loan
DRM	Disaster risk management
ECLAC	Economic Commission for Latin America and the Caribbean
FONDEN	Natural Disaster Fund (Mexico)
FOPREDEN	Fund for Disaster Prevention (Mexico)
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
HEAT	Hands-On Energy Adaptation Toolkit
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEG	Independent Evaluation Group
IFC	International Finance Corporation
IMF	International Monetary Fund
IRM	Immediate Response Mechanism
LEAP	Livelihoods, Early Assessment and Protection
Moz-Adapt	Open climate and disaster data platform
MDB	Multilateral development bank
NGO	Non-Governmental Organizations
ODI	Overseas Development Institute
PDNA	Post Disaster Needs Assessment
PPCR	Pilot Program for Climate Resilience
PSNP	Productive Safety Nets Programme
RDM	Robust decision making
RDVRP	Regional Disaster Vulnerability Reduction Project
SCF	Strategic Climate Fund
SVG	Saint Vincent and the Grenadines
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
US$	United States Dollar
WB	World Bank
WBG	World Bank Group
WDR	World Development Report
WMO	World Meteorological Organization

I. Introduction

Over the last few decades, the World Bank has been proactively supporting partner countries to manage the increasing risk from extreme weather events[1] as part of their disaster risk management (DRM) programs. As the impacts of climate change become more evident and add to development pressures, the World Bank has also increased its efforts to support partner countries in climate resilient development by addressing gradual[2] as well as extreme changes in the climate. This report addresses these two increasingly interconnected fields as "climate and disaster resilient development."

The report aims to contribute to the loss and damage work program, established by the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) under the 2011 Cancún Adaptation Framework. The work program states that "*approaches should be considered to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to (its) adverse effects…*" This was further elaborated under a decision agreed to at the COP18 in Doha (Box 1). The loss and damage work program seeks to go beyond adaptation to address residual disaster impacts in the poorest and most vulnerable countries affected by climate change.

By focusing on the World Bank's experience in climate and disaster resilient development, this report aims to contribute to the specific Doha decisions related to the understanding of loss and damage, and strengthening institutions and coordination among partners and stakeholders (see Box 1). The report's structure is outlined below.

- The remainder of the **"Introduction"** provides an overview of the UNFCCC's loss and damage work program, and the relevance of the World Bank's experience to it. It also introduces key concepts and definitions relevant to climate and disaster resilient development.
- Section II on **"Rising Disasters in a Changing World"** describes the impacts of globally increasing weather-related disasters in recent decades.
- Section III on **"Climate and the Poor"** summarizes how World Bank's goals to end extreme poverty and boost shared prosperity are expected to be affected by rising disaster losses in a changing climate.
- Section IV titled **"Resilience Is Effective…but it Has a Cost"** discusses the issue of attribution in weather-related disasters, and the additional start-up costs involved in climate and disaster resilient development.
- Section V titled **"Towards Climate and Disaster Resilient Development"** builds upon the processes and instruments developed by the climate resilience and the disaster risk management communities of practice to provide some early lessons learned in this increasingly merging field.
- Section VI on **"The World Bank Experience"** highlights case studies and emerging good practices in climate and disaster resilient development.
- Section VII focuses on **"Conclusions"** and summarizes key lessons learned, and implications for the loss and damage agenda. It also identifies potential gaps and avenues for future work to help countries move towards climate and disaster resilient development.

[1] These are also known as hydro-meteorological events, and include floods, droughts, storm surges and cyclones.

[2] Specific examples include: gradual changes in rainfall patterns affecting agriculture and water supply, sea level rise and salt-water intrusion in coastal areas; accelerating glacial melt; changes in mean temperatures and rainfall affecting land degradation and ecosystems; and increasing water scarcity.

Some differences in terminology exist between the UNFCCC and the work highlighted in this report. Under the UNFCCC, no specific definition exists for loss and damage. In this report, these terms are defined as per Post Disaster Needs Assessment (PDNA) methodology, which is the international standard adopted by the World Bank, the United Nations and the European Commission (see Box 2 and ECLAC 2003). The terms loss and damage are also not considered interchangeable; in economic terms, damage refers to disaster impacts on physical stocks and assets, while loss refers to impacts on economic flows.

Climate-related loss and damage are assumed to derive from the interaction of climate and weather events with local drivers of exposure and vulnerability. The events can arise from longer-term changes in climate (such as changing temperatures, rising sea level or glacial melt), as well as from changing frequency and intensity of hydro-meteorological (or weather-related) hazards, such as floods, storms and droughts. They may be rapid or slow in onset, lasting for a few hours or leading to longer-term changes. Other terms used in this report are defined in the Glossary below.

Box 1: The Doha decision on loss and damage

COP18 agreed to establish specific outcomes on loss and damage by December 2013. The decision text is summarized below.

1. The range of options for loss and damage should be informed by:
    - **a.** Promoting an enabling environment to encourage investment and the involvement of relevant stakeholders in climate risk management;
    - **b.** Involving vulnerable communities and populations, civil society, the private sector and other relevant stakeholders in the assessment of and response to loss and damage; and
    - **c.** Enhancing access to, and sharing and use of, data, such as hydro-meteorological data and metadata, on a voluntary basis, to facilitate the assessment and management of climate-related risk.
2. The decision also acknowledges that further work is needed to advance the understanding of:
    - **a.** The risk of slow onset events and approaches to address them;
    - **b.** Non-economic loss and damage;
    - **c.** How loss and damage associated with the adverse effects of climate change affects vulnerable populations and how approaches to address them can benefit those population segments;
    - **d.** Appropriate approaches to address loss and damage, such as risk reduction, risk sharing, risk transfer and rehabilitation;
    - **e.** Integration into climate-resilient development processes; and
    - **f.** Impacts of climate change on patterns of migration, displacement and human mobility.
3. Strengthening the collection and management of relevant data to assess the risk of loss and damage.
4. Enhancing coordination, synergies and linkages among various organizations, institutions and frameworks.
5. Strengthening and promoting regional collaboration, centers and networks.
6. Enhancing capacity building at the national and regional levels.
7. Strengthening institutional arrangements at the national, regional and international levels.
8. Requesting developed country Parties to provide developing countries with finance, technology and capacity building.
9. Establishing institutional arrangements, such as an international mechanism, to address loss and damage associated with the impacts of climate change in developing countries that are particularly vulnerable.

Source: UNFCCC, Doha Decisions on Loss and Damage (2012).

Box 2: Glossary of terms and concepts used

Hazard, exposure, vulnerability and resilience are terms commonly used among practitioners in the disaster and risk management and climate resilience communities; however, they can have different interpretations. This report uses definitions provided by the Intergovernmental Panel on Climate Change (IPCC) and, when applicable, the United Nations International Strategy for Disaster Reduction (UNISDR). The terms "loss" and "damage" are as defined by the PDNA methodology adopted jointly by the World Bank, the United Nations and the European Commission.

Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate (IPCC 2007, 2012).

Adaptive capacity: The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, take advantage of opportunities, or cope with the consequences (IPCC 2007, 2012).

Climate and disaster resilient development: A set of institutional arrangements, processes and instruments that help identify the risks from disasters, climate extremes, gradual and long-term climatic changes, and their associated impacts, and the design of measures to reduce, transfer and prepare for such risks. Climate and disaster resilient development combines development benefits with reductions in vulnerability over the short and longer term, using a development planning, multi-sectoral and multi-stakeholder approach (report authors).

Damage: The total or partial destruction of physical assets existing in an affected area. Damages are measured first in physical units (such as numbers or square meters of housing destroyed, or kilometers of roads), and then in monetary terms, expressed as replacement costs according to prices prevailing just before the event (GFDRR 2010b).

Disaster: A serious disruption in the functioning of a community or 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. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social wellbeing, together with damage to property, destruction of assets, loss of services, social and economic disruption, and environmental degradation (UNISDR 2009a).

Disaster risk: The potential occurrence of a hazard—hydro-meteorological or geophysical—that may cause loss of life, injury or other health impacts, damage to exposed assets (property, infrastructure, environmental resources), and loss of livelihoods and service provision. The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard are related to its vulnerability (IPCC 2012). UNISDR (2009a) defines disaster risk as potential disaster losses in lives, health status, livelihoods, assets and services, which could occur in a particular community or society over some specified future time period.

Disaster risk management: Processes for designing, implementing and evaluating strategies, policies and measures to improve the understanding of disaster risk, foster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response and recovery practices, with the explicit purpose of increasing human security, wellbeing, quality of life and sustainable development (IPCC 2012).

Exposure: The presence of people, livelihoods, environmental services and resources, infrastructure, or economic, social or cultural assets in places that could be adversely affected (IPCC 2012).

Hazard: The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision and environmental resources (IPCC 2007, 2012).

Loss: Changes in economic flows arising from a disaster which continue until the achievement of full economic recovery (for example, decline in agriculture output, lower revenues and higher operational costs in health services provision, or losses in trade from damaged commercial facilities). Losses are expressed in current monetary values (GFDRR 2010, ECLAC 2003).

Box 2: Glossary of terms and concepts used (continued)

Resilience: The ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions (IPCC 2012).

Risk transfer: The process of formally or informally shifting the financial consequences of particular risks from one party to another, whereby a household, community, enterprise or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party. Examples include gifts or credit amongst communities/families, insurance and reinsurance contracts, catastrophe bonds, contingent credit facilities and reserve funds as part of risk transfer from governments to financial markets (UNISDR 2009a).

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC 2007). The IPCC (2012) has since changed the definition of vulnerability to the propensity or predisposition to be adversely affected.

II. Rising Disasters in a Changing World

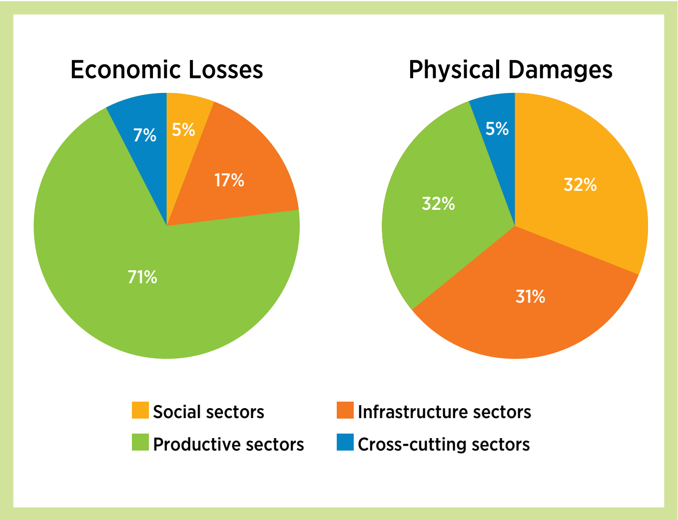
Since the 1980s, there has been an upward trend in disaster losses. During the 1980–2012 period, estimated total reported losses due to disasters amounted to US$3.8 trillion. Weather-related or hydro-meteorological disasters accounted for 74% (US$2.6 trillion) of total reported losses, 87% (18,200) of total disasters, and 61% (1.4 million) of total lives lost (see Figure 1 and Munich Re 2013a,b). Recent disasters provide a grim reminder of this human and economic toll. In Thailand, the 2011 floods resulted in losses of approximately US$45 billion, equivalent to 13% of the country's gross domestic product (GDP) (World Bank 2012a). In the Horn of Africa, the extended 2008–2011 drought, which at its peak left 13.3 million people facing food shortages, caused estimated total losses of US$12.1 billion in Kenya alone (Government of Kenya 2012).

Damage and loss trends are difficult to monitor over time, due in part to inconsistent methodologies, and the fact that only a few countries (about 50) keep national disaster databases. Even among those, a recent United Nations Development Programme (UNDP) study found that as many as 81% of countries did not consistently record economic losses, and only 18% maintained quality control and validation (UNDP 2013). Increasingly, however, major disasters are being assessed based on standard Damage and Loss Assessments (DaLAs) (ECLAC 2003), and (since 2007), the PDNA methodology. Among the 72 hydro-meteorological disasters assessed, economic losses occurred primarily in productive sectors (such as agriculture and commerce), while physical damages were almost equally distributed between infrastructure, and social and productive sectors, reflecting

Figure 1: Total number of disasters and losses from 1980–2012

Source: Adapted from © 2013 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE (as of January 2013).

Figure 2: Total loss and damage from hydro-meteorological disasters, by affected sector (1972–2013)



Source: GFDRR Global Disaster Damage and Loss Database for 72 hydro-meteorological disasters. Currency in constant 2010 value.

the destruction of physical structures, such as roads, bridges, houses, schools, hospitals and irrigation infrastructure. This pattern is fairly standard across all types of disasters (tropical cyclones, floods, El Niño/La Niña events and droughts). In some case, droughts can result in more economic losses to infrastructure sectors: during the 1998–2000 drought in Kenya, for example, more than 80% of the losses were in the hydropower sector (Government of Kenya 2012).

The private sector, particularly in climate-sensitive areas such as commerce, industry, agriculture, power, shipping and tourism, is often the first to be affected by changes in the climate[3]. Flooding, wind and other weather events are also often fatal to smaller, uninsured businesses, particularly in the informal sector (IFC 2010a).

The economic impact of disasters is concentrated in rapidly-growing middle-income economies due to increasingly exposed (and valuable) assets. In these countries, the average impact of disasters equaled 1% of GDP between 2001 and 2006, ten times higher than the average in high-income economies for the same period (World Bank 2012c). However, the impact can be particularly crippling on smaller and poorer countries, such as small island developing states and land-locked developing countries. Hurricane Tomas, for example, devastated Saint Lucia in 2010 and wiped out the equivalent of 43% of its GDP. In terms of human lives lost, low- and low-to-middle income countries suffered 85% of total global disaster fatalities (Munich Re 2013a,b).

Over time, cumulative impacts from small, recurrent disasters can equal or even exceed those from larger catastrophes (Campos et al. 2010). Often escaping national or international awareness, these smaller events reinforce poverty and compound the hardships endured by poor communities. In Colombia, for example, cumulative total small-scale losses between 1972 and 2012 were 2.5 times greater than those resulting from large-scale disasters. Recent research concluded that if the impacts associated with smaller disasters were included in global databases, reported impacts would likely be at least 50% higher (UNISDR 2013). These figures refer primarily to damages and, for the most part, exclude the cost of indirect and non-quantifiable losses.

Losses are normally more difficult to quantify than damages, particularly when they involve non-market values, such as human fatalities, or environmental damage, or when they result from indirect impacts. Yet in many countries, disaster losses can be significant and last over long periods of time. For example, the 2011 drought in the Horn of Africa led to an extremely high rate of malnutrition and infectious diseases, especially among children (World Bank 2013a). The 2013 floods in Mozambique led to the temporary displacement of about 250,000 people. While methodological refinements in DaLAs have allowed for the quantification of these losses (see ECLAC 2003), most countries have not applied them systematically to allow comparisons over time.

Among the most insidious effects of weather-related disasters are their impact on the poor. Unless measures are taken to reduce these risks, climate change is likely to undermine poverty goals and exacerbate inequality worldwide for decades to come. This is examined in further detail in the next section.

3 See: www.ifc.org/climaterisks

III. Climate and the Poor

Disasters trap people into poverty, as indicated by the evidence from many countries. For example, following the 2011 drought, poverty levels in Djibouti returned to levels above those in 2002, indicating a loss of almost 10 years of development gains. Studies from rural Ethiopia and Andhra Pradesh, India, indicate that drought is the most important factor in keeping people poor. China lists natural disasters among the eight key pressures undermining its progress in poverty reduction. And in Afghanistan, drought in the 1990s was identified as contributing to worsening food security and poverty a decade later (République de Djibouti 2011; Shepherd et al. 2013; White 2004).

Poor and marginalized households tend to be less resilient and face greater difficulties in absorbing and recovering from disaster impacts. Recurrent events also lead to compounding losses for many households, leading them to organize livelihoods in such a way that their overall risks are reduced in the face of uncertainty, even if it means a reduction in income and an increase in poverty (UNISDR 2009b). This is typically the case for farmers who hedge their risks against uncertain weather by planting well after the early rains, or by using less productive but more resilient varieties. To maintain basic food consumption, poor households may sell their limited remaining productive assets after disasters, often their only source of savings; others, however, may lower their food consumption. Both coping mechanisms can have long-term implications for human development, by affecting nutrition and children's access to education and health (World Bank and GFDRR 2013).

