

# GVR

## Global Assessment Report on Disaster Risk Reduction

2015

Making Development Sustainable:  
The Future of Disaster Risk Management

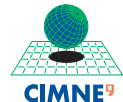


United Nations

UNISDR is grateful to the organizations whose logos are shown below for their contributions to the production of the 2015 Global Assessment Report on Disaster Risk Reduction. In addition, financial resources were also generously made available by the European Commission (Directorate-General for Humanitarian Aid and Civil Protection, and Directorate-General for Development and Cooperation), the United Nations Development Programme (UNDP) and by the Government of the United States of America.



AXIS



# GVR

**Global Assessment Report  
on Disaster Risk Reduction**



2015

Making Development Sustainable:  
The Future of Disaster Risk Management



United Nations

The Global Assessment Report on Disaster Risk Reduction (GAR) 2015 includes enhanced content. Augmented reality (AR) icons link the report to its companion application, GAR for Tangible Earth (GfT), and provide the reader with additional information and multimedia content.

To use these features, first point the camera on your GfT-installed tablet or smartphone at the desired icon, then press the AR button when it appears. A variety of dynamic information functions designed to enrich the reading experience will then play on your device.

2012 Hurricane Sandy



**The Earth Icon:** Links the user to a dynamic 3D globe, enabling geospatial data relevant to the subject in the text.

Address disaster risks



**The Researcher Icon:** Links to data about the researchers behind the article being read, their reports, web links, and videos.

Global wealth distribution



**The Tablet Icon:** Opens dynamic animations and additional information on the static print charts in GAR.

Orissa success story



**The Video Icon:** Links to videos of UNISDR and partners relevant to the subject in the text.

Media handbook



**The Web Link Icon:** Links to external websites that provide details relevant to the subject in the text.



Download the full report:

To download the application, use the QR code provided at the end of this document or visit [www.preventionweb.net/gar](http://www.preventionweb.net/gar).

To share your comments and news on the GAR on Twitter and Facebook, please use #GAR15.

ISBN 978-92-1-132042-8

© United Nations 2015. All rights reserved.

#### Disclaimer

The views expressed in this publication do not necessarily reflect the views of the United Nations Secretariat. The designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of the United Nations Secretariat concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delineation of its frontiers or boundaries.

This publication may be freely quoted but acknowledgement of the source is requested.

Citation: UNISDR (2015). Making Development Sustainable: The Future of Disaster Risk Management. Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: United Nations Office for Disaster Risk Reduction (UNISDR).

Design and layout: AXIS and ELP, Tokyo, Japan. Takae Ooka, New York, U.S.A.

Editing: Christopher J. Anderson, Vienna, Austria

Printing: Imprimerie Gonnet, Belley, France

This paper contains 60% post-consumer recycled fibre and 40% FSC certified virgin fibre sourced from well-managed forests.



# Foreword

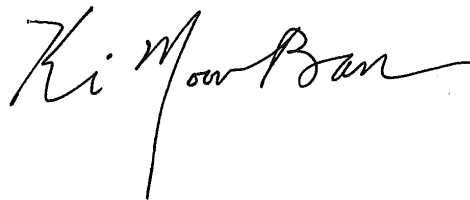
The fourth edition of the United Nations *Global Assessment Report on Disaster Risk Reduction* is being issued at a pivotal moment for the future of development.

In 2015, the global community is aiming to adopt an ambitious set of sustainable development goals and a meaningful, universal agreement on climate change. Disaster risk reduction can play an important role in advancing these agendas through its close links with poverty reduction, sustainable growth and shared prosperity.

As we prepare for the third *World Conference on Disaster Risk Reduction* in Sendai, Japan, it is crucial to understand and act upon the messages of this report. Many countries continue to face large potential losses from disasters – especially

those which can least afford to invest in future resilience. Global models suggest that the risk of economic losses is rising as a result of the rapidly increasing value of the assets that are exposed to major hazards. In addition, a large proportion of losses continue to be associated with small and recurring disaster events that severely damage critical public infrastructure, housing and production – key pillars of growth and development in low and middle-income countries.

Governments, civil society and the private sector have the opportunity and obligation to work together to commit to a safer future. A more inclusive and ambitious framework for disaster risk reduction is crucial to our efforts to build a better world for all. Together, let us ensure that development is resilient and sustainable.

A handwritten signature in black ink, reading "Ki-moon Ban". The signature is fluid and cursive, with the first name "Ki" and last name "Ban" clearly legible, and "moon" written in a smaller, more connected script.

Ban Ki-moon  
Secretary-General of the United Nations

# Most disasters that could happen have not happened yet.

Economic losses from disasters such as earthquakes, tsunamis, cyclones and flooding are now reaching an average of **US\$250 billion to US\$300 billion** each year. **Future losses** (expected annual losses) are now estimated at US\$314 billion in the built environment alone. **This is the amount that countries should set aside each year to cover future disaster losses.** (→ Chapter 3)

The mortality and economic loss associated with **extensive risks** (minor but recurrent disaster risks) in low and middle-income countries are **trending up**. In the last decade, **losses due to extensive risk** in 85 countries and territories were equivalent to a total of **US\$94 billion**. (→ Chapter 4)

Extensive risks are responsible for most **disaster morbidity** and **displacement**, and represent an ongoing **erosion of development assets**, such as houses, schools, health facilities, roads and local infrastructure. However, the cost of extensive risk is not visible and tends to be **underestimated**, as it is usually **absorbed by low-income households and communities and small businesses**.

For small island developing states (SIDS), **future disaster losses represent an existential threat**. For example, compared to Europe and Central Asia, **SIDS are expected to lose on average 20 times more of their capital stock** each year in disasters. The expected annual losses in SIDS are equivalent to almost **20 per cent of their total social expenditure**, compared to only 1.19 per cent in North America and less than 1 per cent in Europe and Central Asia. (→ Chapter 3)

**Countries face a financing gap** if they do not have the resources to buffer against infrequent but severe disaster losses. Many countries, including Algeria, Chile, Indonesia, Iran, Madagascar, Pakistan, Peru and many SIDS, **would not pass a stress test of their fiscal resilience to a 1-in-100-year loss**. Their limited ability to recover quickly may increase **indirect disaster losses** significantly. (→ Chapter 5)

Between 1980 and 2012, **42 million life years were lost** in internationally reported disasters each year. (The concept of “human life years” provides a better representation of disaster impact, as it provides a metric describing the time required to produce economic development and social progress.)

**Over 80 per cent** of the total life years lost in disasters are spread **across low and middle-income countries**, representing a **serious setback to social and economic development** comparable to diseases such as tuberculosis. (→ Part I)

If this risk were shared equally amongst the world’s population, it would be **equivalent to an annual loss of almost US\$70 for each individual person of working age, or two months’ income for people living below the poverty line**: an existential risk for people already struggling for survival on a daily basis.

It also represents a significant **opportunity cost** for development, as these resources **could be used to make investments in infrastructure, social protection, public health and public education**. (→ Chapter 3)

Expressed as a **proportion of social expenditure**, expected annual losses in low-income countries are **five times higher** than in high-income countries. The countries with **the greatest need** to invest in social development are those **most challenged** by disaster risk. (→ Chapter 3)

This is a problem not only for low-income countries, but for **middle-income countries** like Jamaica and the Philippines and for **high-income countries** like Greece. Although countries like Jamaica and Greece have far lower relative risk compared to the Philippines, the **overall impact on future development** will be very similar. While economic growth will be mainly undermined in Greece, the challenge facing the Philippines is one of social development. (→ Chapter 5)



## **GAR at a Glance**

**Sustainable development cannot be achieved unless disaster risk is reduced.**

# Climate change will increase expected future losses.

Through changing temperatures, precipitation and sea levels, amongst other factors, **global climate change is already modifying hazard levels and exacerbating disaster risks.**

By 2050, it is estimated that **40 per cent of the global population will be living in river basins that experience severe water stress**, particularly in Africa and Asia. In the Caribbean basin, climate change will contribute an additional US\$1.4bn to the expected annual losses from cyclone wind damage alone. (→ Chapter 3)

The ecological footprint from the **unsustainable overconsumption** of energy and natural capital now **exceeds the planet's biocapacity by nearly 50 per cent. Coastal wetlands declined by 52 per cent between the 1980s and early 2000s.** Other critical regulatory ecosystems such as mangrove forests and coral reefs are also degrading at a rapid pace. (→ Chapter 12)

**The effects of climate change are not evenly distributed, however.** It will affect different countries in different ways. For example, the risk from wind damage would double in Anguilla and increase fivefold in Trinidad and Tobago. In contrast, Mexico would actually see a reduction in its risk.

Although “**climate change is very likely to have an overall negative effect on yields of major cereal crops across Africa**” (IPCC), strong regional variability in the degree of yield reduction is anticipated.