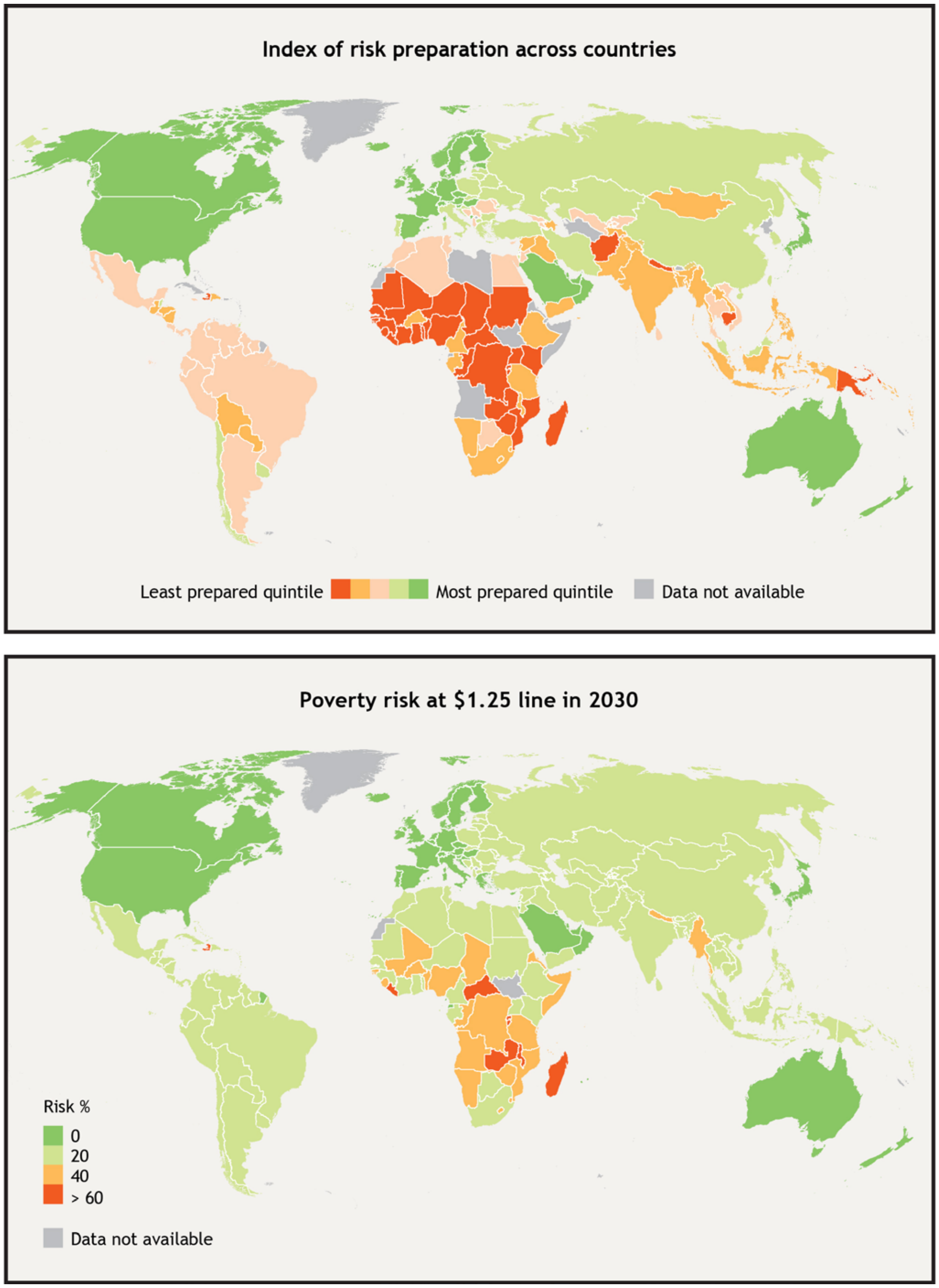
Due to limited opportunities and resources, the poor frequently accept higher levels of risk relative to their income, and live and/or work in informal settlements located in high-risk areas. In Dar es Salaam, Jakarta, Mexico City and São Paulo, those living in informal settlements are the most vulnerable to climate and disaster risks (World Bank 2011a). Overall, approximately 72% of Africa's urban population lives in informal settlements, where investment in drainage infrastructure that can reduce flood risk is often lacking, and existing infrastructure is inadequately maintained (UNISDR 2009b). As a consequence, poor households must not only rebuild their assets after a disaster, but often bear the costs of reconstruction of public and social infrastructure, such as community schools, health clinics or local roads damaged by recurrent events. An example of this is in eastern and western Madagascar, where a single cyclone season can cause losses and damages to individual households equivalent to 10–30% of the average annual GDP per capita (Government of Madagascar 2008).

Among the poor, disabled, elderly, orphans, widows and other vulnerable and marginalized groups are more likely to be affected by weather-related events. In many cases, women are more affected than men due to their lower mobility and cultural sensitivities that may prevent them from seeking livelihood opportunities away from high-risk areas, or to use shelters during extreme events. As a result, for example, some 91% of fatalities in Bangladesh after Cyclone Gorky were women (World Bank 2012c).

> Building climate resilience is essential to the global goals of ending extreme poverty and promoting shared prosperity by 2030

Climate change could affect poverty targets directly, as well as indirectly, by curbing economic growth. Recent modeling studies indicate relatively modest impacts on global poverty—about 10 million additional poor under climate change scenarios by 2055, assuming steady annual economic growth of 2.2 percent (Skoufias 2012). However, Dell et al. (2009) suggest that economic growth is also sensitive to temperature rises, which could, therefore,

Figure 3: Comparison of current Index of Risk Preparation with projected poverty risk by 2030



This figure suggests that investments in risk preparation today could help reduce poverty risks in the future. The Index of Risk Preparation, developed for the 2014 World Development Report (World Bank 2013b), measures assets and services across four categories (human capital, physical and financial assets, social support, and state support). Poverty risk, developed by ODI (Shepherd 2013), reflects the proportion of the population that is projected to be living below US$1.25/day by 2030. However, if numbers, rather than the proportion of the poor, are taken into account, several large low-to-medium income countries, such as India, Nigeria and Pakistan, will also score highly.

Sources: World Bank 2013b and Shepherd et al. 2013.

significantly increase the number of poor. Data from 134 countries, for example, indicated that temperature rises of 1°C were associated with a statistically significant reduction of about 9 percentage points in per capita GDP. A more recent study by the Overseas Development Institute (ODI) also indicates significant numbers of poor living in hazard-prone countries by 2030 (Shepherd et al. 2013). These global studies also suggest that an immediate reduction of greenhouse gases would only have a significant impact on poverty beyond 2100. This is due to the longevity of many greenhouse gases in the atmosphere and inertia in the climate system (IPCC 2013, World Bank 2012d), underscoring the urgent need to implement resilience—or adaptation—measures targeted towards the poor.

The impacts of climate change are expected to be both regressive and heterogeneous, and, thus, contribute to higher inequality. In Brazil, for example, climate change is expected to affect poorer regions more than richer ones; poorer municipalities are expected to suffer a decline of up to 40% in agricultural output by 2040, while richer ones may actually benefit (Assunção and Chein Feres 2009). A study from Ahmed et al. (2009) of 16 countries also suggests that while rural areas are expected to have the greatest numbers of poor, poor populations in urban areas are expected to suffer proportionally more under projected extreme dry events due to their vulnerability to food price increases. An estimated 16% increase in poverty is expected in urban areas compared to a 12% increase amongst rural populations. This introduces an added concern given the rapid pace of urbanization in the developing world.

Differences in impacts at subnational and even inter-community levels also illustrate the need to carefully target pockets of poverty, as well as the near poor. Already, prolonged droughts, land degradation, development patterns and conflict in the Sahel and Horn of Africa have displaced pastoral populations into more marginal land. Similar trends are seen in coastal areas of West Africa, where many vulnerable fishing communities face rapidly shrinking coasts, with few alternative places to go (as surrounding land is already occupied). Under extreme dry events, a highly vulnerable country like Zambia could see an additional 4.6% of its population impoverished by the end of the century (Ahmed et al. 2009). Given the risks to the near poor, targeted programs may need to consider a higher threshold than the standard US$1.25/capita, to cover both the poorest, as well as those at risk of falling into climate-induced poverty (Shepherd et al. 2013).

Another key challenge relates to the fact that many countries with the highest projected future poverty risk are also the ones with the lowest level of current risk preparedness (World Bank 2013b; Shepherd et al. 2013). Figure 3 illustrates this problem in simplified terms; countries with the lowest risk preparation capacity generally have the highest poverty risk, in terms of the proportion of their population projected to be living below US$1.25/day by 2030. The picture changes if one considers the sheer number of projected poor, as in that case several low-to-medium income countries—such as India and Pakistan—would also take prominence. Regardless, the recent ODI report concludes that, without concerted action, some 325 million people could be living in the 45 countries most exposed to hazards by 2030, highlighting the close links between poverty, hazards and risk governance, and the need to integrate social protection into development strategies (Shepherd et al. 2013).

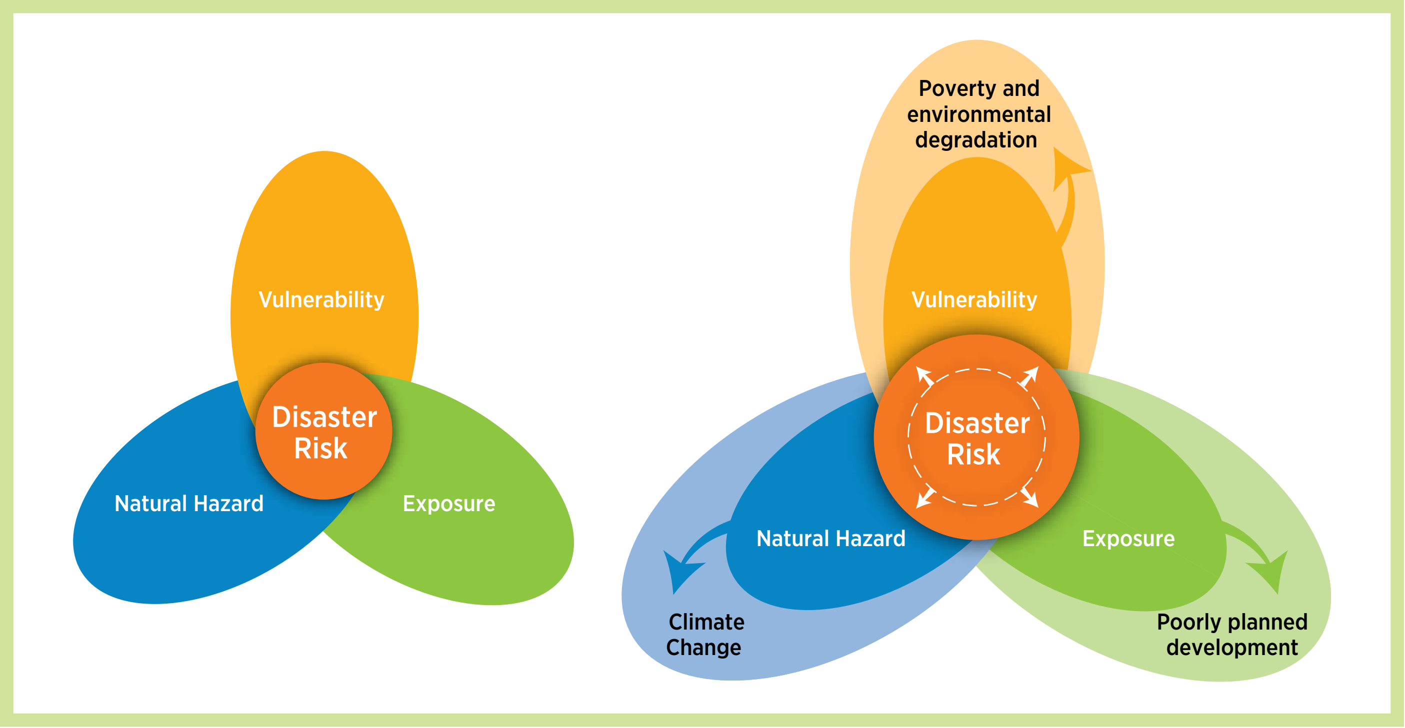
The poor are already resilient, both by nature as well as by necessity; however, they need further funding, information and support to escape poverty traps and to better cope with weather-related disasters. Because poverty and vulnerability are so closely intertwined, climate and disaster resilient development must be central to the global goal of ending poverty and promoting shared prosperity. The next section examines the costs and benefits of making this happen and implications for development.

IV. Resilience is Effective… But it Has a Cost

The rising concentration of population and assets in naturally at-risk areas remains the most important driver of growing disaster risk (IPCC 2012). This includes rapidly expanded settlements in low-lying coastal areas and floodplains, inadequate spatial planning and regulation enforcement, and lack of compliance or weak building standards. In addition, ecosystem degradation lowers the capacity to buffer for the effects of climate extremes and provide for basic needs, such as food and shelter, before, during and after disasters (Renaud et al. 2013). Consequently, the world's 136 largest cities could be facing annual flood losses of US$1 trillion by 2050 (Hallegatte et al. 2013).

At the same time, evidence is growing that extreme weather events associated with temperature, precipitation and sea level rise has intensified since the 1960s and the latest IPCC report (IPCC 2013) attributes this to an increase in greenhouse gas emissions. The extreme weather events include warmer spells and heat waves, increased heavy rainfall events (often leading to flash floods) and higher sea levels (IPCC 2013). Areas of the world hit by heat waves

Figure 4: The role of natural hazards, exposure and vulnerability in disaster risk



Source: Adapted from IPCC 2012.

are set to double in size by 2020 (World Bank 2013a, Coumou and Robinson 2013). Intense tropical cyclones and droughts are also likely to increase, although these projections vary by region and are subject to low confidence levels (IPCC 2013).

Figure 4 illustrates how weather-related hazards, exacerbated by climate change, can interact with local drivers of exposure (such as location of settlements in high-risk areas) and vulnerability (such as poverty or environmental degradation) to increase disaster risk. The three factors are closely inter-connected.

Under the current state of knowledge, clearly attributing disaster costs to climate change remains extremely difficult, as does separating climate change from local drivers of rising loss and damage. Current scientific efforts have focused on trying to quantify the contribution of climate change to particular hazard intensities, but they remain limited (Peterson et al. 2013). For example, in Madagascar, simulated changes in the probability of Category 3–5 cyclones making landfall under future climate change scenarios indicated a moderate expected increase in landfall of the most intense cyclones (Direction Générale de la Météorologie 2008). Studies of this type, however, are subject to high uncertainties associated with climate modeling and cannot address attribution of disaster impacts to climate change. This attribution remains extremely difficult, if not impossible, as the relationship between intensity of hazard and impacts of disasters is not proportional, and disaster drivers are dynamic and subject to complex uncertainties. This is further complicated by the scarcity of historical information on weather-related disaster impacts, and the fact that recorded disasters are relatively rare events, making it inherently difficult to produce statistically significant trends (Huggel et al. 2013).

What is clear is that all key drivers—climate change, poorly planned development, poverty and environmental degradation—influence the risk of a climate event becoming a disaster. In order to address loss and damage appropriately, these factors need to be managed collectively.

Climate and disaster resilient development provides an opportunity to do just that by combining elements of adaptation (which help to reduce disaster risk) with DRM, thus also addressing risk transfer, disaster preparedness and resilient reconstruction. It also recognizes that addressing climate and disaster risks without addressing the development deficit could be an ineffective response fragmenting an already complicated climate, disaster and development finance landscape.

Achieving climate and disaster resilient development requires the international community and national governments to promote approaches that progressively link climate and disaster resilience to broader development paths, and fund them appropriately. Climate and disaster resilient development is consistent with the Doha decision on loss and damage, which promotes the integration of climate risk management into development planning. At the same time, it recognizes that despite the best adaptation efforts, a residual risk of disasters must also be managed. A study in India, for example, suggested that gradual adaptation in crop production and consumption patterns could reduce long-term losses in per capita consumption by half. In Brazil, modeled population mobility across municipalities reduced climate change impacts on poverty by 63% (Skuofias 2012).

Climate and disaster resilient development are clearly effective over the long term. Early warning systems have been proven to save countless lives worldwide, and typically yield benefits that are 4–36 times higher than initial costs (Hallegatte 2012, Rogers and Tsirkunov, 2013). Examples from Bangladesh and India also clearly show the benefits of prevention in terms of lives saved; for example, Cyclone Phailin, which hit Odisha and Andrah Pradesh in October 2013, resulted in 40 deaths, compared to the 10,000 who perished during a similar event in 1999 (see Box 13).

At the same time, climate and disaster resilient development involves additional upfront costs which cannot be neglected. These include the cost of: "building back better" (building or retrofitting with safer standards) during disaster reconstruction; upgrading hydro-meteorological systems; risk assessments; and establishing and maintaining risk financing instruments (see Section VI). Another important upfront investment is institutional strengthening and improved coordination, which can take time to develop. Finally, some areas may face long-term social and economic repercussions of population relocation.

Indicative estimates of the costs of "building back better" are provided in Box 3. These costs greatly depend on the choices and resources available. Recent disaster assessment experience suggests that this typically costs between 10–50% more than the replacement cost of the original structures (Box 3). For example, the low-cost option would be to simply rebuild or retrofit structures, using similar materials; alternatively, upgrading to better construction standards, moving assets to another (safer) location or redesigning the system outright, will cost more. These choices account for the wide range of factors used in past disaster assessments, particularly in sectors, such as transport, or water and sanitation. In Namibia, for example, estimated road rehabilitation needs following the 2008 floods included elevating roads and improving drainage in flood-prone areas (thus, costs were 5.5 times the replacement value of damaged structures). In Pakistan, after the 2010 floods, housing reconstruction options varied between 0% (no safety improvements) to 50% more, using multi-hazard resistant standards—which became the recommended option (GFDRR 2010 and various PDNAs).

Box 3: The costs of building back better after disasters

The experience of past Damage and Loss Assessments and, more recently, PDNAs, suggests the following approximate mark-ups for "building back better."

Sector	Building Back Better Factor
Housing	1.10–1.35
Schools	1.10–1.50
Hospitals	1.10–1.50
Agriculture/Livestock and Fisheries Infrastructure	1.10–1.40
Industrial Facilities	1.10–1.40
Commerce and Trade	1.10–1.35
Water and Sanitation	>1.00*
Transport	>1.00*
Electricity	>1.00*
Communications	>1.00*

Where: Costs of building back better = Replacement Costs x Building Back Better Factor and Building Back Better Factor = Costs of Quality Improvements + Technological Modernization + Relocation to Safer Areas (if needed) + Disaster Risk Reduction Standards + Multiannual Inflation

* Factors for infrastructure sectors vary highly depending on the choice of reconstruction.

Source: GFDRR (2010).

The fact that reconstruction needs, following a disaster, have so greatly depended on the existing development deficit, as well as on the adaptation choices made, suggests that financing decisions for climate and disaster resilient development may need to follow simple guidelines, such as the indicative sliding scale previously used by the Global Environment Facility (GEF).[4] This could take into consideration the country's level of development and the financing needed. Such an approach was recently used in Zambia to justify a 30% level of top-up financing for local development plans that incorporated climate resilience (World Bank 2013c). Incentives may also need to be built in to progressively reward countries and communities that take positive action towards climate and disaster resilient development.

The common goal should be climate and disaster resilient development… while recognizing that it comes at a cost

Previous sections highlighted the increasing losses caused by weather-related disasters from 1980–2010, arguing that attribution of disasters to climate change, as opposed to the more likely local drivers of vulnerability, remains a very difficult challenge. They also suggest focusing on promoting climate and disaster resilient development, while recognizing that it has a higher initial cost. The next section focuses on how climate resilient development can be implemented, based on the extensive experience of the World Bank and its partners.

4 The sliding scale was used in the initial period of the GEF's Least Developed Country Fund and Special Climate Change Fund, as a simplified way to determine the degree of additional financing required for climate resilient projects. Financing varied based on the amount requested. This approach has since been discontinued.

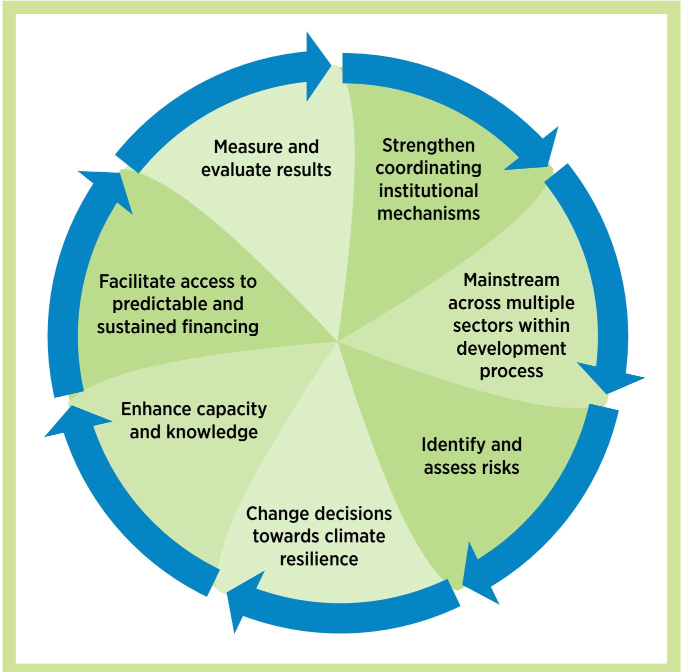
V. Towards Climate and Disaster Resilient Development

The multi-sectoral nature of climate change impacts, and the close interlinkages with local drivers of vulnerability and exposure remains a complex but unavoidable challenge. Over the last decade or so, many countries have taken steps to integrate risks from climate change into the development planning process (World Bank 2008, 2010, 2012a, 2012d). This process is often referred to as climate resilient development, the elements of which are presented in Figure 5. The process draws largely on early lessons from the Pilot Program for Climate Resilience (PPCR), which is supporting 18 countries integrate climate risk and resilience into core development and initiates transformational change (see Box 7). The elements outlined in Figure 5 often occur in parallel and in interactive ways. Most countries have started the process by strengthening institutions, identifying and assessing risks, and enhancing capacity and knowledge.

A similar approach was developed by the disaster risk management community, building on experience accumulated since the 1970s (Figure 6). This operational framework is organized around five well-known risk management action pillars, approaching the problem from an action-oriented perspective. Risk identification provides the base for all other actions: to reduce risk (by putting policies and plans in place that will help avoid the creation of new risk or by addressing existing risks); to prepare for the residual risk either physically (preparedness) or financially (financial protection); and to inform improved resilient reconstruction design. The DRM community also recognizes that reconstruction programs provide opportunities to change the status quo and behaviors that contribute to underlying vulnerabilities.

Although the approaches used for climate resilience and disaster risk management originated from different disciplines, the two communities of practice are increasingly converging and both often use the approaches and operational framework described above. The convergence may also be due to the fact that a high proportion of recent disasters are weather related. Yet, institutional resistance towards integration at the national and international levels persists.

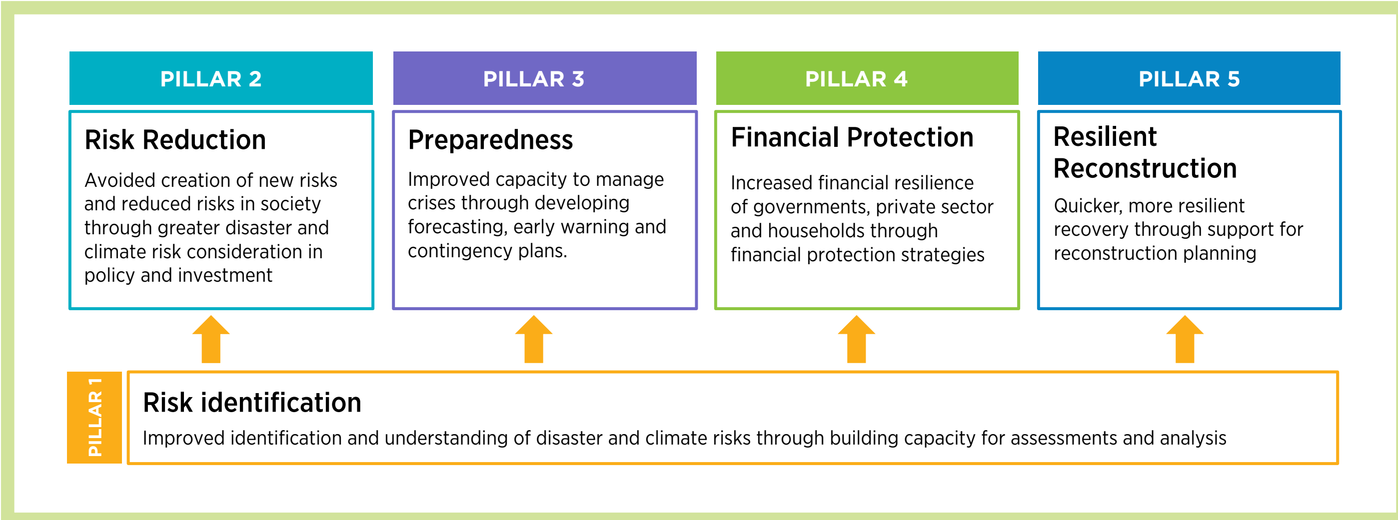
Figure 5: Process of integrating climate resilience into development



Source: Report authors

The closer the problems and solutions are to affected populations—particularly the poor—the more indistinguishable the approaches become. Communities and households consider primarily short-term weather extremes in their decisions; increasingly, however, they are also feeling the impacts from gradually changing average conditions, particularly as they affect crop production, flowering and fruiting of plants, and trees and livestock diseases.

Figure 6: An operational framework for managing climate and disaster risk



Source: The Sendai Report (World Bank 2012c)

Many of the tools and instruments that support actions developed predominantly by the disaster risk management community—such as risk identification, preparedness and financial protection—are also key to climate resilient development. At the technical level, the expertise of disaster management agencies (such as engineering, building codes, livelihood enhancement and early warning) complements that of climate resilient experts (such as agriculture production, livestock and ecosystem management).

> Much is already known regarding how to build resilience to weather-related disasters—but it requires sustained, long-term and flexible programs, and better coordination between the adaptation and disaster risk management agendas

Bringing the disaster risk management and climate resilience communities together is helping to draw on complementary disciplines. At the national level, this means that adaptation and climate resilience work, which has traditionally involved Ministries of Environment, and disaster risk management work managed by civil protection agencies (often under Ministries of Interior) need to be progressively brought together, and given sufficient strength to influence climate and disaster resilient planning decisions across other line ministries.

The roles of institutions in climate and disaster resilient development is arguably the single most important—yet the most difficult—part of the process. As climate change and disasters affect multiple sectors, countries where governance systems are divided across sectoral lines face a particularly complex challenge, since the institutions that have historically driven climate change and disaster risk management agendas are typically newer and weaker than the more established sectoral Ministries, such as Agriculture, Transport and Energy. Yet the lead agency needs to be able to convene decision makers from multiple agencies and levels of government, as well as the private sector and civil society. It must also be able to: mobilize and coordinate development partners; promote information sharing and knowledge management; and influence development planning and the budget in the short and long term.

Emerging experience indicates that in order to have effective convening power, this agency should be located at the highest possible level of government. While the choice varies, several countries, such as Kiribati, Mexico, Mozambique, Morocco, Samoa and Zambia have established coordinating agencies under Finance and Planning Ministries, or Offices of the President or Prime Minister.

In addition to assisting partner countries with emerging institutional arrangements, the World Bank and many other development partners have been drawing on the complementary experience in climate resilience and disaster risk management to derive emerging lessons and good practices. Section VI outlines the main instruments and tools used, while some of the most important emerging principles and lessons are summarized below. These lessons are not intended to be exhaustive, but rather aim to capture a few of the most important

Box 4: Major considerations for managing risks to development

The World Development Report 2014 provides five insights on managing global risks (including climate and disaster risks) to development.

1. Taking on risks is necessary to pursue opportunities for development. The risk of inaction may well be the worst option of all.
2. To confront risk successfully, it is essential to shift from unplanned and ad hoc responses when crises occur to proactive, systematic and integrated risk management.
3. Identifying risks is not enough: the trade-offs and obstacles to risk management must also be identified, prioritized and addressed through private and public action.
4. For risks beyond the means of individuals to handle alone, risk management requires shared action and responsibility at different levels of society, from the household to the international community.
5. Governments have a critical role to play in managing systemic risks, providing an enabling environment for shared action and responsibility, and channeling direct support to vulnerable people.

Source: World Bank 2013b. "WDR 2014: Risks and Opportunities. Managing Risk for Development".

considerations in climate and disaster resilient development (see also World Bank 2013c and IEG 2006 and 2012).

(a) Climate and disaster resilient development requires long-term, flexible programs, based on predictable financing

Our experience shows that climate and disaster resilient development requires long-term programs with predictable financing (spanning at least a decade). This is required to allow institutional mechanisms to mature and transcend political cycles, and promote a learning-by-doing, iterative and flexible approach to identify risks and incorporate resilience into development planning. The latter is particularly important in the face of uncertainties in climate change and development scenarios, which may require frequent adjustments. For this reason, robust monitoring and evaluation is of critical importance, to allow programs to scale up approaches that have been proven to work, and to adjust those that have been less successful. The PPCR has developed a set of core indicators that can help track progress at the national level (see Box 7).

Long-term programs can benefit from an initial phase, focused on planning, institutional coordination and capacity building. Often, this process takes time—typically at least 18–24 months in PPCR countries—and entails slow initial disbursements. This may at first deter some agencies and prospective donors, but experience has shown that this gradual consensus builds momentum and political will to scale up climate resilient development over the long term.

Predictable, long-term financing, over a decade or more (and often from a range of sources), also helps to drive the above process to implementation and sustain the initial efforts. Finance sources can include grants, credits or other instruments, and a mixture of national and international funds, some of which are highlighted in case studies in Section VI. Long-term financing is also critical to counteract the perverse incentives that favor short-term disaster financing over long-term risk reduction (see example in Box 13). At the same time, longer timeframes also help optimize opportunities to incorporate climate resilience and improved safety standards immediately after disasters, when public support for risk management is at its highest.

(b) Risk identification needs to be effectively linked to decision making, taking future uncertainties into consideration

By quantifying risks and anticipating the potential negative impacts of climate hazards and disasters, risk assessments can help governments, communities and individuals make better-informed decisions. Systematic screening of risks can also help determine the level of risks to people and assets and guide options for risk management. Decisions could include avoiding the creation of new risks, for example through improved territorial planning or enforcement of building standards. They can also include investments to reduce existing risks, such as the retrofitting of critical infrastructure, gradual population relocation to safer areas (retreat), or the construction of coastal (protection) systems. Regardless of the option, early lessons indicate that individual investments can be less important than their role in catalyzing community and national stakeholders and changing their risk behaviors.

Currently, the most effective actions appear to be those that combine development benefits in the near term with reductions in vulnerability over the longer term. However, concerted efforts need to be made to ensure that the short-term solutions do not increase future risks. This is typically the case with protection dykes, which, over the long term, can create a false sense of security and inadvertently expand settlements in high-risk areas. Robust decision making where decisions are "stress-tested" for future climates by considering a broad range of climate and socioeconomic conditions are proving to be useful in this regard (see Box 5).

(c) Risk management requires complementary actions at various levels of responsibility—household, community, national and international

Local disaster risks, such as storms or moderate drought, can often be managed by individuals or communities at the local level but as risks increase—for example, with major cyclones—national governments and the international community will have to play larger roles. While individuals are able to deal with many risks, they are inherently ill-equipped to manage large or systemic shocks, such as those that arise from climate change, since the past can no longer be considered a reliable predictor of the future (World Bank 2013d). As a result, climate and disaster resilient development needs to occur at different scales—individual, household, community, enterprise, national and international. These different actors have the potential to support climate risk management in different yet complementary ways.

(d) Institution building and mainstreaming need to take incentives into account

Capacity building for climate and disaster resilient development needs to be broad based and invest in professionals, especially in early to mid-career, to shield programs from political changes or high staff turnover. In addition, appropriate incentives are required to promote inter-sectoral planning: many multi-stakeholder committees have failed because line agency participants perceive climate and disaster resilience to be an added responsibility to their already full agenda. For this to be adequately addressed, stakeholders must feel that the programs are part of their own area of responsibility. This helps explain why many stand-alone adaptation and disaster risk management plans have not been successful in the past. If, by contrast, they are effectively mainstreamed into line Ministries' own programs and budgets, staff are more motivated to perform. For example in Zambia, the Sixth National Development Plan led to the creation of a specific program within the public works sector that considered climate resilience in infrastructure planning, allowing public works staff to participate more actively in the activities of the multi-sectoral Secretariat for Climate Change (under the Ministry of Finance).

In many emerging climate and disaster resilience programs, stakeholder champions frequently emerge to lead and facilitate the process. The result has been the genesis of multi-sectoral and multi-stakeholder processes, which facilitate decisions on incorporating climate risk as part of development planning.

(e) In their urgency to protect assets, climate and disaster resilient development programs should not lose sight of the people

The complexity of most climate and disaster resilient development programs often requires multiple stakeholder meetings and consensus-based decisions, which consume time and resources. By the time decisions are translated into action on the ground, programs may lose sight of their most important objective—to diminish the risk to people and assets, in particular for the poorest and most vulnerable. Continuously reemphasizing this focus will be critical to achieving the global goals of ending extreme poverty and increasing shared prosperity by 2030.

This section highlighted how climate resilience and disaster risk management are increasingly converging. In order to prevent fragmentation of scarce local capacity and global resources, the two disciplines need to be progressively harmonized, which can bring about the best of complementary expertise and help optimize the use of scarce financing.

The next section presents practical examples of instruments and tools used in the different stages of climate and disaster resilient development. Many of these are already widely employed by specific disciplines (such as social protection), but require further integration into national programs to optimize their use in resilient development.

Box 5: Making decisions under deep uncertainty

Many approaches to decision making focus attention on reducing uncertainty, for example by making predictions of factors and model parameters that affect decisions. But when uncertainty is difficult, if not impossible, to characterize (e.g., the likely climate and land use in specific locations in a century from now), focusing on predictions can lead to gridlock. Approaches like robust decision making (RDM) are different in that they seek to acknowledge and manage deep uncertainties by identifying decisions that are robust across a wide range of potential futures. Analysts run models over hundreds or thousands of different sets of assumptions to understand how strategies and plans perform in a wide range of conditions. They use statistical analysis and visualizations to identify the specific conditions that would lead to selecting one decision over another. This information is shared in an iterative process with decision makers in an effort to identify and build consensus around robust strategies. The World Bank is presently using RDM in flood risk management studies in Ho Chi Minh City and in infrastructure investments in Africa.

Source: Lempert et al. 2013a and b; Hallegatte et al. 2012.

VI. The World Bank Group Experience

Overview of the World Bank's Engagement

Demand is growing for the World Bank's support in climate and disaster resilient development. Building on experience and lessons learned, and collaboration with multiple partners, the World Bank has developed a range of expertise, tools and instruments to help countries manage climate and disaster risks.

The World Bank Group provides investment financing in the form of grants and credits to low-income countries through the International Development Association (IDA), and as loans to middle-income countries through the International Bank for Reconstruction and Development (IBRD). Some lower-middle income countries qualify for a blend of the two. Investments in climate resilient development as a share of the total project portfolio are steadily growing; the share of IDA projects with climate change co-benefits were 9% in fiscal year 2011, 16% in fiscal year 2012 and 13% in fiscal year 2013. The IDA disaster risk management portfolio demonstrates similar trends. This upward trend is occurring across all regions and country income groups. All 12 of the country partnership frameworks prepared in fiscal year 2012 for IDA countries, which lay out the agreed World Bank support to client countries, address country vulnerability to climate change and 10 (or 83%) also address disaster risk management.

In addition to IDA and IBRD financing, the World Bank leverages, packages and combines a number of lending instruments to assist countries in addressing climate and disaster risks. For example, the GFDRR is a multi-donor partnership and grant-making facility housed within the World Bank. GFDRR's technical assistance and capacity support for mainstreaming disaster and climate resilience into country development strategies is often instrumental in ensuring that the design of larger IDA and IBRD investment projects integrate disaster and climate resilient measures (see Box 6). The PPCR, as part of the multi-donor Climate Investment Funds (CIF), has a first phase dedicated for such support and, often combined with IDA funding, is helping 18 countries to moving towards transformational climate resilient development (see Box 7).

The World Bank helps countries access funds from GEF's Least Developed Country Fund and the Special Climate Change Fund. At the country level, support from these funds is aligned with activities financed through other sources, such as the Adaptation Fund, bilateral donors, and regional and multilateral development banks (MDBs). By strengthening the capacity to understand and prioritize actions for climate and disaster resilient development, countries are able to draw together and leverage different sources of finance and expertise.

The WBG's private sector investment arm, the International Finance Corporation (IFC), has also been actively engaging with the private sector on climate and disaster resilience. IFC is increasing awareness of climate risks and has begun incorporating climate change into its policies and investments (see Box 8). Working with other MDBs, IFC is also supporting public-private collaboration for climate resilient development (IFC 2011).

The rest of this section outlines examples of good practices, tools and instruments used by the World Bank and its partners to meet the increasing demand from countries in this rapidly growing field. It is structured around the main elements of climate and disaster resilient development that have been outlined in the previous sections.