Losses in maize production from a 1-in-25-year drought in Malawi could be 23 per cent higher in the years 2016 to 2035 than they were from 1981 to 2010. Given that agriculture contributes 30 per cent to Malawi's GDP, this could **push the country over a resilience threshold in terms of the national economy as well as poverty.** However, in the Rift Valley in Kenya and in Niger, where agriculture generates 30 and 38 per cent of GDP (respectively), the **losses would actually** decline in the same climate change scenario.

(→ Chapter 3)

Growing **global inequality, increasing hazard exposure, rapid urbanization and the overconsumption of energy and natural capital** now threaten to drive risk to dangerous and unpredictable levels with **systemic global impacts**.

The richest 2 per cent of the world's adult population now own over 50 per cent of global wealth, whereas the bottom 50 per cent own less than 1 per cent of global wealth. An increasing concentration of wealth, accompanied by depressed real wages and cuts in spending on social welfare and safety nets, is expected to lead to **growing risk inequality** across territories and social groups. (→ Chapter 9)

Sectors and territories without comparative advantages for economic development face **increasing risks due to low levels of investment in risk-reducing infrastructure, an absence of social and environmental protection, and rural and urban poverty**. In many low and middle-income countries, **urban development is characterized by highly unequal access** to urban space, infrastructure, services and security. (→ Chapter 11)

**Socially segregated urban development** in turn generates new patterns of disaster risk. Low-income households are often **forced to occupy hazard-exposed areas** with low land values, deficient or non-existent infrastructure and social protection, and high levels of environmental degradation.



## Growing risk inequality

# The continuous “mispricing of risk” threatens our future

As the economy becomes more global, **investment tends to flow to locations that offer comparative advantages**, including low labour costs, access to export markets, infrastructure and stability. Investment decisions **rarely take into account the level of hazard in those locations, and opportunities for short-term profits continue to outweigh concerns about future sustainability.**

As a consequence, **large volumes of capital continue to flow into hazard-prone areas**, leading to **significant increases in the value of exposed economic assets.**

( → Chapter 10 )

Over the last 10 years, there has been **significant progress in strengthening disaster preparedness, response and early warning capacities** and in reducing specific risks, according to **the HFA Monitor. However, progress has been limited in most countries when it comes to managing the underlying risks.** ( → Part II )

The continuous **mispricing of risk** means that consequences are rarely attributed to the decisions that generate the risks. **This lack of attribution and accountability creates perverse incentives for continued risk-generating behaviour**, as those who gain from risk rarely bear the costs.

As such, **new risks have been generated and accumulated faster than existing risks have been reduced.** ( → Chapter 10 )

An enormous volume of capital is expected to flow into urban development in the coming decades, particularly in South Asia and sub-Saharan Africa. **Some 60 per cent of the area expected to be urbanized by 2030 remains to be built.** Much of the growth will occur in countries with **weak capacities to ensure risk-sensitive urban development.**

( → Chapter 11 )

**Managing risk, rather than managing disasters** as indicators of unmanaged risk, **now has to become inherent to the art of development**; not an add-on to development, but a set of practices embedded in its very DNA. Managing the risks inherent in social and economic activity requires a combination of three approaches: (→ Chapter 13)

1. **prospective risk management**, which aims to avoid the accumulation of new risks;
2. **corrective risk management**, which seeks to reduce existing risks;
3. **compensatory risk management** to support the resilience of individuals and societies in the face of residual risk that cannot be effectively reduced.

**Global average annual loss** is estimated to increase up to **US\$415 billion by 2030** due to investment requirements in urban infrastructure alone. However, **this growth in expected losses is not inevitable**, as annual investments of US\$6 billion in appropriate disaster risk management strategies could generate benefits in terms of risk reduction of US\$360 billion. This is equivalent to an annual reduction of new and additional expected losses by more than 20 per cent.

Such an annual investment in disaster risk reduction represents **only 0.1 per cent of the US\$6 trillion per year that will have to be invested in infrastructure over the next 15 years**. But for many countries, **that small additional investment could make a crucial difference in achieving the national and international goals** of ending poverty, improving health and education, and ensuring sustainable and equitable growth. (→ Chapter 13)



**Managing risks rather than managing disasters — Disaster risk reduction needs to be reinterpreted.**

# Contents



<b>Foreword</b>	<b>iii</b>
-----------------	------------

---



<b>GAR at a Glance</b>	<b>iv</b>
------------------------	-----------

---



<b>Preface</b>	<b>xiii</b>
----------------	-------------

---



<b>Chapter 1</b>	<b>Introduction: A history of violence</b>	<b>023</b>
------------------	--	------------

---



<b>Part I</b>	<b>Unfinished business</b>	<b>039</b>
---------------	----------------------------	------------

---

<b>Chapter 2</b>	Reducing disaster losses: A partial success	<b>043</b>
------------------	---	------------

<b>Chapter 3</b>	The global riskscape	<b>053</b>
------------------	----------------------	------------

<b>Chapter 4</b>	Extensive risk	<b>089</b>
------------------	----------------	------------

<b>Chapter 5</b>	Resilience challenged	<b>099</b>
------------------	-----------------------	------------



## **Part II Inside disaster risk management 113**

---

**Chapter 6** Disaster risk governance 117

**Chapter 7** A culture of prevention and resilience? 131

**Chapter 8** Managing disasters 153



## **Part III Enter the void 177**

---

**Chapter 9** Risk inequality 183

**Chapter 10** For a few dollars more: The increasing hazard exposure of economic assets 199

**Chapter 11** Segregated urban disaster risk 213

**Chapter 12** Welcome to the Anthropocene: Overconsumption and biocapacity 229



## **Chapter 13 Conclusion: Making development sustainable 247**

---

Glossary	cclxviii
Acronyms	cclxx
Acknowledgements	cclxxii
References	cclxxxii
Index	cccviii



The Global Assessment Report (GAR) brand iconography is based on an image of a person holding an inverted umbrella. The inverted “A” in the GAR 2015 logo is a resonance of this motif.

The person holding an inverted umbrella is about seeing something from a new perspective, a call for creative responsiveness to change. A simple, ubiquitous tool, proposed in a new way... the grandest breakthroughs often come from such humble beginnings.

The image represents acting to overturn a legacy of apathy and ignorance. It points to a way beyond conducting business as usual. GAR 2015 provides clear and actionable information about the risks and rewards of disaster risk reduction, as well as a wealth of information about how we unwittingly generate, and exacerbate, risks.

The icon also represents the key message of GAR 2015: “Making Development Sustainable”. This is nowhere more evident than in the power that each of us has to work together to make our societies more resilient, to reduce disaster risks and enable responsible the use of resources. Raindrops, one at a time, may seem insignificant, but given a platform to become pooled resources, they can quickly become a powerful force for good.

Thus, the inverted umbrella is an icon of positive empowerment, advocating disaster risk management as an opportunity rather than a cost, and as something which makes human and planetary well-being possible.



# Preface

The 2015 Global Assessment Report on Disaster Risk Reduction (GAR15), *Making Development Sustainable: The Future of Disaster Risk Management*, is the fourth in the series coordinated by the United Nations Office for Disaster Risk Reduction (UNISDR) in the context of the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* (HFA). The HFA is an international framework adopted by 168 UN member States in Kobe, Japan in January 2005 to achieve an expected outcome of:

*The substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and societies.*

Every biennium governments have self-assessed their progress towards the achievement of this outcome using the online HFA Monitor. In 2007 UNISDR published *Disaster Risk Reduction: Global Review 2007*, which assessed progress in the first two years of the HFA. Shortly afterwards, work began on the first edition in the GAR series, which has compiled and analysed data and information on disaster risk patterns and trends, government self-assessments of progress, and critical challenges to disaster risk reduction since 2009.

GAR09, *Risk and Poverty in a Changing Climate*, provided evidence that disaster risk is disproportionately concentrated in lower-income countries with weak governance. Within countries, it showed how underlying drivers such as badly planned and managed urban development, vulnerable rural livelihoods, environmental degradation, poverty and inequality further generate and accumulate disaster risk in low-income communities and households. GAR09 highlighted that the relationship between disaster risk and poverty is bidirectional. Unless poverty and underlying

inequality are addressed, disaster risk will continue to rise. At the same time, disaster losses aggravate the depth and breadth of poverty and undermine any progress towards poverty reduction and sustainable development. GAR09 made the case for action to address the underlying risk drivers through aligning the efforts pursued under the disaster risk reduction, climate change and poverty reduction agendas.

The findings of GAR09 flowed into GAR11, *Revealing Risk, Redefining Development*, where the focus shifted to identifying effective public policies to address the disaster risk-poverty nexus. GAR11 analysed the political and economic imperatives and constraints for increased public investment in disaster risk reduction. Using innovative hybrid probabilistic risk models, GAR11 produced risk profiles for a number of countries in order to demonstrate how a risk-layered approach to managing disaster risks could maximize benefits while reducing costs. GAR11 also built on the recommendations of GAR09, highlighting opportunities to integrate disaster risk reduction into existing development instruments and mechanisms in the urban, environmental, social and economic sectors.

In GAR13, *From Shared Risk to Shared Value: The Business Case for Disaster Risk Reduction*, the focus shifted once again, this time from public policies and investment to the largely unexplored nexus between private investment and disaster risk. In most economies, public investment represents only 15-30 per cent of total capital formation. How disaster risk is addressed in the other 70-85 per cent of capital investment is therefore critical. GAR13 showed how businesses can invest in managing their disaster risks to reduce the costs and interruptions represented

by disaster losses and impacts, and how they can enhance performance and reputation by minimizing uncertainty and unpredictability. By underlining the interdependence of the public and private sectors, the report demonstrated why effectively managing disaster risks in both sectors is critical to competitiveness, sustainability and resilience, and why it is necessary to adopt a broader approach to value creation that also addresses the underlying drivers of risk.

Each GAR produced detailed sets of recommendations. While these were specific to the theme of each report, they can be summarized as two mutually supportive streams, brought into increasing focus as they flowed through the three reports: (1) address the underlying drivers of disaster risk to avoid risk generation and accumulation, and (2) strengthen the governance of disaster risk in order to be able to do so.

GAR15 focuses on the second of these streams and presents the case for a broad reinterpretation of disaster risk reduction. As the HFA draws to a close, GAR15 questions whether the way in which disaster risk reduction has been approached under the HFA is really *fit for purpose* in a world now threatened by catastrophic increases in disaster risk.

In Part I of GAR15, new evidence on contemporary patterns and trends in disaster risk is presented in order to assess the extent to which the expected outcome of the HFA has been achieved. Parts II and III examine whether the way disaster risk reduction has been approached is appropriate to address an increasingly accelerated generation and accumulation of disaster risks. The concluding chapter shows why the focus of disaster risk reduction needs to move from managing disasters to managing risks if it is to contribute to making development sustainable.

### **Disaster risk still on the rise**

GAR15 comes at a critical time for disaster risk

reduction. The expected outcome of the HFA has only been partially achieved. Twenty-five years after UN Member States adopted the International Decade for Natural Disaster Reduction (IDNDR) and ten years after the adoption of the HFA, global disaster risk has not been reduced significantly. While improvements in disaster management have led to dramatic reductions in mortality in some countries, economic losses are now reaching an average of US\$250 billion to US\$300 billion each year.

More critically, both the mortality and economic loss associated with extensive risks in low and middle-income countries are trending up. Internationally, extensive risk is a largely invisible risk layer. Nevertheless, it is a central concern for the low-income households and small businesses that depend on public infrastructure and for the local governments that provide it.

Presented using a different metric, around 42 million human life years are lost in internationally reported disasters each year, a setback to development comparable to diseases such as tuberculosis. Disaster risk continues to be disproportionately concentrated in low and middle-income countries, in particular in small island developing states (SIDS), and is being magnified by climate change.

Meanwhile, the average annual losses (AAL) from earthquakes, tsunamis, tropical cyclones and river flooding are now estimated at US\$314 billion in the built environment alone. The AAL is an accumulating contingent liability and represents the amount that countries should be setting aside each year to cover future disaster losses.

### **Protecting development against itself**

Since the HFA was adopted, there has been an exponential increase in political commitment to disaster risk reduction, in the development of institutional and legislative arrangements, in improvements in preparedness and early

warning, in the production of risk information and in the formulation of policies and strategies at all levels. From that perspective the HFA has undoubtedly been a success.

While the HFA gave detailed guidance on managing underlying risk, most countries have understood and practised disaster risk reduction as the management of disasters. The latter approach includes appropriate and effective actions to strengthen disaster preparedness and early warning, and to reduce disaster impacts through appropriate response. But while this approach is appropriate to manage disasters, it has proved *unfit for purpose* to manage the underlying risks. Given that these risks are generated *inside* development, addressing them requires actions such as reducing poverty, planning and managing cities appropriately and protecting and restoring ecosystems. This is the area where most countries have made least progress during the HFA. Cases where disaster risk considerations are fully factored into social and economic investments or where risk knowledge is integrated into development plans and practice are still the exception. As such, and despite notable improvements in disaster management, new risks have been generated and accumulated faster than existing risks have been reduced.

This approach reflects an interpretation of disasters as external threats and shocks. As a result, the policy goal of disaster risk reduction has been interpreted as the protection of social and economic development from those externalities. The expected outcome of the HFA has not been achieved because, on the contrary, disasters are socially constructed *inside* development. Development cannot be protected from itself, and until development itself is transformed, disaster risk will continue to increase.

### **Economic growth, overconsumption and inequality**

In its pursuit of economic growth, the current development paradigm generates an

overconsumption of natural capital, social inequality, as well as the generation and accumulation of disaster risk. GAR15 highlights four interlinked global drivers that, if left unmanaged, are likely to lead to dangerous increases in risk.

### **Increasingly globalized disaster risks**

Investment decisions rarely take hazard exposure into account, or otherwise they excessively discount disaster risk due to the potential for short-term returns. As competition increases, large flows of investment may continue to flow into hazard-exposed areas, leading to further increases in intensive risk. These risks become increasingly systemic as both risk drivers and disaster impacts ripple through global supply chains and spill over from one sector to another.

### **Growing risk inequality**

Social and economic inequality is likely to continue to increase, and with it disaster risk for those countries, communities, households and businesses that have only limited opportunities to manage their risks and strengthen their resilience. The geography of risk inequality expresses itself at all scales: between regions and countries, within countries and inside cities and localities.

### **Segregated cities**

Disaster risk is increasingly concentrated in hazard-exposed cities. However, within cities, particularly in low and middle-income countries, urban space is structured in a way that accentuates risk inequality. Globally, the population living in informal settlements continues to grow in absolute terms. Disaster risk is thus amplified as low-income households are forced to occupy hazard-exposed areas with low land values, deficient or non-existent infrastructure, an absence of social protection and high levels of environmental degradation.

### **Consumption surpassing biocapacity**

The overconsumption of energy, water and other resources arising from economic growth has

now surpassed the biocapacity of the planet, breaching the limits of critical planetary systems and threatening human survival. Many ecosystems that provide vital protective and provisioning services are being degraded beyond the point of recovery, while changes in temperature, precipitation, sea level and other factors due to global climate change are modifying hazard patterns and magnifying disaster risks. These risks are unequally distributed, as sectors and territories with high levels of income live beyond their means, consuming environmental resources and exporting risks to and importing them from other areas.

### **Disaster risk reduction at a crossroads**

In 2015, three mutually supportive intergovernmental processes will come to a conclusion. In March 2015, at the Third World Conference on Disaster Risk Reduction in Sendai, Japan, UN Member States are expected to adopt a successor framework to the HFA. This new framework will guide how countries should achieve the policy goal of disaster risk reduction in the coming years.

The main outcome of the 2012 Rio+20 Conference was the agreement by Member States to launch a process to develop a set of Sustainable Development Goals (SDGs) by September 2015, which will build upon the Millennium Development Goals (MDGs) and converge into the post-2015 development agenda.

The Conference of the Parties (COP 21) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 11<sup>th</sup> session of the Meeting of the Parties (CMP 11) to the 1997 Kyoto Protocol will be held in Paris in December 2015, with the objective of reaching a legally binding and universal agreement on climate change among all countries.

These three processes are closely interrelated. Growing disaster risks, climate change as well as poverty and inequality are all indicators

of unsustainability. At the same time, increasing disaster loss and impacts, magnified by climate change, will undermine the capacity of many low and middle-income countries, particularly small island developing states (SIDS), to make the capital investments and social expenditures necessary to achieve the SDGs.

In this context, disaster risk reduction is at a crossroads: It can continue to focus on managing an increasing number of disasters or it can shift the focus to managing the underlying risks in a way that facilitates sustainable development.

### **Making development sustainable**

If an accelerated increase in disaster risk is to be avoided, there is a growing consensus that the development drivers of risk, such as climate change, the overconsumption of natural capital, poverty and inequality will have to be addressed. Implicit values with regard to social and economic development do seem to be changing, challenging and overturning deep-rooted assumptions about economic growth, social well-being and disaster risk. The understanding that beyond a given threshold social progress and human development are not dependent on unlimited economic growth and increasing energy consumption is now increasingly well accepted and is informing the global discussion on sustainable development.

The private sector, citizens and cities have generated increasing momentum to transform development practices in renewable energy, water and waste management, natural resource management, green building and infrastructure, and sustainable agriculture. These development transformations contribute to reducing disaster risks: for example, moving to a low-carbon economy reduces the risk of catastrophic climate change; protecting and restoring regulatory ecosystems can mitigate a variety of hazards; and risk-sensitive agriculture can strengthen food security. All editions of the GAR have consistently

identified and highlighted transformative development practices with co-benefits for disaster risk reduction.

### **Managing disaster risks inside development**

GAR15 consolidates and builds on those recommendations by highlighting not only how such transformative practices are essential to reduce risks, but also how an effective management of risks *inside* development can play a critical role in making development sustainable and in achieving the outcomes of all three of the new international frameworks under negotiation in 2015.