Mainstreaming

In the past decade or so, many countries have recognized the importance of mainstreaming climate and disaster resilience into key investments and broader development planning. Mainstreaming—compared to stand-alone projects—can influence broader

Box 6: The Global Facility for Disaster Risk Reduction and Recovery (GFDRR)

Launched in 2006, GFDRR is a multi-donor partnership and grant-making facility designed to protect lives and livelihoods from disasters by: (i) expanding and strengthening global and regional partnerships to coordinate and scale up technical and financial support for national disaster risk management and climate change adaptation; (ii) contributing towards mainstreaming disaster risk reduction and climate change adaptation as key elements of sustainable development; and (iii) assisting post-disaster countries in achieving efficient, effective and resilient disaster recovery.

GFDRR is hosted by the World Bank on behalf of the 21 participating donors and other partnering stakeholders. It offers a unique business model for advancing disaster risk management based on ex-ante support to high-risk countries and ex-post assistance for accelerated recovery and risk reduction following a disaster. This partnership has been successful in raising the profile of disaster risk reduction for sustainable development. GFDRR's position in the World Bank provides an opportunity to leverage the financial, political and human resources the institution holds. The Secretariat also acts as the support hub for a decentralized network of DRM expert focal points in priority countries. These specialists play a leading role in locally managing the GFDRR program and in developing relationships with governments and other partners at the country level.

As of December 2012, GFDRR has provided support to over 80 countries and received US$342 million in pledges and contributions to implement its multi-annual work program. Grant making has increased from US$6.4 million in FY07 to US$46.7 million in FY12, and demand for GFDRR support continues to grow six years into the program. Financial resources are administered as grants (typically one to three years in duration) to government agencies, their development partners, technical bodies, NGOs and others. The Secretariat judges all grant proposals on their potential to leverage investment or institutional reform, and behavior change for improved management of disaster risks. GFDRR is responsible for allocating funds entrusted to it in line with geographic and thematic priorities set by its donors and partners.

development paths and potentially much larger multi-sectoral financing, and ensure that climate resilience initiatives are not undermined by contrary policies.

At the country level, examples are emerging where disaster and climate risks have been integrated into development; for example, the Philippines is integrating disaster risk management and climate change resilience into multiple levels of government planning (see Box 9). Other examples include Samoa, where climate and disaster risks are considered an intrinsic part of coastal and infrastructure management plans and embedded into a "'ridge-to-reef" approach.

Mainstreaming efforts are, in some cases, monitored through budget tracking. For example, in Zambia, the Climate Change Network (an umbrella civil society organization) and the Ministry of Finance have started monitoring funding allocations to climate resilient programs in the national budget, both in real terms (annual allocations in constant US$ equivalent terms), as well as in relative terms (proportion of allocations that goes to climate resilient programs). The PPCR in Zambia aims to increase real term budget allocations for climate resilience by 25% by 2019. The Government of the Philippines, in its efforts to mainstream climate change, is also monitoring climate activities and budget allocations through the Climate Public Expenditure and Institutional Review. This recently completed review by the Department of Budget and Management and the Climate Change Commission has identified many institutional challenges and are being supported with technical assistance.

As part of its support for a systematic assessment of climate change risk to development, the World Bank has developed a set of screening tools. These tools are designed to help government officials and development practitioners identify whether climate and disaster risks could have an impact at the national level, or as part of key sectoral investments, and whether to carry out a risk assessment in order to design appropriate resilience measures.

At the strategic level, the National Climate Impact Screening tool allows for the identification of climate vulnerabilities, including vulnerable locations and sectors hotspots. This draws on climate data available from the Climate Change Knowledge Portal (CCKP) and other key resources. This analysis is complemented by an Institutional Readiness Scorecard, which provides a rapid indication of the institutional and adaptive capacity gaps and needs.

At the project and sectoral levels, a number of screening tools are also being developed. The most advanced is the Hands-on Energy Adaptation Toolkit (HEAT) to assess climate risks to the energy sector (http://esmap.org/node/312, Figure 7). The toolkit also suggests measures to reduce risks and vulnerability.

Box 7: The Pilot Program for Climate Resilience (PPCR)

The PPCR is a targeted program of the Strategic Climate Fund (SCF), which is one of two funds within the Climate Investment Funds (CIF). It is implemented through a partnership of five MDBs: African Development Bank, Asian Development Bank, Inter-American Development Bank, the European Bank for Reconstruction and Development and the World Bank Group (WBG). The World Bank is the Trustee for the CIF and hosts the CIF Administrative Unit.

The PPCR supports technical assistance and investments to support countries' efforts to integrate climate risk and resilience into core development planning and implementation. It provides incentives for scaled-up action and initiates transformational change by catalyzing a shift from "business as usual" to broad-based strategies for supporting a climate resilient development path at the country level. The PPCR fosters a programmatic approach and builds on National Adaptation Programmes of Action and other national development programs and plans. The country-led strategic programs for climate resilience supported through the PPCR help prioritize and implement large-scale investments in support of national development goals. The PPCR complements existing development efforts and supports actions based on comprehensive planning consistent with countries' poverty reduction and development goals. The process for developing a strategic program involves broad and inclusive stakeholder consultations to identify and prioritize key interventions.

With about US$1.3 billion pledged since its establishment in 2008, the PPCR supports pilot programs in nine countries and two sub-regions (the Pacific and Caribbean), which involve nine additional countries. The PPCR provides phased funding: grant financing of up to US$1.5 million to undertake analytical studies and capacity building to support the preparation of country-specific strategic programs (Phase I), generally lasting 18–24 months; and near-zero interest credit for the implementation of key climate resilience measures (Phase II). The design of these measures aims to be transformative, be multi-sectoral, and integrate multiple stakeholders into the development process. Phase II is generally implemented in partnership with representatives of civil society, local communities and the private sector. In addition to financial support, the PPCR also provides a platform to share lessons and experiences, with the aim of replicating effective strategies and activities at scale. The requirement for broad-based stakeholder consultations ensures that the views of key stakeholders inform the strategic programs from the conceptual phase to implementation. In an effort to enhance private sector involvement, the PPCR has also established a competitive fund to provide support for private sector-oriented operations across the five MDBs, and, in particular, to create opportunities to overcome barriers to private sector adaptation investments in challenging business environments. The PPCR results framework was developed as a collaborative effort among PPCR countries, donors and development partners, and includes core indicators designed to measure PPCR program outcomes at the national level, aggregated from individual PPCR components.

Source: PPCR 2009. PPCR Design Document; PPCR 2012. PPCR program overview page; PPCR undated. PPCR Fact Sheet; PPCR 2013a. PPCR Measuring Results; SCF 2009. SCF Governance Framework.

Box 8: Engaging the private sector in addressing climate and disaster risks to development

As part of engaging the private sector, IFC has published a series of reports that assess private sector risk from climate change (IFC 2013; www.ifc.org/climaterisks). The reports highlight the complex factors that determine the financial vulnerability of a business in a specific location and sector; for example, a food processor in Ghana may have to deal with changing disease vectors and not just rising temperatures (IFC 2010b). In some cases, the simple provision of information has proven to be sufficient to motivate a client to take action; for example, a port in Colombia took action to include climate risks in its operations (IFC 2011).

IFC has also begun to incorporate climate resilience into its investments, through a policy that requires the inclusion of climate change risks in the review of environmental, health and safety risks during the appraisal. This policy is applied to all investments in the most climate-sensitive sectors, including agriculture and infrastructure. In 2013, IFC announced its first officially defined adaptation project, with Modern Karton—a large paper company installing equipment to enable recovery and reuse of water in Turkey, thereby avoiding the need for tapping limited groundwater resources (IFC 2013).

IFC also participates in the PPCR and other donor-supported programs; for example in Nepal, it is supporting efforts to promote more climate resilient seed varieties for the most widely grown agricultural commodities.

Source: IFC staff

Box 9: Mainstreaming across administrative levels to enable national resilience in the Philippines

The Philippines is one of the most disaster-prone countries in the world: weather-related disasters account for 90% of annual damages and cause on average 0.7% of losses to GDP growth. At least 60% of the country's total land area is exposed to multiple hazards, and 74% of its population is considered at risk. Rapid urbanization has led to urban squalor and the proliferation of unplanned, informal and overcrowded settlements, often situated in high-risk areas. Poor urban practices have also aggravated flooding risk over the past years and are expected to worsen in the future. Furthermore, 70% of the 1,500 municipalities located along the coast are vulnerable to sea level rise. The country is already witnessing longer episodes of drought and El Niño events, causing a large drop in the volume of agricultural production and sharp declines in GDP.

In October 2009, the Philippines was hit by the devastating Tropical Storm Ondoy (Ketsana) and Typhoon Pepeng (Parma), resulting in recovery and reconstruction requirements totaling US$4.4 billion, including US$2.4 billion in public spending needs. In the aftermath of the typhoons, the Government of the Philippines, with support from the World Bank, GFDRR and partners (Asian Development Bank, the Australian Agency for International Development and the Japanese International Cooperation Agency), undertook a PDNA resulting in a series of recommendations to strengthen the country's resilience to natural disasters. The PDNA was followed by a flood management master plan for metropolitan Manila to build the resilience of surrounding areas to future flood events.

In 2010, the Government of the Philippines signaled a policy shift from post-disaster response to prevention and risk reduction. It enacted the Disaster Risk Reduction and Management Act and adopted a Strategic National Action Plan for Disaster Risk Reduction, effectively institutionalizing a comprehensive and integrated approach to risk reduction. The Government recognized that reforming the policy and action framework on disaster risk management must be a national priority, requiring a cross-sectoral national strategy that applied a unified approach across administrative levels. In addition, a March 2013 National Summit for Local Chief Executives agreed to a comprehensive understanding of their role in disaster risk management, as well as mechanisms for the transparent and accountable use of resources.

Prioritizing the strengthening of local level governance, the Philippines is now pursuing the integration of climate resilience into local ordinances, policies and plans. Targeted actions include the operationalization of laws, policies, plans and other legal documents highlighting the Local Chief Executive's responsibilities in disaster risk management, standardization of a local disaster risk management plan template, optimizing trade-offs, employment and tourism priorities, and enhanced coordination and communication in times of disasters.

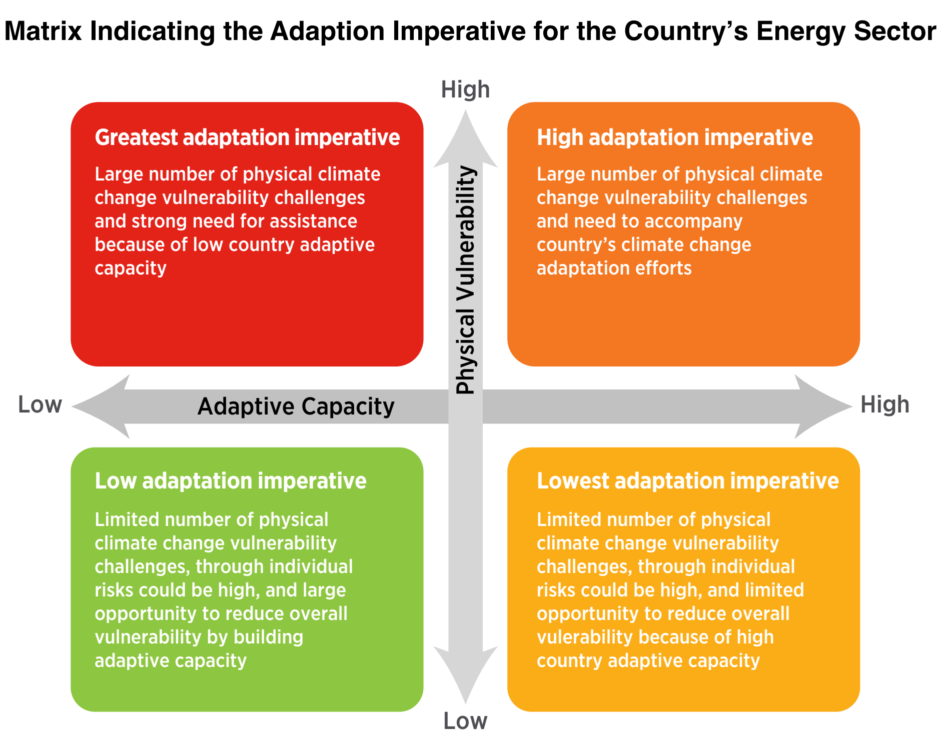
The Philippines is planning to continue focusing on mainstreaming with specific emphasis on integrating disaster risk management and climate resilience into the Comprehensive Land Use Plan and other local laws, policies and plans. Local communities and stakeholder coordination and communication will be strengthened through a common platform, and a whole-of-nation approach to DRM decisions pursued.

The World Bank's engagement helped to strengthen the DRM policy dialogue. The 2010 disaster act formed the basis for a World Bank DRM Development Loan with a Catastrophe Deferred Drawdown Option (CAT-DDO), which will be activated in case of a major disaster. This operation forms the foundation for the World Bank's ongoing policy dialogue on DRM. The World Bank has also conducted a Climate Public Expenditure and Institutional Review, and is helping address the identified challenges through a technical assistance program. The technical assistance provides targeted support for the Government's planning, budgeting, execution, tracking and reporting efforts.

Risk Identification

Risk assessments serve multiple purposes for various stakeholders, ranging from urban risk assessments for disaster preparedness, to multi-country financial risk assessments, and to the design of financial transfer mechanisms. The World Bank has been supporting climate and disaster risk assessments through open geospatial data tools, and the establishment of the Understanding Risk Community of Practice (now with 2,850 members worldwide). The focus has been on promoting open data and information sharing between in-country agencies, the scientific community and decision makers in the field, and in supporting

Figure 7: Hands-On Energy Adaptation Toolkit (HEAT)



This tool, developed by the Energy Sector Management Assistance Program (ESMAP), uses a simple set of multiple-choice questions to determine vulnerability, adaptive capacity and adaptation urgency. The sector's vulnerability (e.g., whether it is water intensive) is assessed against climate hazards (e.g., decreasing annual rainfall) to determine a simple, color-coded score signaling the level of risk (white, green, orange, red). This is then assessed against coping capacity to yield an overall score for the sector (the adaptation imperative).

Available at http://www.esmap.org/node/312

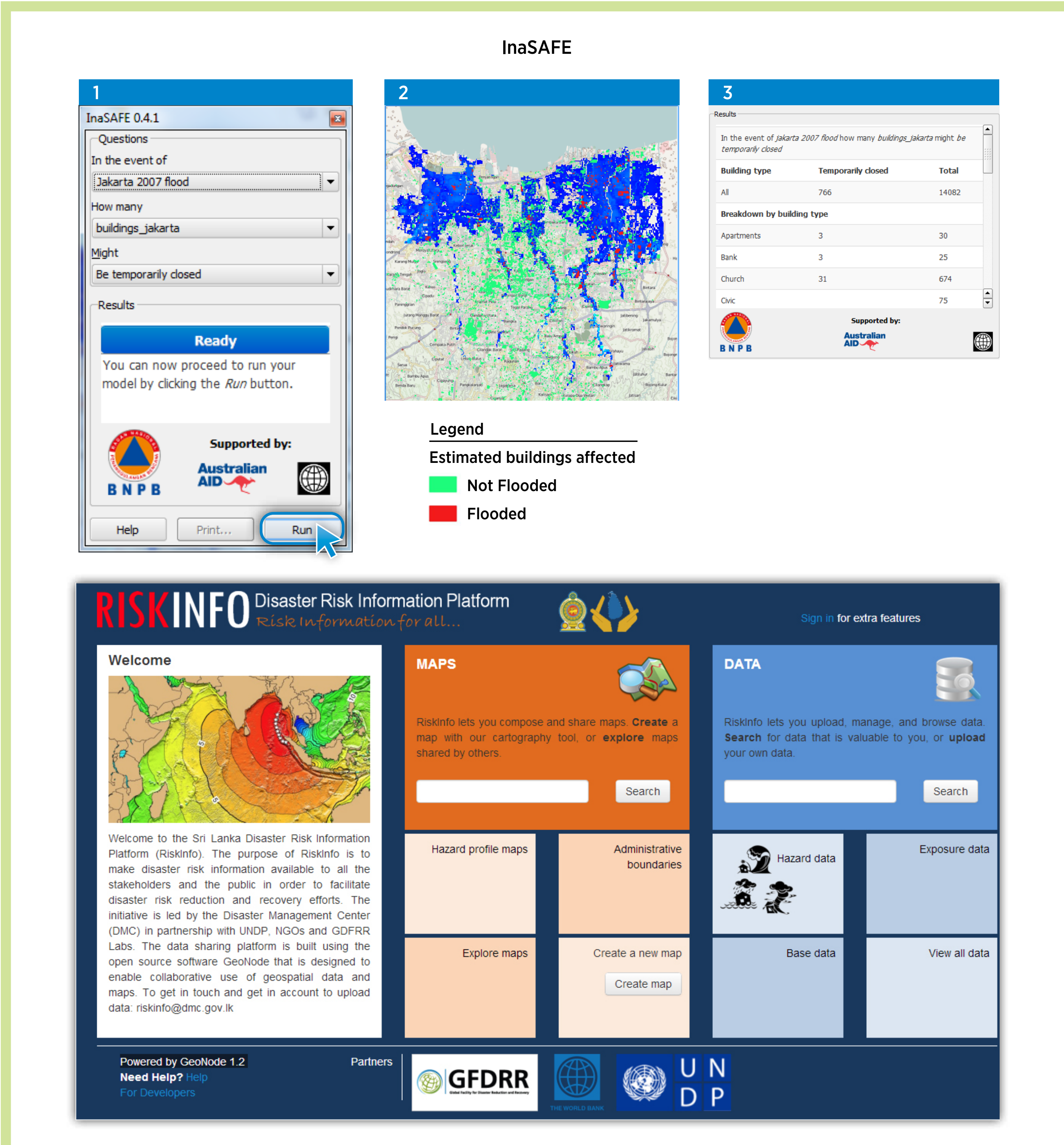
informed decision making for climate and disaster resilient development. As a consequence, access to risk information has improved for the more than 40 million people in 24 countries that have access to the Internet, and some 1,300 datasets related to natural hazard risks have been shared.