Managing the risks *inherent* in social and economic activity, rather than mainstreaming disaster risk management to protect against *external* threats, is very different to the current approach to disaster risk reduction. It implies that managing risk, rather than managing disasters as indicators of unmanaged risk, now has to become inherent to the art of development; not an add-on to development, but a set of practices embedded in its very DNA. Without effective disaster risk management, sustainable development will not be sustainable and the SDGs will not be achieved.

Investing in disaster risk reduction is thus a precondition for developing sustainably in a changing climate. It is a precondition that can be achieved and that makes good financial sense. Global annual investments of only US\$6 billion in appropriate disaster risk management strategies can generate benefits of US\$360 billion or an equivalent of more than 20 per cent reduction in new and additional expected annual losses.<sup>i</sup>

Such an annual investment in disaster risk reduction represents only around 0.1 per cent of the US\$6 trillion per year that will have to be invested in infrastructure over the next 15 years. But for many countries that small additional investment could make the crucial difference in achieving national and international goals of ending

poverty, improving health and education, and ensuring sustainable and equitable growth.

The key message of GAR15, therefore, is that an appropriate set of mutually supportive strategies for disaster risk management that weave and flow through development decisions is critical to the success of all three international frameworks currently under discussion. Without the effective management of disaster risks, sustainable development will, in fact, not be sustainable.

### **The future of disaster risk management**

As disaster risk has increased rapidly during the HFA, disaster risk management itself is rapidly evolving. New stakeholders, including city governments, businesses and the financial sector are driving change. Innovations in areas as diverse as risk governance, risk knowledge, cost-benefit analysis and accountability are challenging old assumptions and creating new opportunities.

Rather than a *programme* or *framework* for action, GAR15 presents a discussion on the future of disaster risk management that recognizes ongoing innovation. Its purpose is to stimulate further reflection, debate and improved practice as countries begin to address the challenges posed by the new international agreements on disaster risk reduction, climate change and sustainable development in 2015 and beyond.

### **Reforming the governance of disaster risk**

Countries will continue to require a dedicated and specialized disaster management sector to prepare for and respond to disasters, emergencies and other incidents, including maritime, aviation, industrial and environmental accidents. To the extent that risks continue to grow, there will be more rather than less demand for such a sector.

However, disaster and climate risks in development need to be approached not just through a specialized and stand-alone sector, but rather through strengthened governance arrangements

in sectors and territories to ensure a low discounting of future risk as well as transparency and accountability as risks are generated, transferred and retained.

This requires a combination of prospective risk management to ensure that risks are appropriately managed in new investment, corrective risk management to reduce the risk present in existing capital stock, and compensatory risk management to strengthen resilience at all levels.

### **From risk information to risk knowledge**

Managing risks in this way requires greater risk awareness and knowledge. The social production of risk information itself needs to be transformed, with a shift in focus from the production of risk information *per se* towards information that is understandable and actionable by different kinds of users: in other words, risk *knowledge*.

A change in perspective in the production of risk information is also required: from measuring risk as an objective externality that can be reduced towards understanding risk as both an opportunity and a threat, and towards improved identification and estimation of the causes and consequences of risk generation and accumulation.

An increasing sensitivity to extensive risk is particularly important. Because of its pervasiveness, this form of risk relates directly to the day-to-day concerns of households, communities, small businesses and local governments, and therefore it can stimulate and leverage social demand for disaster risk reduction. At the same time, precisely because it is a risk layer that internalizes social, economic and environmental vulnerability, it can be managed effectively through an appropriate combination of prospective, corrective and compensatory disaster risk management practices.

### **Assessing the costs and benefits**

Disaster risk management always weighs risk against opportunity and future threats against

current needs. As such, the costs and benefits of disaster risk management need to become fully encoded into public and private investment at all levels, into the financial system and into the design of risk-sharing and social protection mechanisms.

At present, cost-benefit analyses are usually limited to the avoided replacement costs of damaged buildings or infrastructure versus the additional costs of reducing the relevant risks. This analysis needs to be expanded to highlight the trade-offs implicit in each decision, including the downstream benefits and avoided costs in terms of reduced poverty and inequality, environmental sustainability, economic development and social progress as well as a clear identification of who retains the risks, who bears the costs and who reaps the benefits.

Such a broader approach to cost-benefit analysis can increase the visibility and attractiveness of investments in disaster risk management by stressing their positive development benefits rather than the avoided costs and losses alone. If encoded into the financial system, it can help to identify the potential risks inherent in asset and loan portfolios, in credit and debt ratings and in forecasts and analyses, thus defusing the dangerous link between global financial flows and investments that increase disaster risk.

This approach may also provide a rationale to encourage the expansion of risk financing and social protection measures to low-income households, small businesses and local governments.

### **Becoming accountable**

It will only be possible to encode the full costs and benefits of disaster risk management into investment decisions, the financial sector and risk-sharing mechanisms if those responsible can be held to account for their decisions. If societies become more sensitive to both the causes and consequences of disaster risk, responsibility for

the subsequent losses and impacts will become a societal issue that can be subjected to social discourse and negotiation.

This can lead to enhanced accountability not only for realized disaster loss and impacts, but also for the generation and accumulation of future risks, through a combination of social demand, appropriate normative frameworks, voluntary standards and enhanced monitoring of progress against explicit and transparent benchmarks and targets.

### **A transformational force**

As these and other innovations start to challenge the way disaster risk has been managed up to now, disaster risk reduction has the potential to become a truly transformational force.

The reduction of poverty, the improvement of health and education for all, the achievement of sustainable and equitable economic growth and the protection of the health of the planet now depend on the management of disaster risks in the day-to-day decisions of governments, companies, investors, civil society organizations, households and individuals. Strengthened disaster risk reduction is essential to make development sustainable.

### **Key features of GAR15**

GAR15 is addressed to all those committed to sustainable development, reducing disaster risk and addressing climate change. The report contains a number of new features and enhanced content.

### **Disasters measured in human life years**

In this edition, the concept of human life years is introduced as an alternative representation of disaster impact, as it provides a metric that describes the time required to produce economic development and social progress; time which is lost in disasters. The loss of human life years, be it through disasters, disease or accidents, is therefore a way of measuring setbacks to development that goes beyond conventional metrics such as

mortality and economic loss. This metric brings the real scale of disaster loss into clear focus, and its use as a common currency allows comparisons with other development challenges.

### **Globally comparable risk metrics**

The mapping and understanding of the global risk landscape has been greatly enhanced by the latest iteration of the GAR Global Risk Assessment. This now estimates the risks associated with earthquakes, tropical cyclone winds and storm surges, tsunamis and riverine flooding for all countries of the world. In addition, the risks associated with volcanic ash in the Asia-Pacific region, drought in various countries in sub-Saharan Africa and climate change in a number of countries have been calculated. Using the same methodology, arithmetic and exposure model to calculate risk probabilistically for all hazards enables risk levels to be compared between countries and regions, across hazard types and with development metrics such as capital investment and social expenditure.<sup>ii</sup>

### **Volcanic hazard and risk**

A major scientific review of volcanic hazard and risk has been produced for the GAR by leading national and international scientific institutions. For the first time, GAR15 includes a dedicated section on volcanic hazard and risk, which summarizes selected findings from this review.

### **Increased coverage of data on extensive risk**

One of the principle contributions of the GAR series has been to reveal extensive risk through a pioneering approach in which countries are empowered to record their disaster losses systematically at all levels. The evidence base on extensive risk presented in GAR15 represents another significant step towards a global understanding of this risk layer. GAR15 now presents systematic and comparable disaster loss data from 85 countries and territories, compared to 56 countries and territories in 2013, 22 in 2011 and only 13 in 2009.<sup>iii</sup>

## Measuring financial resilience

The availability of comparable global disaster risk metrics has enabled initial estimates of the financial resilience of governments. Countries have been stress-tested to see if they would be resilient to a 1-in-100-year disaster loss, and their resource gaps have been estimated. In addition, GAR15 updates the findings originally presented in GAR09 on how disaster losses challenge development over the medium term, particularly in countries with small and vulnerable economies.

## A peer-reviewed assessment of progress

Previous editions of the GAR have analysed the results of government self-assessments of progress prepared using the HFA Monitor. The fourth cycle of the HFA Monitor (2013-15) was still in progress when GAR15 was produced, and an insufficient number of progress reports had been completed to enable a global analysis. In GAR15, progress has been reviewed on the basis of a broad, peer-reviewed assessment across the different Priorities for Action specified in the HFA, which complements the results from previous HFA monitoring cycles. The 22 core indicators of the HFA were divided into thirteen research areas, plus an additional four areas identified for elements of the HFA that were not explicitly measured by the core indicators. The progress assessments were coordinated by organizations of the United Nations system, the World Bank, the OECD and other institutions with specific expertise in each sector. Following an open call for papers, more than 200 input papers were received and a peer-reviewed background paper was prepared for each research area.

## The future of disaster risk management

In partnership with UNDP and with leading academic institutions in Africa, Asia and the Americas, an innovative seminar programme on *The Future of Disaster Risk Management* brought together over 100 researchers and practitioners between April 2013 and October 2014. This collective reflection on and identification and

construction of the challenges currently facing disaster risk reduction has informed the objectives and structure of GAR15, especially its findings and recommendations.<sup>iv</sup>

## How to use GAR15

GAR15 is structured around a set of contributed and commissioned background papers as well as risk and disaster data. For this edition of the GAR, more in-depth research and case studies have been developed than ever before. All this material and data is available on the interactive web version of GAR15 at [www.preventionweb.net/gar15](http://www.preventionweb.net/gar15).

The print version of GAR15 is available in all six UN languages (Arabic, Chinese, English, French, Russian and Spanish). The main report includes augmented reality features: enhanced content that provides tablet and smartphone users with access to additional digital information, such as dynamic maps, videos, photos and case studies. The Pocket GAR provides the main evidence and messages of the report in a short and easy-to-read format.

The risk and loss data produced for GAR15 is available on a new interactive data platform on PreventionWeb as well as Tangible Earth, the world's first interactive digital globe, and the GAR for Tangible Earth (GfT), a fully interactive stand-alone application for tablet and smartphone users.

## Notes

---

**i** Depending on the benefit-cost ratio (BCR) and discount rate applied.

**ii** For more information on the global risk assessment methodology and results, see Annex 1.

**iii** For more information on the loss databases and extensive risk analysis, see Annex 2.

**iv** For a summary of all inputs and discussions in the meeting series, see Annex 4.





# Introduction: A history of violence

## 1.1 Dis-astrum and kata-strophe

**Disasters have been interpreted as threatening development from the outside. As a result, disaster risk generation within development has not been addressed effectively.**

In the early morning hours of 26 December 2004, a 9.1 magnitude earthquake, the third largest ever registered on a seismograph, occurred between the island of Simeulue and mainland Indonesia.<sup>1</sup> The earthquake triggered massive tsunamis that impacted the coast of Sumatra as well as most of the countries that border the Indian Ocean. The violence of their impact was such that an estimated 230,000 people died in 14 countries, particularly in Indonesia, Sri Lanka, Thailand and India, but also as far away as Somalia.

Devastating tsunamis have occurred throughout history. The word *tsunami* is Japanese, formed by the combination of *tsu* (= harbour) and *nami* (= waves). The most destructive tsunami in Japanese history took place on 15 June 1896, killing

around 22,000 people.<sup>2</sup> Triggered by an earthquake off the Sanriku coast, the waves reached a height of 40 metres, destroying everything in their path.

The earthquakes and tsunamis that engulfed the port of Callao in Peru in 1746 and Lisbon in 1755 captured the attention of Enlightenment thinkers such as Voltaire and Rousseau and provoked speculation on the causes of disaster (UNISDR, 2011a). In the Indian Ocean, the eruption of Krakatoa on 27 August 1883 led to massive tsunamis. On 28 December 1908, the Messina earthquake and tsunami in the Mediterranean killed approximately 123,000 people in Sicily and Calabria and was considered the worst tsunami-related disaster prior to the events in the Indian Ocean in 2004 (Figure 1.1).

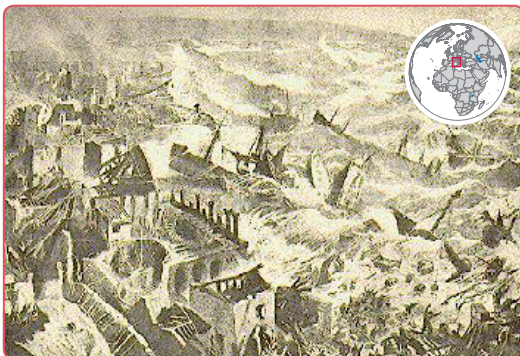
2004 Indian Ocean tsunami



The coastal population of Simeulue and the Andaman Islands largely escaped the impact of the Indian Ocean tsunami in 2004. Understanding and responding to tsunamis was still deeply ingrained in their culture, prompting them to evacuate to higher ground. But elsewhere the tsunami caught local populations and foreign tourists unaware and unprepared.

A tsunami early warning system, including education and preparedness on how to react after an earthquake, could have enabled hundreds of thousands of people to evacuate and survive the disaster. An operational tsunami warning system had existed in the Pacific Basin since 1949.<sup>3</sup> However, no such early warning system had been developed in the Indian Ocean, and for

**Figure 1.1** Devastating earthquake and tsunami in Messina, 1908



(Source: Miller, 1909.)



most coastal populations living there in 2004, the experience of responding to a tsunami had long faded from living memory.

Eight months after the Indian Ocean tsunamis, a very different history of violence unfolded on the other side of the world. On 29 August 2005, Hurricane Katrina (Figure 1.2) hit coastal areas of the States of Louisiana and Mississippi in the United States of America, killing 1,833 people and causing an estimated US\$125 billion in economic damage.<sup>4</sup>

Katrina was a large, strong but not exceptional Category 3 hurricane when it made landfall. In fact, Hurricanes Andrew and Charley, which impacted Florida in 1992 and 2004, respectively, and Hurricane Camille, which hit Mississippi in 1969, involved higher wind speeds and, in the case of the Florida storms, lower central pressure than Katrina (NOAA, 2005). Moreover, unlike the Indian Ocean tsunamis, Katrina could hardly be

considered unexpected. Hurricane early warning systems have existed in the Atlantic Basin since the nineteenth century. Katrina occurred in the middle of the Atlantic hurricane season and made landfall in a region with a history of recurrent hurricane activity.

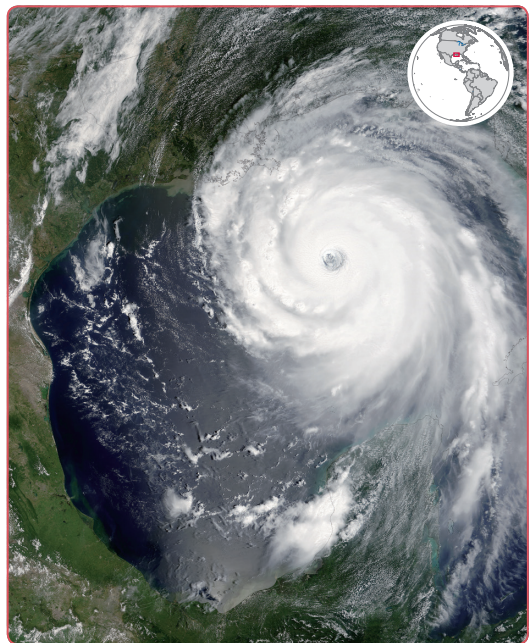
Similarly, the cascading disaster that unfolded in New Orleans, where the levees that protected the city from flooding were breached and utilities and the transport network collapsed, should not have come as a surprise. Much of the city of New Orleans lay below sea level and was considered a disaster risk hotspot. The Federal Emergency Management Agency (FEMA) had already developed scenarios that modelled the consequences if the levees that protected the city were to fail.

On August 26<sup>th</sup>, three days before Katrina made landfall, warnings were issued and the Governors of Louisiana and Mississippi declared states of emergency (Moynihan, 2009). However, the city, state and federal authorities failed to evacuate in a timely fashion around 100,000 out of a total population of approximately 1.3 million (Tierney, 2008).

When the Mayor of New Orleans finally gave the evacuation order on the morning of August 28<sup>th</sup>, twenty-four hours before the hurricane made landfall, a significant share of the largely low-income population that inhabited flood-exposed areas of New Orleans did not have access to any means to evacuate. The contingency plans for the city assumed evacuation by automobile. No plans had been made for those without cars, including the elderly and disabled, or without the resources to procure transport and hotel rooms.

There are many reasons why the federal, state and city authorities, faced with a predictable hazard event and identified risks, failed to respond effectively and why so many people were left behind. FEMA had been weakened as priority shifted from physical hazards like hurricanes to other threats

**Figure 1.2**  
Hurricane Katrina



(Source: NASA.<sup>5</sup>)

in the wake of the World Trade Center attacks of September 11, 2001. Emergency management organizations at all levels were reportedly understaffed and under-resourced. But over and above institutional weaknesses and administrative failures, the disaster unveiled a history of inequality that configured the city's vulnerability to the hurricane as well as the authorities' response to it. In some ways, that history seems to have continued unchanged in the recovery of New Orleans, reproducing and rebuilding new vulnerabilities (Box 1.1).

Superficially, the disasters associated with the Indian Ocean tsunamis and Hurricane Katrina appear to be different moments in a common history of violent and destructive disasters: representations of overwhelming natural events causing massive death and destruction. But beneath the surface, the two disasters have very different narratives.