In an effort to make as much of this risk data and analysis open and available as possible to potential users around the world, the World Bank has been implementing an Access to Information Program since 2010. Building on this, GFDRR established the Open Data for Resilience Initiative (OpenDRI), in partnership with governments, international organizations and civil society groups, to develop open systems for disaster risk and climate change information. OpenDRI also promotes innovative approaches to transparency and accountability, ensuring that a wide range of actors can participate in the challenge of building resilience. Complimenting this initiative is the CCKP, an online platform that draws together various international open sources of climate information (see Figure 9).

Risk Reduction

With better information on disaster and climate risk, informed decisions can be made to reduce that risk. Since the main driver of growing disaster losses is increasing exposure, reducing new risk through anticipatory action is critical, for example through improved territorial planning or building practices. Existing risks can also be addressed by retrofitting critical infrastructure or constructing flood protection systems.

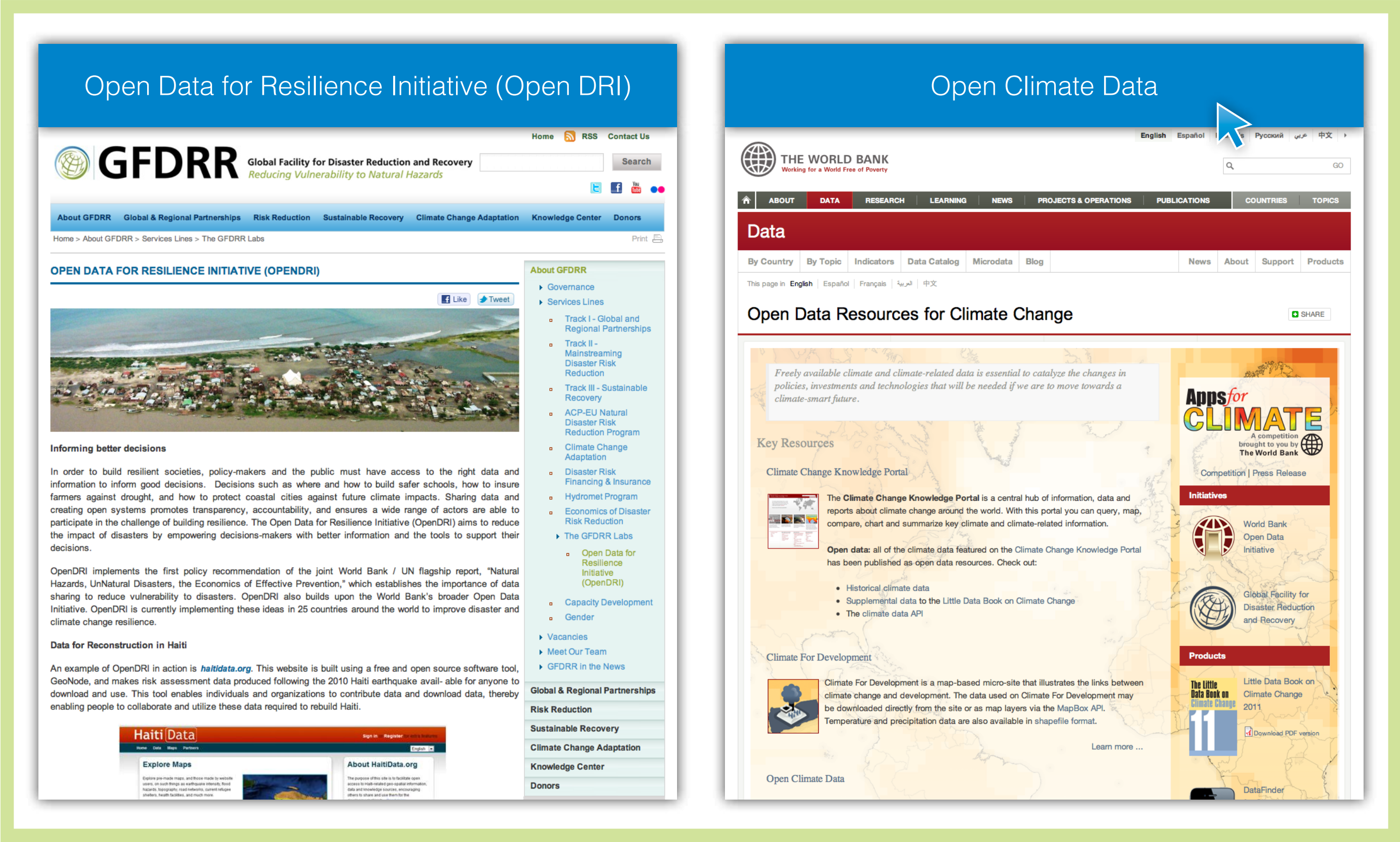
Figure 8: Examples of risk information platforms for decision making



The examples of InaSAFE, developed originally for Indonesia, and the Sri Lanka Disaster Risk Information Platform

Source: http://inasafe.org/en/

Figure 9: Open data resources for a wide range of uses and users



OpenDRI can be accessed here: https://www.gfdrr.org/opendri ; Open Data Resources for Climate Change can be accessed here: http://data.worldbank.org/climate-change . It includes links to the Climate Change Knowledge Portal (http://sdwebx.worldbank.org/climateportal/index.cfm), Climate for Development (http://climate4development.worldbank.org), Open Climate Data (http://data.worldbank.org/data-catalog/climate-change), and a range of other relevant open data links.

When considering a disaster risk, be it new or existing, there are three major ways to deal with it.

a) **'Retreat' by reducing exposure to the hazard**

'Retreat' refers to moving an existing development which is exposed to a given hazard to a new, safer location—or to plan a new development in the safer area. The latter is often a very effective and low-cost option, if appropriate alternative locations exist. However, when considering existing assets and communities that are already established in an exposed area, retreat is not easy as it normally involves resettling people and assets, with all its associated socioeconomic challenges. In addition, the most exposed people are often the poorest, and surrounding (safer) land tends to already be occupied. Good practices in managing population retreat are still emerging, although initial work has begun in Latin America and in large urban areas in East Asia (see for example Correa 2011).

In addition, many other countries, such as island nations and drought-affected countries in the Horn of Africa, have started discussing retreat options.

b) **'Protect' by reducing the hazard risk**

'Protecting' people and assets from a hazard can be done through 'hard' infrastructure-based options (e.g., sea walls) and 'soft' ecosystem-based approaches, such as ensuring that there is sufficient wetland and coastal vegetation to act as buffers. Ecosystem-based solutions are proving to be extremely cost effective and provide a level of flexibility that can adapt to changing hazard patterns over time. Often, however, a combination of hard and soft solutions are required.

c) **'Accommodate' by reducing vulnerability**

'Accommodating' implies an active decision to live with the hazard, but reduce vulnerability to it, for example by retrofitting existing

Box 10: Decision support through open risk assessment and information platforms—CAPRA and InaSAFE

Since 2006, more than 20 countries have produced national risk information. World Bank and GFDRR support for risk assessment has occurred through specific country-level studies, development of guidelines for methodologies, support of spatial datasets, and setting up of risk analysis tools for decision makers. Specific examples include: the Central America Probabilistic Risk Assessment (CAPRA) and InaSAFE, which are now well-established tools that exemplify decision support through open data sources; the Disaster Risk Information Platform of Sri Lanka (see Figure 8); and Moz-Adapt, an open data platform maintained by the National Institute for Disaster Management in Mozambique to support data sharing between government, academic stakeholders and the general public. Extensive aerial imagery over the Limpopo River Basin is complementing Moz-Adapt to establish an exposure baseline from which to simulate the impact of different flood return periods.

Understanding hazards, exposure and vulnerability is the first step towards managing climate and disaster risk. People living in disaster-prone areas have been assessing the risks they face in various ways for centuries. Today, a range of new methods can help governments, communities and private sector actors quantify and anticipate the potential impacts of natural hazards, make more informed decisions on how to manage risk and facilitate climate resilient development. CAPRA is a free and modular platform for risk analysis and decision making, which applies probabilistic techniques to hazard and loss assessment. Initiated with seed funding from GFDRR in Nicaragua, CAPRA has grown into a partnership between the World Bank, the Inter-American Development Bank, UNISDR, the Coordination Center for the Prevention of Natural Disasters in Central America, and governmental institutions in Belize, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

The platform was designed to be modular and extensible. Hazard information is combined with exposure and physical vulnerability data, allowing the user to determine risk from multiple hazards, thus distinguishing it from previous single hazard analyses. The CAPRA suite of software includes hazard mapping tools or add-ons to connect with existing hazard tools, risk assessment and cost-benefit analysis. CAPRA can also be used to design risk-financing strategies.

Colombia, El Salvador, Dominica, Panama, Ecuador, Costa Rica and Peru are currently preparing major public investment plans, based on risk assessments conducted through the CAPRA program. CAPRA is also assisting governments in creating new analytical products to inform land use planning and public investments. For example, in Colombia, risk modeling undertaken in three cities resulted in quantitative risk information on buildings in the education, health and housing sectors.

InaSAFE is a free software tool that produces realistic natural hazard impact scenarios for better planning, preparedness and response. The software allows users to combine data from many sources and explore the impacts a single hazard would have on specific sectors, e.g., location of primary schools and estimated number of students affected by a possible flood. This open source tool enables users to download a free Geographical Information System editor (QuantumGIS), install the InaSAFE plugin, and pull in hazards and exposure data layers either with manual offline sources or via Internet web services. Afterwards, users can run a risk impact analysis to show the vulnerability of certain infrastructure or populations to a specific hazard.

The software was developed in a partnership with the World Bank/GFDRR, the Australia-Indonesia Facility for Disaster Reduction and the Government of Indonesia. Prototype questions addressed by the tool include: how many schools might be closed and/or damaged by a flood; how many buildings might be damaged by a 50-year compared to a 100-year flood; and what might be the fatalities/injuries from such an event?

structures to more resistant standards or at higher elevation. This approach is common, especially amongst the poor. Because of uncertainties and cost-benefit considerations, many infrastructure investments use a gradual approach to safety standards (e.g., elevate bridge decks or increase drainage when risk becomes greater than previously envisaged). For sectors, such as agriculture, typical strategies include livelihood diversification or adoption of more climate resilient crops or livestock.

A portfolio of cost-effective measures can be combined to reduce a large part of climate and disaster risk. Under high-emission climate change scenarios, one World Bank study found that economically efficient adaptation measures could reduce expected losses by 40–68% in 2030, with even greater reductions in specific locations (World Bank 2009). This assessment considered a number of adaptation measures, for example infrastructure improvements, structural hazard management, technological measures, and systemic or behavioral initiatives. A range of analyses have also shown a strong economic case for disaster risk reduction, with the benefits of avoided and reduced losses outweighing investment costs on average by about four to one (Mechler 2012)—although the time horizon of the expected benefits influences investments' cost effectiveness. In order to avoid the creation of potential new risks, using a low or no-regret approach is often suggested. This would mean that there are development benefits with or without the projected climate change (Government of the UK 2013).

To underpin the reduction of both future and existing risk, the World Bank has been supporting improvements in safety standards and building codes, and participatory spatial planning taking resilience into account (see Box 11 for Madagascar, and Box 12 for Samoa and São Tomé Island). In Vietnam, where typhoons can affect up to 90 percent of the population, GFDRR supported the creation of new disaster resilient policies in infrastructure and land use. An assessment of Vietnam's rural roads and national highways led to climate resilient road designs applied in a nationwide IBRD rural transport project. Additionally, the Ministry of Agriculture is using studies of damaged irrigation systems to develop an irrigation improvement project. These concrete actions by government in response to existing climate risk are occurring in a country where sea level rise could flood up to five percent of its arable land.

Following Tropical Storms Ondoy and Pepeng in 2009, the World Bank and GFDRR supported the Philippines Department for Public Works and Highways to develop the Metro Manila Flood Risk Management Master Plan, which prioritizes policy reform and structural risk reduction investments costing approximately US$8.6 billion. Studies have begun on a plan that proposes alterations for the upstream catchment area and the Laguna Lakeshore, and the government is in discussions with affected communities on new housing and resettlement options. Similarly, GFDRR supported the city authorities in the Senegalese capital Dakar with designing a large-scale IDA investment program to protect communities from recurrent floods and storm surges. The US$55.5 million project targets municipalities located in flood-prone, peri-urban catchment areas, home to 1.2 million people. The project will improve drainage systems and develop an integrated urban flood risk and storm water management program.

Preparedness

Considering the context of increasing uncertainty, "planning for the worst" must assume a central role in development. All 31 GFDRR priority countries include some aspect of preparedness in their national plans, depending on needs. These form integral components of national strategic approaches, helping link disaster response with resilience building for a holistic approach. GFDRR support generally targets strengthening national and local coordination, capacitating response and civil protection structures, providing real-time impact analysis and enhancing financial preparedness. For example, World Bank and GFDRR are supporting the Senegalese Civil Protection Agency to strengthen its risk management capacity by setting up coordination mechanisms for early warning, preparedness and response. In Burkina Faso, support is going to the National Council for Disaster Management and Recovery to develop local contingency and emergency preparedness plans, link the plans to the existing early warning system, and strengthen community-based preparedness planning, including drills and simulation exercises. In Haiti, where preparedness for evacuation and shelter is a priority, support is being provided to the Directorate of Civil Protection to modernize the country's evacuation shelter network and engage local communities in mapping and emergency planning.

Weather, climate and hydrologic monitoring and forecasting are essential to inform decision making for climate resilience and provide critical inputs to early warning systems. The World Bank's portfolio of projects supporting hydro-meteorological investments is currently close to US$500 million, including integrated support in Central Asia, Mozambique, Nepal and Yemen. In 2011, GFDRR launched a hydro-metrological initiative to support and leverage World Bank investments to strengthen weather, climate and hydrological services, and ensure that World Bank investments support and contribute to international norms, standards, systems and efforts under the auspices of the World Meteorological Organization (WMO) and the Global Framework for Climate Services.

Hydro-meteorological support emphasizes the role of the ultimate information users as demand drivers and ultimate beneficiaries of quality weather, climate and hydrologic services. Investments are, therefore, context and country specific. In Nepal, for example, a core component of the PPCR support for "Building Resilience to Climate Related Hazards" is the creation of an agriculture management information system to provide timely agro-climate and weather information to farmers, so they can anticipate major changes in weather patterns and take appropriate action.

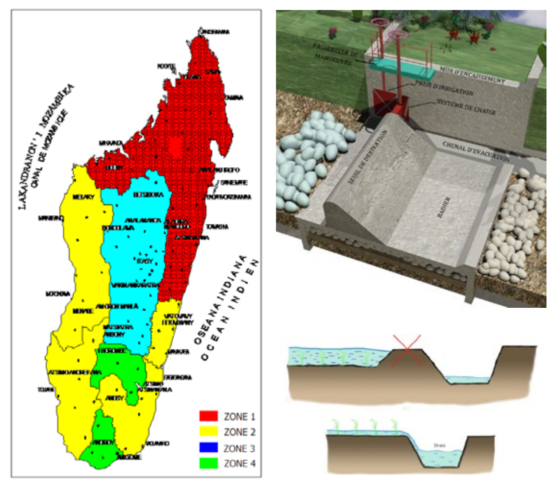
Regional approaches are often employed to support national capacity by linking with neighboring regional and global centers of excellence for data, forecast and expertise sharing, for example through a system of "cascading forecasts" for snowmelt runoff and severe weather in Central Asia, supported by IDA and the PPCR.

Building capacity of the agencies involved across the service delivery chain improves early warning and preparedness, as well as

Box 11: Investing in improved safety standards and building codes in Madagascar

Madagascar is one of the most exposed countries in the world to cyclone risks, averaging 3–4 cyclones a year. The 2008 cyclone season, for example, damaged some 6% of existing health centers and 4% of primary schools, in addition to causing extensive damage to irrigation and transport infrastructure (Government of Madagascar 2008). Many of the structures were weakened by poor maintenance and past cyclone damage. Despite an international call for funds, less than half of the public reconstruction needs were eventually met. This left many poor communities in high-risk areas with the burden of having to rebuild not only their own damaged assets, but also essential public infrastructure (such as schools and access roads), further compounding the cycle of vulnerability.

To address this, the National Unit for the Prevention and Management of Disasters gave the highest priority to the development of weather-resistant building and infrastructure codes, using a GFDRR Track II Grant and relying mostly on local experts. Madagascar's new building codes were adopted by a Government decree signed by all 31 Ministries on April 20, 2010. They were based on the codes of Réunion and the Kingdom of Tonga, following extensive discussions with builders and communities. The codes are strictest in Zone 1 (see map below), where they are set to resist wind speeds of 266 km/ha (74 m/s). They are mandatory for public buildings (schools and health centers), recommended for traditional houses in high-risk areas, and have been integrated into urban and habitat regulations. In case a public building fails to meet the codes, the Decree provides for a public hearing by local collectivities. Most importantly, the decree allows for the possibility of civil penalties for both constructors and inspectors. By also making inspectors liable, the new regulation aims to encourage certification of inspecting firms and discourage the proliferation of corrupt practices that contribute to building failure. Post-disaster assessments are starting to show that the codes are effective, with only one in 1000 improved public buildings constructed by a social fund suffering damages.



Transport and irrigation infrastructure safety codes were developed next. Similar to the construction codes, the country was divided into risk zones based on hydro-geological characteristics, existing assets, river morphology and projected climate change scenarios. Safety return periods and improvement in designs were then developed for the different risk zones and types of infrastructure (see figure below).

Minimum return periods for transport infrastructure (in years)

Zone	Roads		Drainage		Bridges		Dykes
	Surface	Embankment	Longitudinal	Transversal	Decks	Pillars	
High plateau, high rainfall	150	150	50	150	300	150	150
High plateau, low rainfall, occasional flooding	50	50	50	50	300	100	100
Watersheds in extreme south	75	75	50	75	300	150	150

The experience of Madagascar yields several important lessons: first, the codes were developed at a very low cost (as Madagascar's aid was interrupted following a military coup), and relied heavily on local knowledge and dedicated national champions; and, second, the codes were extensively field tested and discussed with industry and communities. Awareness, training and regulatory incentives were perceived to be as important as the codes themselves. The decree on building codes, for example, was discussed at length with legal experts and experienced implementers, to ensure that potential loopholes would be addressed, and was kept very simple to help ensure compliance.

The codes were spearheaded by a unit located within the Office of the Prime Minister—with sufficient leverage to bring together all relevant stakeholders. This was a top priority for three years, which helped focus attention towards the common goal of minimizing the recurrent damage from cyclones and floods.

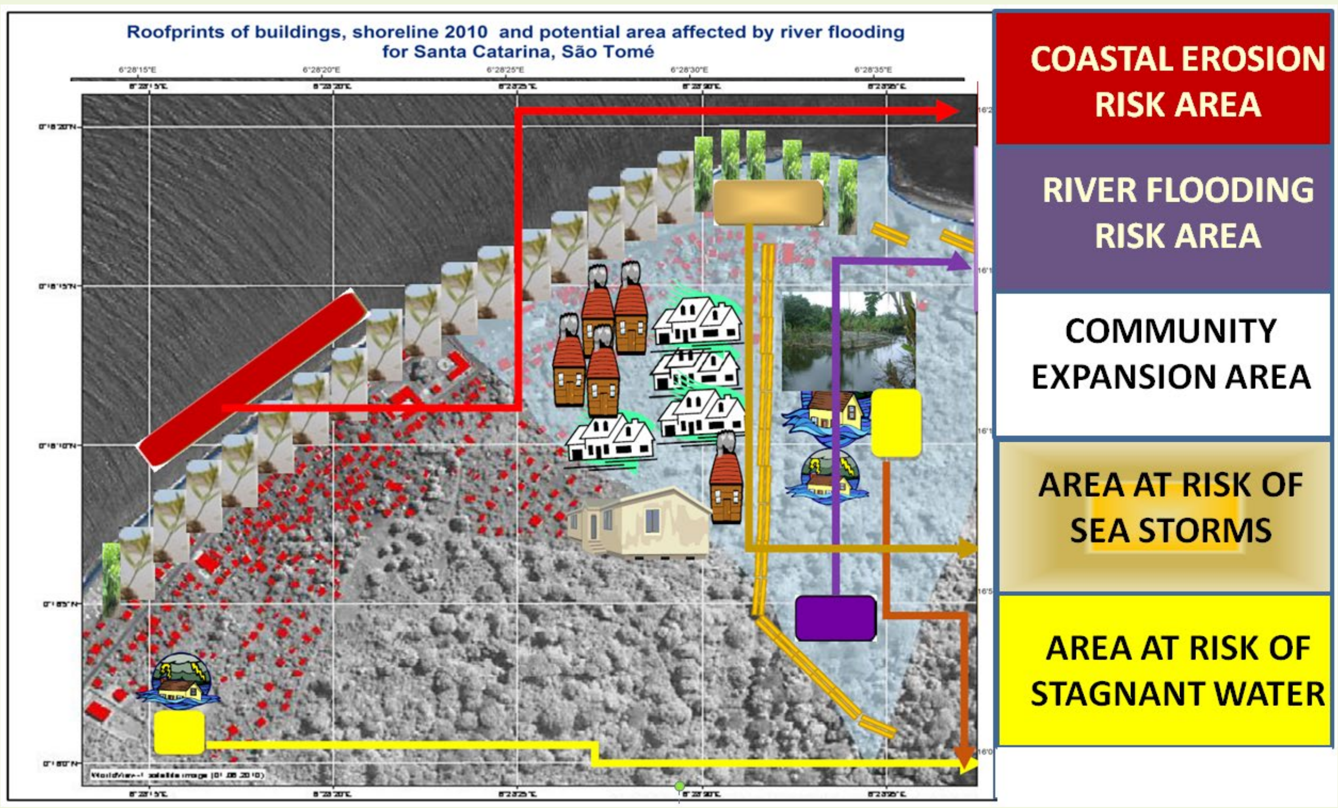
Sources: Adapted from Razakanaivo et al., 2010; Cellule pour la Prévention et Gestion des Urgences (2013a and b).

Box 12: Integrating climate resilience into spatial planning in small islands

Samoa presents an example where risks were considered part of integrated development (infrastructure) plans. These "Coastal Infrastructure Management" plans were developed in 1999 for all districts and villages. They assess the resilience of infrastructure to flooding, erosion and landslides; identify potential solutions; and assign responsibility for implementation amongst different stakeholders. They also take a ridge-to-reef or landscape approach that involves managing climate and disaster risks from the coastal zone to upper water catchment areas. Implementation of the plans, using a participatory approach, is being supported by the PPCR, through the World Bank, and the Adaptation Fund, through UNDP.

Interestingly, not all options identified by local stakeholders involve climate resilience. Many involve simple development needs, such as electrification and water supply, which can have indirect resilience benefits. However, the process of incorporating resilience into spatial planning allows local communities to use the plans to access funding for both everyday development needs, as well as for adaptation to climate change. A similar approach to climate resilient planning is being followed in other countries, including the Barotse sub-basin of the Zambezi, Zambia, which is supported by the PPCR.

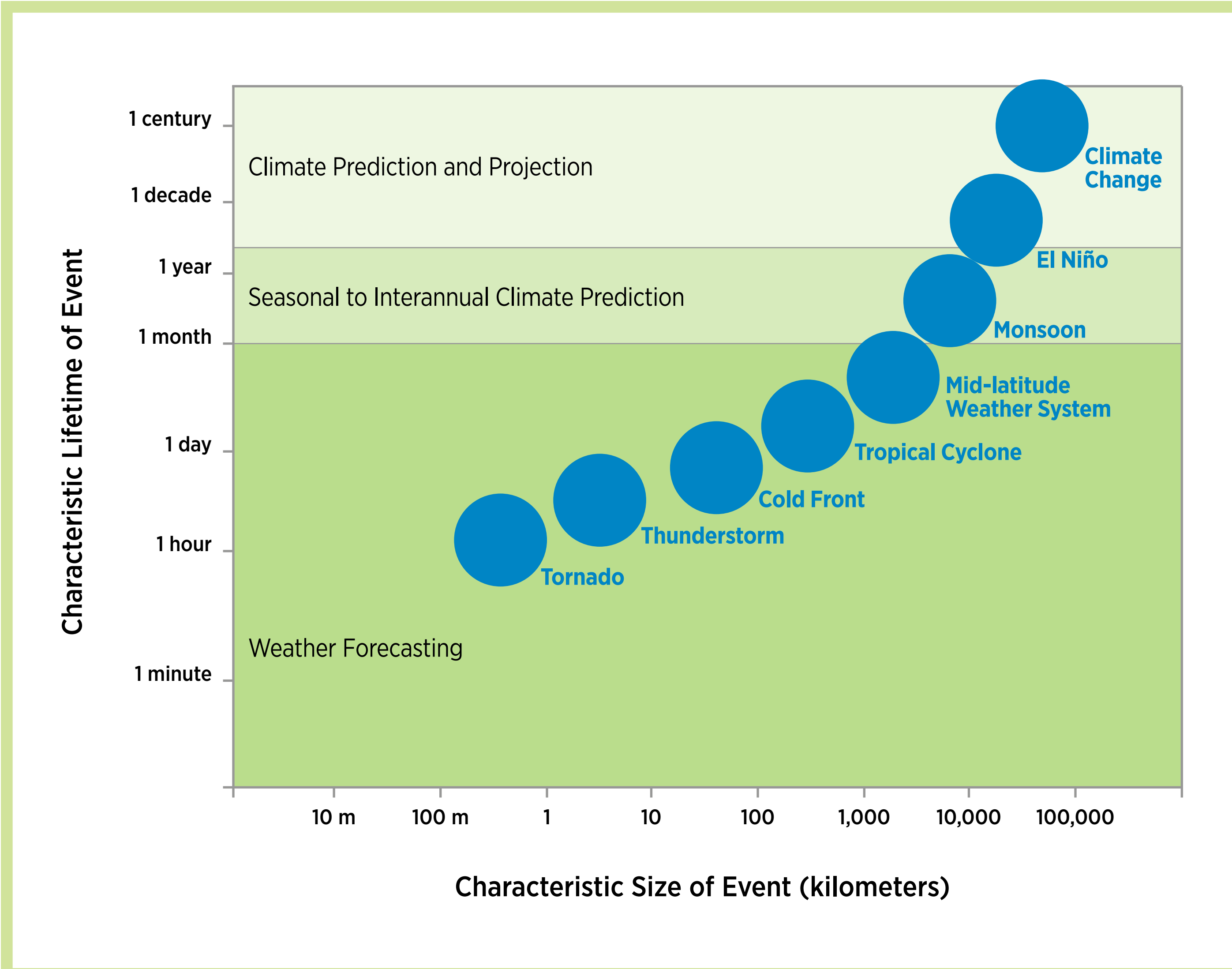
The map below illustrates how simple planning can be done with the right information and risk mapping available in São Tomé Island. Areas at risk are marked in red (coastal erosion), purple (river flooding), cream (sea storms) and yellow (stagnant water). Simple adaptation measures selected include reinforcement of embankments combined with mangrove replantation along the coast. At the same time, risk mapping has allowed the community to plan the future expansion of the settlement to safer areas.



Source: Enhancing Climate Resilience of Coastal Resources and Communities Project, Samoa; and São Tomé and Principe Adaptation Project

coordination and information exchange. As an example, in Mozambique, the PPCR on "Strengthening Hydrological and Meteorological Information Services for Climate Resilience" supports the national meteorological service, national water directorate, regional water authorities, national disaster management agency and local NGOs to develop and deliver early warning from producers to last-mile users.

Figure 10: Inputs of climate information services to various stages of the climate resilient framework



Source: Adapted from Figure 2 in Zillman, J.W. (1999). The National Meteorological Service. WMO Bulletin 48(2): 129–159 pp, World Meteorological Organization, Geneva, Switzerland)

Financial and Social Protection

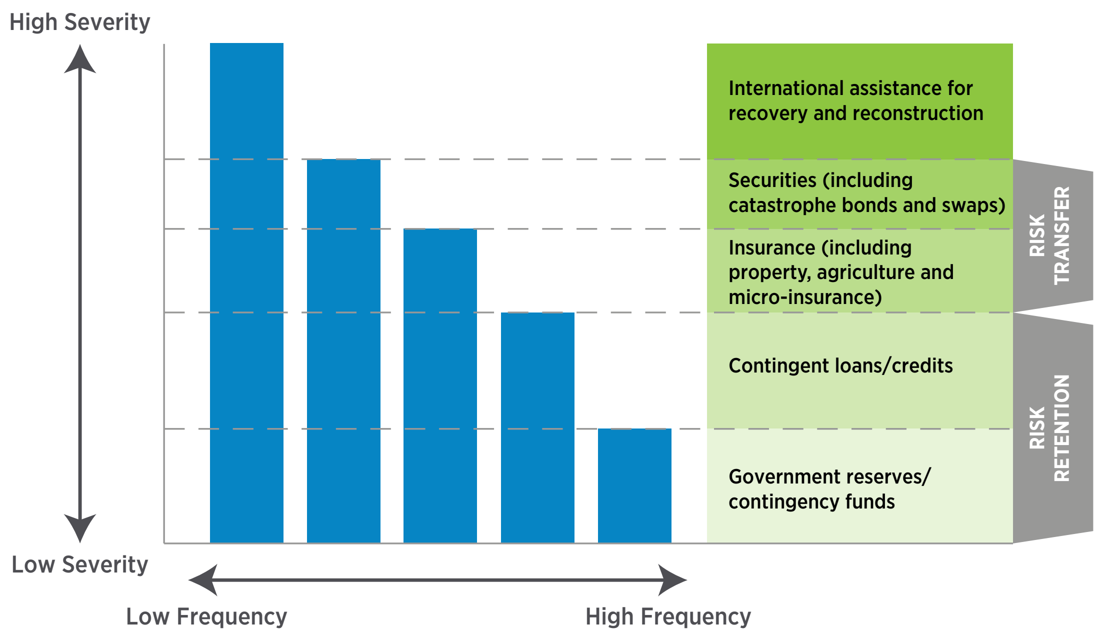
Financial Protection

Financial protection allows for accelerated resource mobilization in an emergency or pre-emergency situation, through contingency funds and credit, and a set of risk transfer and insurance instruments, which include disaster micro-insurance, agriculture insurance, private property insurance and public asset insurance. The World Bank's Disaster Risk Financing and Insurance Team, supported by GFDRR, the Bank's Treasury and Finance and Private Sector Development Departments, and IFC, provides advisory services to countries to increase their financial resilience to natural disasters.

The World Bank uses a series of instruments (Figure 11) to support financial protection, which are tailored for national and often regional needs and varying disaster risk profiles. This means that for low-severity, high-frequency events, risk retention, in the form of budget reserves and contingent credit, is the most appropriate solution. However, for more severe disasters, risk retention will not be sufficient; therefore, more expensive risk transfer options may be considered (see Figure 11).

The World Bank has also supported regional initiatives in the Caribbean and the Pacific. For example, in 2007, it helped the Caribbean Community and Common Market (CARICOM) establish the Caribbean Catastrophe Risk Insurance Facility

Figure 11: Financial protection instruments for climate and disaster resilience



Source: Disaster Risk Financing and Insurance Program, Non-Bank Financial Institutions Capital Markets Practice and GFDRR, The World Bank.

(CCRIF—http://www.ccrif.org), a Caribbean-owned "parametric" insurance pool, which offers fast payout to its 16 Caribbean member countries upon occurrence of pre-defined hurricane strengths and earthquake magnitudes within defined geographical locations. The CCRIF offers participating countries an efficient and transparent vehicle to access international reinsurance and capital markets, and is a self-sustaining entity, relying on its own reserves and reinsurance for its financing. Building on the Caribbean experience, a similar effort is underway in the Pacific.

The World Bank also supports efforts to improve risk transfer for households and individuals, recognizing the limitations to insuring the poorest sustainably and at scale (World Bank 2013e). For example, the team assisted: Romania and Turkey in establishing national catastrophe risk insurance pools to protect homeowners against natural disasters; Mongolia to create a livestock insurance pool to protect herders against harsh winters; and the Indian government to move towards market-based crop insurance. Continued technical support to reform the National Agricultural Insurance Scheme in India, together with its successor schemes, constitutes the largest crop insurance program in the world with more than 25 million farmers insured. This project reduces delays in claims payments provided to farmers, provides improved coverage and highlights the need for strong public-private partnerships.

Financial instruments not only help reduce the impacts of risk from household to government levels, but many utilize innovative approaches to transfer risk off government balance sheets to the capital markets. This helps governments manage and reduce contingent expenditures, for example by insuring safety nets or traditionally uninsurable concepts, like low-income housing.

The World Bank is providing a combination of technical assistance and investment support to facilitate a shift from ex-post response to ex-ante DRM under the Regional Disaster Vulnerability Reduction Project (RDVRP) (see Box 14). At the core of this approach is an attempt to change the culture of decision making to incorporate climate and disaster risk information on where and how to build. This, in turn, aims to reduce the base physical risk to external hazard shocks (i.e., more resilient transport systems, water supply infrastructure, public and private buildings), and develop the appropriate instruments, capacity and financial protection mechanisms to smooth out the impact of disasters on public finances.

To encourage greater use of market-based solutions and to respond to the diversity of demand, the World Bank also provides intermediation services for disaster-related transactions. IBRD began providing treasury services to the CCRIF in 2007, intermediating catastrophe swaps. In 2008, IBRD and IDA introduced intermediate weather derivatives. Both initiatives represent the broader options of customized financial solutions to help protect government investments and development resources.

The World Bank has also supported the development of catastrophe bonds (CAT bonds) in Mexico, covering hurricanes and earthquakes at the sovereign level (see Box 15). By providing an investable security (rather than an insurance or derivative contract), CAT bonds can help broaden the scope of potential investors, which increases the chances of achieving the scale needed for DRM financial solutions, particularly in middle-income countries. Over US$40 billion in CAT bonds have been issued in the last decade, mostly in high-income countries, and after Superstorm Sandy, the New York Metropolitan Transit Authority attracted US$200 million in investments to cover flooding risk in the subway through a CAT bond (Economist 2013).

Since 2008, the World Bank, through IBRD, has been issuing Green Bonds to raise funds from investors in the capital markets

Box 13: The proven benefits of early warning and preparedness against disasters

Improving weather forecasts and early warning systems must be effectively linked to action on the ground, to save both lives and property. Preparedness activities, therefore, must include strengthening the capacity of local organizations to plan for and respond to the effects of disasters. In the case of approaching cyclones, for example, local authorities use early warnings to evacuate large numbers of people to safer locations or to protect them in situ. Long lead times enable people to protect property and infrastructure; reservoir operators, for example, can reduce water gradually to accommodate incoming floodwaters. Early warning can also provide information on the occurrence of a public health hazard and enable a more efficient response to seasonal drought and food insecurity. Effective systems, therefore, require a combination of government leadership, multiagency coordination to ensure effective responses based on pre-agreed operating procedures, and community participation (Rogers and Tsirkunov 2013).

India—a case in point

In October 1999, a Category 5 cyclone devastated the eastern coastline of India. The strongest cyclone on record in the North Indian Ocean left 10,000 people dead and about 1.7 million homeless, and caused disaster losses estimated at US$4.5 billion. Fourteen years later in October 2013, Category 4 Cyclone Phailin hit the same stretch of coastline around Andhra Pradesh and Odisha (formerly known as Orissa). This time, a different story unfolded: fewer than 40 people died (0.4% of the 1999 casualties) and initial estimates of economic losses stood at US$700 million.