In many ways the Indian Ocean disasters were a representation of *dis-astrum* (Latin for "bad star"), the impact of an infrequent and unexpected natural event of extraordinary magnitude outside of human agency. In *Timaeus*, Plato commented:

*"There have been many and diverse destructions of mankind. We know this because we possess the records of those who witnessed the events and*

*survived. Now the stories as they are told have the fashion of a legend, but the truth of them lies in the shifting of the bodies in the heavens that recurs at long intervals."*

In the case of such extreme hazards, the degree of disaster risk is conditioned more by exposure than by vulnerability. In other words, all those exposed to the tsunamis were at risk, irrespective of their income, ethnicity or social class (UNISDR, 2011a). The only possible disaster risk management strategies would have been to reduce exposure through timely evacuation, which in turn would have depended on the existence of reliable early warning systems and effective preparedness planning grounded in the exposed communities, and then to compensate for loss through insurance or other risk financing instruments.

In contrast, the disaster in New Orleans represented a predictable and tragic *kata-strophe* (Greek for "down-turn"), the tragic finish to a long drama. While Hurricane Katrina was an intense hurricane, it was the historically configured risk in New Orleans, the vulnerability of those left behind and the lack of effective actions to assist them that conditioned the scale of the disaster.

**Box 1.1** Rebuilding social vulnerability in New Orleans



The failure of flood protection infrastructure, a failure to anticipate the disaster and a badly managed response exacerbated and magnified the pre-existing conditions of social vulnerability and inequality in New Orleans (Levitt and Whitaker, 2009; Tierney, 2006; Amnesty International, 2010; Masozera et al., 2007).

Subsequent to Hurricane Katrina, the reconstruction process, and within it the construction sector, have been key drivers in the reproduction of inequality and social vulnerability (Jenkins et al., 2012). In 2011, six years after the disaster, the average wage in New Orleans was 6 per cent lower than the US average and poverty stood at 29 per cent, almost double the US average of 15.9 per cent. Recent data shows that New Orleans ranks second among all major US cities in terms of inequality.<sup>6</sup> Between 1999 and 2011, median household income fell by 9 per cent, while income inequality had risen by up to 50 per cent (Bishaw, 2012; GNOCDC, 2013).



In the case of Category 3 hurricanes affecting similar numbers of exposed people, about 46 per cent of the variance in mortality risk is explained by vulnerability (UNISDR, 2011a). This means that if effective actions are taken to address social and economic vulnerability and to strengthen resilience, disaster risk can be significantly reduced. Disasters such as the one that unfolded in New Orleans in 2005 cannot be blamed on extreme natural events or on “bad stars”, but rather on the lack of a political and economic imperative to reduce risks.

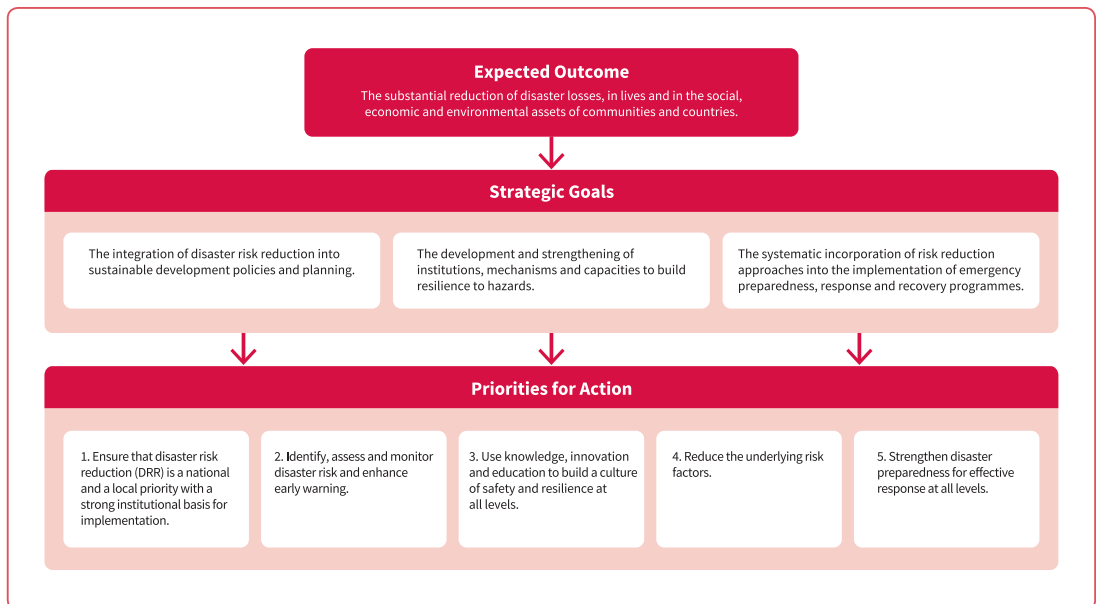


Disaster risk is normally considered a function of the severity and frequency of the hazard, of the numbers of people and assets exposed to the hazard, and of their vulnerability or susceptibility to damage. From that perspective, *dis-astrum* and *kata-strophe* are not opposing or mutually exclusive disaster types, but rather different layers of risk.

The most intensive risk layers, which are characterized by very low-frequency but high-severity losses and are normally associated with extreme hazard events such as the Indian Ocean tsunamis, manifest as *dis-astrum*. The more extensive risk layers, which are characterized by high-frequency but low-severity losses and are associated with localized and recurrent hazard events such as flash floods, landslides and storms, manifest as *kata-strophe*. In the more intensive risk layers, it is the hazard and exposure that dominate the risk equation, while in the more extensive layers vulnerability plays a larger part.

The risk profile of most countries includes a range of risk layers. However, in most contexts, disaster risk reduction has been approached through an interpretation of disaster as *dis-astrum*, as a set of practices to protect development against exogenous threats rather than to prevent or avoid the generation and accumulation of risks *within* development. This interpretation has influenced and permeated the practice of disaster risk management and its effectiveness in achieving the policy objective of disaster risk reduction.

**Figure 1.3** The Hyogo Framework for Action



(Source: UNISDR, 2005.)

## 1.2 Enter the HFA

**Decades of disaster and risk management experience have defined the disaster risk reduction agenda laid down in the Hyogo Framework for Action (HFA).**

On 17 January 1995, the Great Hanshin earthquake devastated the port of Kobe, Japan (UNISDR, 2013a). Ten years after the quake, some 23 days after the impact of the Indian Ocean tsunamis and 223 days before Hurricane Katrina made landfall in New Orleans, 168 UN Member States gathered in Kobe to adopt a new international framework for disaster reduction, better known as the Hyogo Framework for Action: 2005-2015, or HFA.



Under the slogan *Building the Resilience of Nations and Communities to Disasters*, the HFA was structured around an expected outcome, three strategic goals and five priorities for action (Figure 1.3).

### Box 1.2 International agreements to address disaster risks

As early as 1979, an expert group convened by the Office of the United Nations Disaster Relief Coordinator (UNDRO) concluded that *"it is now also realized that the actual and potential consequences of natural hazards are becoming so serious and so increasingly global in scale, that much greater emphasis will henceforth have to be given to pre-disaster planning and prevention"* (UNDRO, 1980).

Nearly a decade later, the UN General Assembly designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) and defined five specific goals, including *"to disseminate existing and new information related to measures for the assessment, prediction, prevention and mitigation of natural disasters"* and to develop programmes of *"technical assistance and technology transfer, demonstration projects and education and training, tailored to specific hazards and locations, and to evaluate the effectiveness of those programmes"*.

In 1991, the General Assembly noted that approximately 100 States had established national strategies to achieve the objectives of the IDNDR and endorsed a World Conference, which took place in Yokohama, Japan in June 1994. The resulting Yokohama Strategy for a Safer World emphasized the importance of disaster prevention, mitigation and preparedness, highlighting that response alone was not sufficient.

The shift in emphasis from disaster response to disaster risk reduction was taken further in the International Strategy for Disaster Reduction (ISDR), which was launched in 1999 to follow up on the IDNDR and to develop the Yokohama Strategy and Plan of Action. In addition, in 2002 the Plan of Implementation of the World Summit on Sustainable Development declared: *"an integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery, is an essential element of a safer world in the twenty-first century"*.

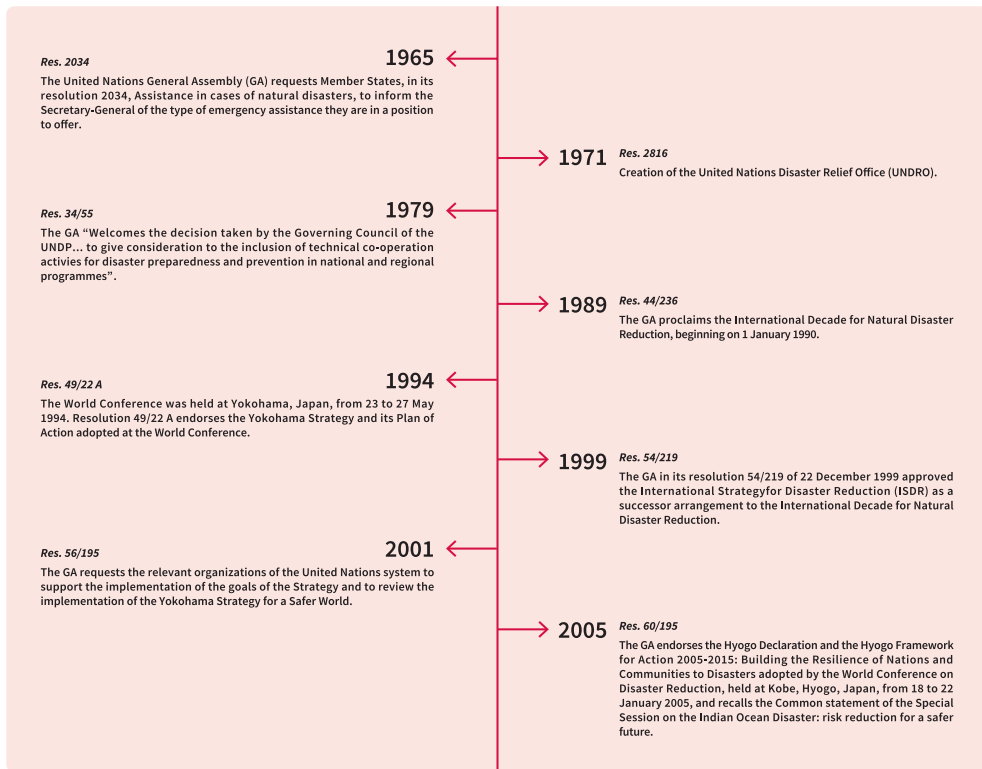
The World Conference in Kobe was planned long before the Indian Ocean tsunamis, and the HFA was not the first international agreement to address disaster risks. Since 1979, a number of international agreements and policy frameworks have evolved to guide global and national efforts in disaster risk reduction (Box 1.2). However, the magnitude of the disasters in the Indian Ocean and the consequent global humanitarian response galvanized a level of political interest in the HFA that might not have arisen otherwise.

These 25 years of international agreements indicate a growing, albeit sometimes symbolic, political commitment by UN Member States to the policy goal of disaster risk reduction (Olson et al., 2011). However, 25 years after the declaration of the IDNDR, 20 years after the Yokohama Strategy, 15 years after the launch of the ISDR and 10 years after the endorsement of the HFA, evidence of continued disaster risk and loss still questions the extent to which the expected outcome of the HFA, *"The substantial reduction of disaster losses,*

### Addressing risk



**Figure 1.4** From disaster response to disaster risk reduction



(Source: adapted from UNISDR Virtual Library.)

In 2004 the UN General Assembly convened the second World Conference on Disaster Risk Reduction, held in Kobe in 2005, to build on the Yokohama Strategy and the Johannesburg Plan of Action. The resulting Hyogo Declaration emphasized the reduction of vulnerabilities and the strengthening of resilience of nations and communities *"in the context of the disaster reduction cycle, which consists of prevention, preparedness, and emergency response, as well as recovery and reconstruction"*.

(Source: International Law Commission, 2013.)

*in lives and in the social and economic assets of communities and countries",* has really been achieved and therefore whether the way disaster risk reduction has been understood and practised by most countries is really fit for purpose.

## 1.3 The emergence of the disaster risk management sector

**An evolution from managing disasters to managing risks has slowly taken shape at national and international levels. At its centre has been the disaster management cycle.**

### A national system is born

On 13 November 1985, the Nevado del Ruiz Volcano in Colombia erupted. Although the government had received multiple warnings of volcanic

activity from scientific organizations since September of that year and hazard maps had been prepared, the local population was warned but not evacuated. In the town of Armero, around 20,000 out of a total population of 29,000 were killed, as were a further 1,500 in nearby Chinchiná.

### Armero disaster



Just one week earlier, 100 hostages—including 11 judges—had died when the Colombian armed forces ended a siege of the Palace of Justice in Bogota by the M-19 guerrilla group (Procuraduría General de la Nación, 2005). The government was widely held responsible for the loss of life in both events. In the case of the volcanic disaster, the government was faulted for multiple failures in risk identification, early warning, preparedness, evacuation and response (Zeiderman and Ramirez Elizalde, 2010).

Four years later, in 1989, the National System for Disaster Prevention and Response was created in an ambitious reform of disaster risk management (Government of Colombia, 1988). The national system embraced better disaster management and incorporated the country's original civil defence organization at the time. But it also adopted disaster risk reduction as a policy goal and gave explicit priority to a much broader range of disaster risk management practices. Moreover, it introduced an innovative systems approach to risk governance which was integrated horizontally across government ministries and departments, vertically across regional, departmental and local governments, and with specified roles for scientific and technical institutions, the Red Cross and other non-governmental organizations.

The concurrent creation of the Colombian national system and the declaration of the IDNDR marked a paradigm shift in the governance arrangements that countries adopt to

manage disaster risk (Government of Colombia, 1988; World Bank, 2012) and were symbolic of the emergence of a dedicated disaster risk management sector; this paradigm shift was consecrated with the adoption of the HFA in 2005.

### Emergency management



### Emergency management

The origins of what is now a disaster risk management sector in most countries can be found in the institutions, legislation and policies, administrative arrangements and instrumental systems created to respond to and manage disasters and crises. The concept of civil defence emerged following the bombing of civilian areas in the First World War, and in 1935 a Civil Defence Service was established by the Home Office of the United Kingdom. Likewise, the Office of Civilian Defense was created in the United States of America in 1941.<sup>7</sup>

After the Second World War, the focus of civil defence, particularly in Europe, shifted to the goal of protecting the population against nuclear destruction. But when the Cold War came to an end, the focus shifted again towards protecting the population against hazards such as floods, earthquakes and storms, and in the 2000s towards protection against terrorist attacks. These successive changes in focus can be observed in the United States of America, where in 1979 the different civil defence agencies were brought together in the Federal Emergency Management Agency (FEMA), which was assimilated into the Department of Homeland Security following the September 11, 2001 attacks in New York and Washington, D.C.

Massive disasters associated with droughts and conflict in sub-Saharan Africa, with floods, cyclones and conflict in Bangladesh, and with earthquakes, for example in Peru in 1970, Nicaragua in 1972 and Guatemala in 1976, generated



a perceived need for stronger international coordination of response and relief efforts (Hannigan, 2012; FAO, 2010; Bamidele, 2011; CEPAL, 1973; CEPAL, 1976; European Commission and Comunidad Andina, 2006). This was supported by the creation of the United Nations Disaster Relief Office (UNDRO) in 1971 to coordinate international efforts to respond to disaster and conflict (Hannigan, 2012).

The governance arrangements developed for emergency management displayed a number of characteristics that would later influence the way disaster risk management has been approached.

These arrangements were adopted to protect societies against what were conceived as external threats to civilians and to national security. Disasters were perceived as one such threat, along with technological, maritime and aviation accidents and the effects of conflict. Disasters were regarded as unpredictable, extreme events, which is aptly illustrated by an early 1990s slogan from the Pan American Health Organization: “Disasters don’t warn; be prepared”.

An effective response to such external threats required increasingly sophisticated, professionalized and technically specialized institutions and mechanisms at all levels, leading to the structuring of a distinct sector with its own doctrine, dogma, and distinctive signs and symbols. In some countries, civil defence and protection organizations were military structures, while in others they were located in the interior or home ministry, which is also responsible for law enforcement, emergency services and domestic security.

The sector and the institutions it comprises have demonstrated a remarkable institutional resilience and capacity to adapt to changing circumstances and needs, as the series of shifts from warfare to nuclear threat, to disaster and to terrorism have shown. This highlights a consolidated sector that defends not only national

security but also its own interests and agenda and expresses this in its distinctive community identity and branding.

### **Standards and regulation**

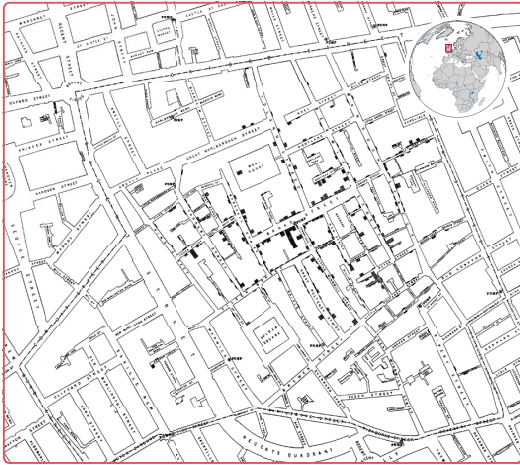
In parallel with the evolution of emergency management, countries adopted other kinds of governance arrangements to manage disaster risk, including statutory norms and standards in areas such as public health, environment, planning and building.

Societies have always adapted their building, agricultural and other practices to manage disaster risks within a range of environmental, technological, social, economic and political constraints.