What changed? Essentially, years of disaster risk prevention and preparedness paid off. After 1999, the Odisha State Disaster Management Authority (OSDMA) invested heavily in improving capacity to manage disaster risk through early warning systems and preparedness simulations, including annual storm drills and the involvement of local community and volunteer organizations. OSDMA also invested in new cyclone shelters, evacuation routes and strengthening coastal embankments.

With improved forecasting, the Indian Meteorological Department was able to provide accurate advance warning (72+ hours) and tracking forecasts before Phailin made landfall, allowing about a million people to evacuate. Improvements in communication technology also played a central role in enabling the network of community and volunteer organizations to mobilize the larger population; currently, 60% of the population in Odisha own mobile phones, compared to just 2 million handsets in all of India in 1999.

Continued and increased support is necessary to ensure that Andhra Pradesh, Odisha and other similar jurisdictions with well-developed disaster management structures do not become victims of their own success, due to the perverse incentives surrounding disaster response. The widespread devastation in 1999 captured global media attention and catalyzed a humanitarian relief effort that extended well into the 2000s. This financial assistance is equally important in 2013 to ensure that the fragile success is not undone.

The Government of India and the World Bank continue to support climate and disaster resilience in Odisha and Andhra Pradesh through Phase 1 of the National Cyclone Risk Mitigation Project. The project, totaling US$255 million, has been under implementation since March 2011, and aims to extend the early warning system to the community level, build multi-purpose cyclone shelters and evacuation roads, and strengthen existing coastal embankments. Early indications reveal that project investments are contributing to India's larger efforts to help communities become more resilient to the impacts of natural disasters and the changing climate.

Source: World Bank Project staff, World Bank's blog and NPR blog. http://blogs.worldbank.org/endpovertyinsouthasia/never-again-story-cyclone-phailin; http://www.npr.org/blogs/parallels/2013/10/15/234679285/how-india-has-learned-to-deal-with-major-cyclones?utm_medium=Email&utm_source=share&utm_campaign

Box 14: Tools, capacity and investment support to Eastern Caribbean countries

Grenada and Saint Vincent and the Grenadines (SVG) are exposed to high levels of risk from climate extremes. According to the World Bank and UN ECLAC's Damage and Loss Assessment (DaLA), poor infrastructure is the single largest driver of risk for Eastern Caribbean economies. Due to their small population and geographical size, a single hazard event can impact the entire population and economy at once—significantly impacting public welfare, national economic activities, property and natural resources. Hurricane Ivan (2004), for example, resulted in losses amounting to 200 percent of annual GDP in Grenada, damaging or destroying 97 percent of the country's schools and 67 percent of its housing stock. Over the past 50 years, approximately US$3 billion has been lost as a consequence of natural hazards in the Eastern Caribbean alone, averaging 3% of GDP per year in the same period. The resulting fiscal losses from these disasters and the costs associated with the reconstruction of damaged infrastructure have greatly contributed to unsustainable budgetary deficits and have had a negative impact on economic growth. As a result, SVG's debt-to-GDP ratio currently stands at 68% (IMF 2012).

The total RDVRP funding envelope, including grants and concessional financing from the PPCR, supports activities currently being implemented to reduce the vulnerability of existing infrastructure through retrofitting and rehabilitation of critical structures (international airport, water supply infrastructure, schools and bridges in Grenada; and hospitals, schools, riverine defense, coastal defense and bridges in SVG). These projects also aim to build capacity for improved territorial planning and better building practices in both the public and private sectors, which over time will help reduce both physical and fiscal vulnerability. Complementing these investments is active support to shift to ex-ante risk reduction through an iterative process to identify and prioritize reduced risk investments through: 1) geospatial data consolidation; 2) the application of disaster risk analysis for decision making; 3) the establishment of risk baselines; and 4) quantitative risk reduction. Building on the RDVRP experience, a recently completed analysis on risk of riverine flooding (illustrated in the map) is informing decisions in Belize.

To improve macroeconomic stability, the RDVRP includes a Contingency Emergency Response Component (CERC) that can provide quick disbursements either to meet immediate post-disaster liquidity needs to finance critical emergency goods or to finance emergency recovery and reconstruction works and associated services.

Monitoring and evaluation is critical to support emergency recovery and reconstruction needs, both as a management information tool and as a longer-term learning process for prioritizing and managing post-disaster recovery and reconstruction efforts. Monitoring indicators include improved post-disaster damage assessment practices and procedures and strengthened physical resilience to future adverse events, as reflected in appropriate hazard proofing of reconstruction works.

Source: Report team with material from Justin Locke and Bradley Lyon. IMF 2012. Debt Statistics from the IMF, World Economic Outlook report, October 2012. Germanwatch 2012. Global Climate Risk Index 2013, Germanwatch, November 2012. http://germanwatch.org/en/download/7170.pdf. Regional partnership strategy 2010. IBRD, IDA and IFC Regional Partnership Strategy for the OECS, 2010–2014, May 3, 2010, p. 17.

(World Bank 2012f), in an effort to develop innovative solutions and attract private sector financing for climate action in IBRD borrowing countries, and raise awareness about climate change and the opportunities to invest in climate solutions (see Box 16). Support for climate resilience has included a watershed management project in Tunisia, and flood management in the Huai River Basin in China. Such efforts are critical for climate resilient development, which has, thus far, not attracted much support from the private sector (PPCR 2013b).

The World Bank has also expanded the use of its CAT-DDOs, which are Development Policy Loans (DPLs) that provide client countries with contingent credit lines that can be drawn upon in case of disaster. They were created first and foremost to encourage investment in risk reduction to access a CAT-DDO, countries must show that they have engaged in a comprehensive disaster management program as part of a DPL. Countries have the option to use the revolving feature of these credit lines by repaying draw down amounts, thus preparing themselves for future events.

Box 15: Mexico's Fund for Natural Disasters (FONDEN)

FONDEN, Mexico's Fund for Natural Disasters, was established in the late 1990s as a mechanism to support the rapid rehabilitation of federal and state infrastructure affected by adverse natural events. Funds from FONDEN could be used for the rehabilitation and reconstruction of: (i) public infrastructure at the three levels of government (federal, state and municipal); (ii) low-income housing; and (iii) certain components of the natural environment (e.g., forestry, protected natural areas, rivers and lagoons).

FONDEN consists of two complementary budget accounts, the original FONDEN Program for Reconstruction and the Fund for Disaster Prevention (FOPREDEN), designed in recognition of the need to promote stronger ex-ante DRM. Although resources for prevention remain significantly less than those for reconstruction, the Mexican Government is continuing its efforts to shift the focus and funding from ex-post response to ex-ante DRM.

FONDEN is funded through the Federal Expenditure Budget, at a legally-required amount of no less than 0.4% of the annual federal budget or about US$800 million (available to FONDEN, FOPREDEN and the Agricultural Fund for Natural Disasters).

The FONDEN Program for Reconstruction channels resources from the Federal Expenditure Budget to specific reconstruction programs and acts as the contracting authority for market-based risk transfer mechanisms, including insurance and CAT bonds. Furthermore, FONDEN strives for reconstruction activities that: do not recreate vulnerabilities; fund the reconstruction of infrastructure at higher standards (the "build back better" principle); and relocate public buildings and/or communities to safer zones.

The FOPREDEN Program for Prevention supports disaster prevention by funding activities related to risk assessment, risk reduction and capacity building on disaster prevention. FOPREDEN promotes informed decision making about investment in risk reduction by requiring states to complete a risk assessment (including the development of a risk atlas) before being eligible for financing for risk mitigation projects.

The process for accessing and executing reconstruction funding from FONDEN balances the need for time-efficient disbursement with accountability and transparency concerns. The Ministry of Interior is responsible for managing this process. FONDEN uses innovative information technology, such as geocoding and digital imagery, to ensure efficiency and accuracy of the damage assessment process. FONDEN resources finance 100% of the reconstruction costs for federal assets and 50% of those for local assets. (The first time that assets are impacted by a disaster, this percentage declines thereafter if insurance is not purchased for reconstructed assets.)

FONDEN resources are leveraged with market-based risk transfer instruments to transfer risk through insurance and other mechanisms, such as CAT bonds, to manage the volatility of demand on its resources.

Working in close collaboration with the Ministry of Finance and Public Credit, FONDEN has established a strong link between its technical and financial arms for natural disasters. The National Centre for Disaster Prevention acts as the technical arm for disaster risk reduction and works closely with FONDEN, the financial vehicle for disaster management. The latest in the evolution of this partnership is the development and utilization of R-FONDEN, a probabilistic catastrophe risk model that calculates risk metrics for government assets and low-income housing for major perils.

FONDEN is continuously evolving to integrate lessons learned over the course of years of experience, with modifications by the Mexican Government in order to enhance its efficiency and effectiveness and move toward a comprehensive DRM framework. The FONDEN story provides a compelling study of how governments can establish successful systems to support effective post-disaster interventions, while promoting disaster prevention and, importantly, how such systems should be continuously improved to integrate new understandings.

Source: The World Bank 2012e: FONDEN, Mexico's Natural Disaster Fund—A Review; May 2012.

Box 16: The World Bank Green Bonds—catalyzing climate action

Green Bonds support both mitigation projects, such as renewable energy and energy efficiency, as well as climate resilience projects, such as watershed management and flood prevention. As of 2013, the total volume of World Bank Green Bonds issued has reached US$4 billion through 60 transactions issued in 17 currencies. These were sold to investors worldwide, helping the World Bank to expand and diversify its investor base. In the case of US and European investors, many Green Bond investors were new, or new funds were created by new mandates focused on climate investing, including large pension funds, asset managers, insurance companies, foundations and religious organizations. Investors who purchase World Bank Green Bonds benefit from the Bank's Aaa/AAA rating as a bond issuer.

World Bank Green Bonds act as a catalyst for the growing climate/green bond market, and can play an important role in helping to mobilize financing from the private sector for climate activities, in addition to raising awareness about the urgency of addressing climate change and the opportunities to invest in climate solutions.

Source: The World Bank Green Bonds: fourth annual investor update, 2012, and World Bank's Capital Market Development team.

Of the 16 climate and disaster-related DPLs approved by the World Bank since 2008, seven include a CAT-DDO to enhance government capacity to manage the impacts of natural disasters: Colombia, Costa Rica, El Salvador, Guatemala, Panama, Peru and the Philippines.

Costa Rica, with support from a CAT-DDO, has been proactively reviewing the catastrophe risk exposure of public assets and infrastructure, which has helped them develop effective and affordable catastrophe insurance programs to protect these assets. Costa Rica is also working with the national insurance company to design a dedicated vehicle to insure public assets. Results of preliminary work show that the proposed vehicle would improve coverage with a net savings of at least US$50 million over ten years.

Social Protection

Social protection programs and policies help buffer individuals from shocks and equip them to be able to improve their livelihoods. National safety net systems, while in regular times can help minimize the negative impact of economic shocks on individuals and families, can also be designed and funded to scale up in response to a disaster to prevent households from falling into poverty (World Bank 2013e). The Ethiopia Productive Safety Nets Program (Box 17) provides a case in point. In addition to a diverse range of risk management options, empowerment and poverty reduction also help reduce underlying causes of vulnerability. However, with increasing climate-related shocks, social protection measures may also need to be complemented by other resilience measures.

Community driven development (CDD) approaches and actions are important elements of an effective poverty reduction and sustainable development strategy, promoting scalable models and approaches to empower poor communities to manage climate and disaster risk and to identify practical ways of getting climate and disaster risk finance directly to the people. During fiscal years 2001 to 2011, the World Bank invested US$12 billion in 150 CDD projects that contributed to building climate and disaster resilience (World Bank 2013d). Scaling up and sustaining community-based resilience calls for bridging the gap between the local, subnational and national levels, and understanding the complementary roles of formal and informal institutions. Well-designed CDD projects are also an effective tool for empowering women, often the most vulnerable to the effects of climate change and disasters.

Recognizing that social protection programs, in particular, play an important role in protecting poor and vulnerable people from climate-related loss and damage and helping them reduce their exposure and vulnerability (World Bank 2011b), the World Bank and GFDRR developed a "Building Resilience to Disaster and Climate Change through Social Protection Toolkit." Providing guidance on how to prepare social protection programs to respond to disasters and climate change, the toolkit focuses on: building flexible and scalable social protection programs to respond to larger-scale disasters; adapting beneficiary targeting mechanisms to disaster response and climate change; communicating in a post-disaster context; integrating disaster- and climate-sensitive monitoring and evaluation into social protection programming; and adapting benefit transfer mechanisms to strengthen disaster and climate resilience (World Bank and GFDRR 2013).

Box 17: Ethiopia's Productive Safety Nets Programme

The Productive Safety Nets Programme (PSNP) is a large national social safety net program that responds to both chronic food insecurity and shorter-term shocks (mainly droughts) among Ethiopia's poor. It targets a highly climate-vulnerable population, offering a practical model of how social safety nets can be designed to meet the social protection needs of the most vulnerable, while simultaneously reducing risks from disaster- and climate-related impacts.

The PSNP incorporates a number of interesting features, including: public works activities geared toward improving climate resiliency; a risk financing facility to help poor households and communities, including households outside of the core program, better cope with transitory shocks; and targeting methods that help the most climate-vulnerable households obtain the full benefits of consumption smoothing and asset protection. The program works through and strengthens existing government institutional systems at all levels rather than creating separate systems.

The PSNP entitles poor households to a secure, regular, predictable government transfer, protects them against the impacts of natural disasters, and significantly improves management of the natural environment that contributes to these risks. It has enabled core beneficiaries to meet consumption needs, mitigate risks and avoid selling productive assets during crises. Evidence shows that livelihoods are stabilizing and food insecurity is decreasing among these households. A related pilot program associated with the PSNP allows poor beneficiaries to work in lieu of paying premiums for crop insurance.

The PSNP is expected to cover 8.3 million people by 2015, and is supported by the Livelihoods, Early Assessment and Protection (LEAP) program. LEAP is a food security early warning system that calculates expected crop yields early in the country's dry season. The information helps humanitarian organizations forecast community needs in drought-prone areas, and can be used to scale up the PSNP if a severe drought is anticipated.

Source: Building Resilience to Disaster and Climate Change through Social Protection, World Bank, May 2013.

Resilient Reconstruction

Disasters often provide unique opportunities to promote climate resilient development. Politicians and donors alike are attuned to the issue, and the general public may be more amenable to the often-difficult trade-offs necessary for risk reduction.

A major challenge for post-disaster and climate resilient recovery support is timely and sufficient access to resources. Since 2007, the World Bank has developed procedures that enable faster preparation and approval of emergency projects and recognize upfront the inherent risks involved in emergency situations, including the risks and lost opportunities associated with a delayed response. Two such key instruments are the Crisis Response Window (CRW) and the Immediate Response Mechanism (IRM).

The CRW is a specific IDA funding window for concessional assistance for post-disaster recovery and reconstruction, which is additional to country allocations. The window was first triggered in response to the Horn of Africa Drought in 2011. To alleviate the impacts of the drought, an additional IDA allocation of US$250 million was pooled with other resources to support three new projects and provide additional financing to seven ongoing projects as part of the World Bank's Horn of Africa Drought Response Plan (see Box 18).

The IRM initiative encourages the introduction of Contingent Emergency Response Components (CERC) in all IDA operations. A CERC is a zero-dollar component within a project that allows for existing funds to be quickly reallocated to emergency recovery activities in the event of a disaster, thereby averting the need for time-consuming project restructuring (as the budget line, albeit empty, is already there). The IRM augments the resources that can be quickly mobilized for emergency response by allowing up to 5% of an undisbursed IDA portfolio in an affected country to be channeled through the CERC.

In order to inform the design of resilient recovery and reconstruction measures, the GFDRR Standby Recovery Financing Facility supports sustainable and resilient recovery planning in countries that request assistance. The objective is to assist disaster-hit countries build resilience into the recovery process through: (i) support for PDNAs; (ii) technical assistance for post-disaster recovery planning and financing; and (iii) building institutional capacities for disaster preparedness and response.

As part of a partnership between the United Nations, the European Union and the World Bank, GFDRR has been supporting disaster-hit countries to carry out PDNAs. These country-led assessments provide a coordinated platform for building immediate and longer-term disaster resilience. An assessment estimates damages, economic losses, human impacts and forward-looking needs resulting from disasters, as well as provides a coordinated and credible basis for recovery and reconstruction planning that incorporates risk-reduction measures and financing plans. This serves as a basis for the government to reorient resources towards recovery, and for development partners to direct their external assistance.

Since 2007, GFDRR has supported 32 PDNAs, which have informed at least 61 World Bank-funded recovery projects with a value of US$3.36 billion. This translates into an average of approximately US$105 million in World Bank recovery financing per PDNA, with an estimated 71 million people having benefited.

Although proven to be effective to inform recovery and reconstruction planning, full-fledged PDNAs are time consuming, and, thus, sometimes miss important opportunities to inform funding decisions, which are taken very soon after a disaster. The World Bank and GFDRR are, therefore, piloting a lighter version in several African countries (Madagascar, Mozambique and Seychelles) suffering from extensive, recurrent climate-related disasters. The approach involves a two-week mission with highly trained experts, who conduct a rapid assessment mostly focused on damages. The main focus of the mission is to estimate reconstruction and recovery needs within a predetermined budget envelope, which previous discussions with partners indicate can be realistically raised. This has the important advantage of managing local expectations and focusing discussions on the ensuing prioritized resilient recovery operation(s). In all cases

Box 18: Addressing drought risk across a range of timescales in the Horn of Africa

In July 2011, more than 13 million people suffered food shortages in the Horn of Africa as a result of drought combined with a number of non-climate drivers, such as land, water and ecosystem degradation, economic marginalization and conflict. Despite major domestic and international support, the event clearly showed the importance of integrating risk reduction into long-term development and ensuring effective early warning and early action mechanisms.

To address both urgent needs and longer-term risks, the World Bank committed US$1.8 billion to support safety nets and food security in the Horn of Africa in 2011. Immediate relief, focusing on response-type approaches to support food and nutrition, water supply, sanitation and health, operated for 6–12 months. This transitioned into economic recovery, focusing on livelihood and employment support for 1–2 years. Under the current and final phase, climate resilience is supported through investments in preparedness (early warning and decision support systems, response and relief), risk reduction (robust agriculture, water resources management, livelihood support) and risk mitigation (safety nets, agriculture insurance, risk financing facility).

The recovery phase included PDNAs to prepare regional and country projects. The assessments were conducted in three affected countries (Kenya, Uganda and Djibouti) and complemented by a brief assessment and training in Ethiopia, which helped in developing an effective, three-phased regional drought response plan.

A number of projects in Kenya responded to immediate needs, while building long-term resilience, including the Kenya Health Sector Support Project, which is the first World Bank project supporting large-scale nutrition interventions targeting resident populations who are as vulnerable as the refugees in various camps. The project is still relevant today—long after the drought emergency is over—since hospital admissions of severely malnourished children remain high in Kenya. The Kenya Cash Transfer for Orphans and Vulnerable Children is another drought response project, which consists of an increase in the value of the transfer (from Ksh1,500 to Ksh 2,000 per month) to poor households to mitigate the impact of food price increases. Finally, the Kenya Agricultural Productivity and Agribusiness Project aims to increase agricultural productivity to develop long-term drought resilience. Under this project, drought-related activities were scaled up in response to the 2011 drought.

A mid-term assessment showed that the timely World Bank and GFDRR support resulted in increased food security for the most vulnerable populations in Somalia and in refugee camps in countries along Somalia's border. In Ethiopia, triggering the contingency risk financing facility enabled improved food consumption for 6.5 million chronic and 0.3 million transitory food insecure people. In Kenya, most vulnerable people were given a higher cash transfer to mitigate drought impacts. Other important achievements include the timely preparation of a drought response plan, detailed drought impact assessments in affected countries and support to regional organizations in planning, forecasting and managing for drought resilience.

Source: Compiled by staff from the Africa Region of the World Bank.

where this approach was piloted, a substantial recovery operation followed, in which resilient reconstruction or "build back better" principles were incorporated.

How Much Does It Cost?

All climate and disaster resilient development actions have an upfront cost. However, if the action is well designed and proportionate to the risk, then the outcome will be cost effective and save money in the long run. In all cases, a cost-benefit analysis of risk management is greatly influenced by value judgments on the discount rate, the time horizon over which benefits and costs are accrued, and the inclusion or exclusion of non-monetary outcomes, such as loss of human life (Government of the UK 2013). Despite these analytical challenges, a range of cost-benefit analyses have been implemented, and a strong economic case demonstrated for DRM, with the benefits of avoided and reduced losses outweighing investment costs on average by about four to one (Mechler 2012).

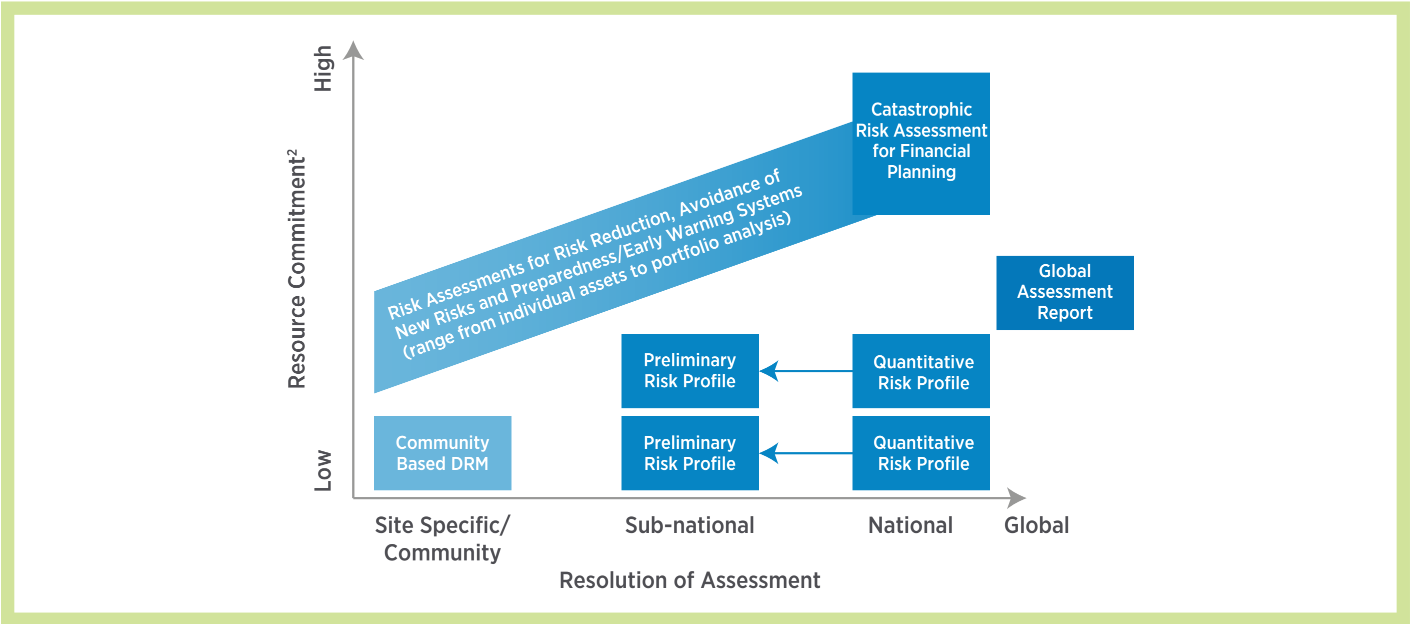
Risk assessment costs depend heavily on the purpose, user needs, scale and available data. Risk assessments can be used to: (i) build disaster risk awareness; (ii) develop financial applications to manage or transfer risk; (iii) guide and inform risk reduction policies, investments and measures; and (iv) inform planning and preparedness at different levels. A range of risk assessment products used in resilient decision making, each with different purposes, scales and resource requirements, are shown below. The cost also varies (see Figure 12 and Table 1) depending on:

- data availability, and whether data is already available or new data is needed;
- whether underlying datasets are provided as part of the final risk assessment product;
- the geographic scale of the risk assessment, which can range from a single building to a country or region; and
- the quality and level of granularity required, as some risk assessments do not need a high level of detail to provide a rough idea of risk, while others require a higher level to influence large investment decisions.

Once a risk assessment is carried out, the information gathered can be used to inform the design of risk management actions, depending on the assessment's original purpose. Risk assessments can guide spatial planning and the design of new public infrastructure, such as schools, hospitals or power stations. They can also be used to understand where the greatest benefit to cost ratio investments can be made to reduce risk—for example, analysis to guide decisions on which government assets to rebuild or retrofit, or where the greatest benefit of flood infrastructure is.

Preparedness and early warning systems are also considered to be high-value investments, with the benefits of saving lives and property far outweighing intervention costs. The budgets of National

Figure 12: Comparative data and financial resource requirements of risk assessments



Source: Report authors

Table 1: Comparative costs of risk assessment

Product	Purpose	Scale	Data Requirements	Cost $ = < $100K $$ = $100-500K $$$ = >$500K
Qualitative National Risk Profile	Advocacy and initiation of DRM dialogue	National	Low: global, regional and/or national datasets	$
Community Based Disaster Risk Assessment	Engages communities, communicates risk and promotes local action	Community Level	Low: typically based on historical disaster events	$
Quantitative National Risk Profile	Advocacy and initiation of DRM dialogue based on quantitative assessment	National	Low-Moderate: global, regional and/or national datasets	$$
Asset-level Risk Assessments, including Cost-Benefit and Engineering Analysis	Informs design of building/asset level risk reduction activities and can promote avoidance of new risk	Building/Infra-structure Level	Moderate-High: requires high-resolution local datasets	$$
Macro-Level Risk Assessment for Risk Reduction, including Cost-Benefit Analysis	Informs urban/regional risk reduction measures	Urban, Regional, National	Moderate-High: requires moderate-high resolution across large spatial areas	$$$
Risk Identification to Identify Critical Infrastructure and Establish Early Warning Systems	Informs preparedness and risk reduction, based on understanding of potential damage at the regional/local level	Urban, Regional, National	Moderate-High: requires asset-level information across large spatial areas	$$-$$$ (broad price range depending on geographic scope)
Catastrophic Risk Assessment for Financial Planning	For financial and fiscal risk assessment of disasters and catalyst for catastrophe risk insurance market growth	National to Multi-Country	High: requires high-resolution, high-quality data for large spatial areas with clear articulation of uncertainty	$$$

Meteorological and Hydrological Services are usually about 0.01–0.05 percent of national GDP, with total annual public funding globally of more than US$15 billion. A conservative estimate of high-priority modernization investment needs in developing countries ranges from US$1.5 to 2 billion. In addition, a minimum of US$400–500 million per year will be needed to operate the modernized systems (staff, operating and maintenance costs)(Rogers, D., and V. Tsirkunov. 2013). However, the benefits of upgrading all hydro-meteorological information production and early warning capacity in developing countries would save an average of 23,000 lives annually and provide between US$3 billion and US$30 billion per year in additional economic benefits related to disaster reduction (Hallegatte 2012).

Elaboration of climate resilient construction codes is generally not expensive: in Madagascar and Mozambique, for example, expenses have ranged from US$160,000 to US$210,000, including for sensitization and training (in Madagascar). Strengthening infrastructure safety standards in Madagascar cost about US$100,000 (for transport) and US$50,000 (for irrigation infrastructure), with an additional US$120,000 envisaged for training.[5] These costs do not include, however, the extensive time required to integrate the new norms into sectoral programs and ensure their effective compliance.

Financial protection schemes, to cover the residual risk that remains after risk reduction activities, also range in cost depending on the layer or risk that is being addressed (see Figure 11). Key variables that affect costs include disbursement speed and the size of funding that can be mobilized (see Table 2). The cost multiplier is the ratio between the cost of the financial product (e.g., premium of an insurance product, expected net present value of a contingent debt facility) and the expected payout over the lifetime of the financial product. So a ratio of two indicates that the overall cost of the financial product is likely to be twice the amount of the expected payout made. These multipliers are only indicative and aim to illustrate the cost comparison of financial products. The speed at which funds can be obtained also

[5] Col. Mamy Razakanaivo, personal communication, November 4, 2013.

Table 2: Comparative costs of different financial protection options

Instruments	Indicative Costs (multiplier)	Disbursement (months)	Amount of Funds Available
Donor Support (relief)	0–1	1–6	Uncertain
Donor Support (recovery and reconstruction)	0–2	4–9	Uncertain
Budget Contingencies	1–2	0–9	Small
Reserves	1–2	0–1	Small
Budget Reallocations	1–2	0–1	Small
Contingent Debt Facility (e.g., CAT DDO)	1–2	0–1	Medium
Domestic Credit (bond issue)	1–2	3–9	Medium
External Credit (e.g., emergency loans, bond issue)	1–2	3–6	Large
Parametric Insurance	2 & up	1–2	Large
ART (e.g., CAT bonds, weather derivatives)	2 & up	1–2	Large
Traditional (indemnity based) insurance	2 & up	2–6	Large

Source: Mahul and Ghesquiere 2010

varies greatly depending on the legal and administrative processes that drive their use (Ghesquiere and Mahul, 2010).

Regional risk pooling among groups of small countries with similar risk profiles can save money, as demonstrated by the CCRIF, where pricing for hurricane coverage runs about 54–59% less than the cost of an individual country going directly to the reinsurance market. The CCRIF has made payouts totaling US$32.2 million to members affected by covered earthquakes and hurricanes within two weeks or less of the event. Similarly, the Pacific catastrophe risk insurance pilot program's use of risk pooling enables an estimated 50% savings on premiums compared to buying individual policies. For the pilot program's first season, premiums were around US$0.4 million per country, and provided coverage of US$6.8–11.3 million (3–10 percent of government annual expenditures). For CAT-DDOs, loan pricing is based on standard IBRD terms with a 0.5 percentage point front-end fee and a 0.25 percent renewal fee.

Risk transfer should not be treated as a standalone solution; rather, it represents one of many components of a holistic DRM approach, helping to reduce the impacts of risks that cannot be avoided. This is particularly relevant for climate-related risks. Insurance costs are likely to increase as climate-related claims continue to rise, and, as is already happening in some regions, insurance companies may completely abandon particular markets as risk becomes more difficult to price (due to climate uncertainty) or too expensive (IFC 2010a). This potential uninsurability, particularly of highly vulnerable people and small and medium enterprises (SMEs), underscores the need for preventive measures.

When a disaster does strike, integrating risk reduction approaches into recovery and reconstruction is a key opportunity. World Bank and GFDRR support for post-disaster assessment and resilient reconstruction planning can range in cost from US$100,000 to US$250,000, not taking into account the costs of data collection, government staff time, and involvement of other agencies and civil society. As mentioned above, post-disaster assessment experiences suggest that "building back better" typically costs between 10–50% more than the replacement cost of original structures (see Box 3).

Even though building resilience requires additional upfront costs, long-term benefits far outweigh costs if done in a proportionate way. But the most cost-effective means of building resilient societies into the future is to avoid creating new risks by integrating resilient approaches into development planning.

VII. Conclusions

This report has shown that all key drivers—climate change, poorly planned development, poverty and environmental degradation—influence the risk of a weather event becoming a disaster. Thus, these factors need to be managed collectively. In the coming decades, disaster losses are expected to continue to rise due to the increasing exposure of populations, assets and environmental degradation, compounded by climate change. Therefore, development paths must take the risks of climate change and disasters into account.

The poor and most vulnerable will be the most directly affected. The close interactions between poverty, development trends and climate change are likely to pose significant challenges to the global objectives of ending poverty and promoting shared prosperity by 2030. Targeted actions will be needed to provide the poor and near poor with the resources, information and knowledge required to become more resilient. Support for community resilience, combined with well-designed social protection mechanisms that can be scaled-up in response to disasters, could play a major role in reducing the expected poverty impacts of disasters and climate change.

Disaster and climate resilience requires startup costs, but if designed in a way that is proportionate to the risk, they will be cost effective in the long run. Spatial planning that takes risk into account, policies to promote ecosystem buffers, safer building practices, and strengthened early warning have all proven effective in saving lives and assets. However, they will not be sufficient to completely eliminate disaster risk. For this reason, and to avoid splitting fragile national capacity, the experiences of the climate resilience and disaster risk management communities should be progressively brought together.

By addressing immediate and urgent disaster risks, while taking into account the long-term effects of climate change, disaster and climate resilient development can offer immediate and longer-term development gains. Using a learning-by-doing approach and engaging early-career committed professionals help develop expertise and knowledge, support local solutions, and provide incentives for capacity maintenance and expertise retention. Robust decision making is a promising approach and could help overcome the challenges of addressing uncertain long-term risks along with more immediate priorities.

An array of instruments and tools has already been developed in support of climate and disaster resilient development. While many are being developed and used in specific regions (such as Latin America and Southeast Asia), they are being gradually expanded to cover other groups of countries. At the same time, concerted efforts at regional and international levels are still needed to fill knowledge gaps and provide on-demand expertise to communities and governments in lower-capacity countries.

Getting the institutions and incentives right is often the single most important issue in climate and disaster resilient development. Although an integrated, multi-stakeholder and multi-sectoral approach takes time and may entail slow initial disbursements, it generally results in stronger buy-in from relevant stakeholders and is likely to be more sustainable over the long term. At the same time, lead institutions must have the necessary authority to coordinate powerful sectoral ministries. Experience indicates this is best done by an agency located at the highest possible government levels.

Many countries lack the incentives to mainstream climate and disaster risks into economic planning and investment decisions. Political cycles favor short-term development decisions, and government employees often have little incentive to participate in inter-sectoral committees to address problems not viewed as part of their mandate. Changing this "culture" is easier when a flexible, learning-by-doing approach is pursued, and the process is relatively independent from political pressures. Effective mainstreaming, in particular, can help ensure that climate and disaster resilience becomes reflected in strategic sectoral programs and budgets, thus becoming, in effect, part of the core work program of participating stakeholders.

Disasters provide opportunities to build political will to integrate resilience measures into recovery and development, with recent evidence showing a growing demand for sustained engagement in countries following a disaster to support the implementation of resilient recovery and reconstruction planning.

Adequate, predictable and long-term financing is needed to bring about transformative change. Some countries have been able to identify disaster and climate risks, plan and prioritize investments, and access and combine funding from different sources to optimize implementation. Instruments, such as Green Bonds, innovative risk financing and strategies to engage the private sector through public-private partnerships, are providing opportunities for increasing the funding envelope, in addition to bringing in much needed expertise. Efforts to use these instruments more widely could be further explored. Promoting approaches that progressively link climate and disaster resilience to broader development paths will also ensure that funding is appropriately provided and used effectively.

While this Report focused on the experience of the World Bank in climate and disaster resilient development, many other partners—including international organizations, national experts, civil society partners, and multilateral and bilateral donors—have also worked extensively in this field. By amassing their experience and promoting closer collaboration between the climate resilience and disaster risk management communities, the loss and damage agenda could help promote closer integration of the actions needed to manage this risk. Better coordination between involved agencies will also be fundamental to keep all stakeholders focused on the goal of diminishing vulnerability, particularly amongst the poor.

Clear progress has been made, but many challenges remain, the biggest of which is overcoming institutional barriers that can enhance coordination between climate resilience and disaster risk management. Limited data and institutional and technical difficulties preventing the free flow of information constrain the ability of many countries to carry out long-term climate projections and development scenarios, and to provide accurate and timely early warning. Perverse incentives and vested interests favor short-term responses over long-term prevention. As a first step, improving the understanding of development risks from a changing climate is necessary. A second step would then consist of deriving decision options based on this information and developing and accessing financing instruments over the long term. A better standardization of disaster databases at the national level could also help collect more consistent information to help distinguish between development deficits and potential climate change impacts. Finally, climate and disaster risk management need to be integrated much more closely with development planning and targeted poverty alleviation programs.

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