In the wake of large disasters, it was common for building practices or urban design to be modified with a view to reducing risk. For example, following the 1746 earthquake in Lima, Peru, Viceroy Jose Antonio Manso de Velasco commissioned French mathematician Louis Godin to develop a reconstruction plan for the city. While never fully implemented, Godin’s plan included detailed specifications for widened streets and reduced building height to avoid future earthquake damage (UNISDR, 2011a), an early example of reconstruction planning which integrates risk-sensitive planning and building codes.

From the nineteenth century onwards, industrialized countries has begun to codify risk-reducing practices into statutory regulations and standards on a scientific basis. For example, during the 1854 epidemic in London, Dr. John Snow used a geographical analysis of cholera cases to trace the cause of the epidemic back to contaminated water from a single well in Broad Street (Figure 1.5). This led not only to the identification of the causes of cholera but also to the introduction of public health regulations in the United Kingdom, which dramatically reduced the risk of devastating epidemics.

**Figure 1.5** Clusters of cholera cases in the Broad Street area of London in 1854



(Source: [http://scienceline.org/2010/05/john-snows-maps-of-the-broad-street-cholera-outbreak.](http://scienceline.org/2010/05/john-snows-maps-of-the-broad-street-cholera-outbreak/))

The work of both Louis Godin and John Snow reflected the change of perspective that had occurred during the Enlightenment in Europe, when disasters began to be identified as the result of human agency rather than divine retribution. Once it was recognized that disaster risk could be configured by social and economic activities over time, the adoption of regulatory frameworks to manage risk became increasingly common, particularly in higher-income countries.

The first quantitative seismic building code was adopted by an Italian commission following the 1908 Messina earthquake; the Home Office of Japan adopted a seismic coefficient and a limit on building heights in 1923, and in response to the Santa Barbara earthquake in 1925, the United States of America introduced seismic design provisions into the 1927 Uniform Building Code (FEMA, 1998).

By the time the IDNDR was declared, most high-income as well as many middle and low-income countries had a range of norms, standards and regulations in place to manage disaster risk in different sectors. In high-income contexts in particular, regulation has proved highly effective in

gradually reducing risk, for example as vulnerable buildings and infrastructure are replaced over time with new structures built to higher standards.

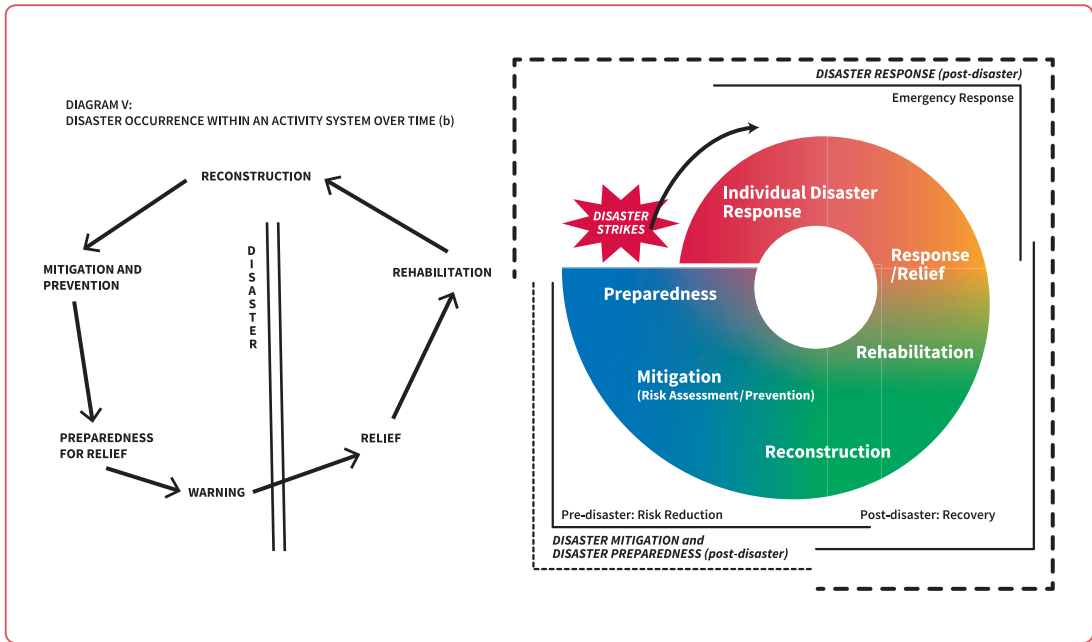
### From emergency to disaster risk management

At some point in the 1970s, disaster risk management began to emerge as a specialized domain and sector. The work of academics (Hewitt, 1983), built environment professionals (Davis, 1978) and progressive emergency management experts (Cuny, 1983) made a strong case that emergency management should be only one component of a broader approach that also includes actions to reduce risks before disasters occur and during the post-disaster recovery and reconstruction phases. An artefact called the disaster management cycle, first presented in 1975 (Baird et al., 1975), was adopted as a pragmatic concept in which activities to reduce risk and to ensure preparedness, response and recovery were described as four phases of a cyclical process (Figure 1.6).

By the time the International Conference on Disaster Mitigation Program Implementation was held in Ocho Rios, Jamaica in 1984, the contours of a broadened disaster risk management sector had begun to take shape (Virginia Polytechnic Institute, 1985). By then, progressive emergency management organizations in countries like Jamaica and the Philippines had already started to adopt the disaster management cycle and expand their mandate to include what were then described as disaster prevention and mitigation, recovery and reconstruction.

By the time the Colombian national system was created, the notion that governments should manage disasters through this more comprehensive approach rather than emergency management alone was becoming increasingly mainstream. With its innovative systems approach, the Colombian national system became paradigmatic. Coinciding as it did with the declaration of the IDNDR, it influenced how

**Figure 1.6** The original disaster management cycle and a current interpretation



(Source: Baird et al., 1975 and Khan et al., 2008.)

other countries began to approach disaster risk management, at first in Latin America (Lavell and Franco, 1996) and later in other regions.

Many countries reformed their governance arrangements after major disasters (Wilkinson et al., 2014), often adopting the principles pioneered in the Colombian system, and with crucial support from national or regional champions. For example, Nicaragua adopted new arrangements in 2000 following the 1998 disasters associated with Hurricane Mitch (Government of Nicaragua, 2005), India followed suit after the 1999 Orissa super-cyclone and the 2001 Gujarat earthquake (Government of India, 2004), and Sri Lanka and Indonesia introduced reforms after the 2004 Indian Ocean tsunami.

At the same time, regional organizations such as CEPREDENAC, CDERA, SOPAC and the SAA-RC Disaster Management Centre, technical centres such as ADPC and time-bound regional programmes such as PREDECAN were created.<sup>8</sup>

Multilateral organizations, including the European Commission (ECHO), UNDP (BCPR) and the World Bank (GFDRR), likewise began to create specialized units which combined emergency management functions, post-disaster recovery as well as activities designed to reduce disaster risks.

The IDNDR, the Yokohama Plan of Action and the HFA served to consolidate, legitimize and empower this emerging disaster risk management sector globally, regionally and nationally. The three strategic goals of the HFA implicitly reflect the logic of the disaster management cycle. The central goal of strengthening institutions and governance arrangements supports the other two goals, which are designed to integrate disaster risk reduction into sustainable development and into effective emergency preparedness, response and recovery.

## 1.4 The limits of control

In recent years, a better understanding of the role of vulnerability and exposure has begun to take shape, suggesting that development creates disaster risk. Yet, disaster risk management practice did not adapt.

It is fitting that Colombia, one of the first countries to create a visible disaster risk management sector in 1989, should also be one of the first to identify the limits of an approach to disaster risk reduction based on the disaster management cycle.

In 2010 and 2011 Colombia experienced a strong but not exceptional El Niño Southern Oscillation (ENSO) event. The country did not experience a single, large disaster, but thousands of smaller-scale extensive events that occurred over an 18-month period and affected 93 per cent of the country's 1,041 municipalities (UNISDR, 2013a), causing over US\$6 billion in direct economic losses. These disasters questioned the effectiveness of the way disaster risk management was being practised, and they revealed an underlying reality of disaster risk accumulation, exacerbated by the displacement and insecurity associated with ongoing civil conflict and by investments in reconstruction that had sometimes rebuilt and reproduced disaster risks. In 2012, Colombia initiated reforms and passed new legislation (Box 1.3).

Most countries would have been seriously challenged to manage the relentless series of

disasters that occurred in Colombia in 2010 and 2011. However, while the Colombian case is idiosyncratic, it unveiled cracks and fissures in the way disaster risk reduction has been approached and organized in other countries and regions.

Research highlighting that risk is endogenous to social, economic, territorial and environmental change has been published since the 1970s and 1980s (Zobler, 1976; Quarantelli, 1978; Davis, 1978; Hewitt, 1983; Watts, 1983; Maskrey, 1989) and has gradually permeated academic literature (Wisner et al., 2003; Lavell, 2003; Weber, 2006; Cannon, 2008; Aragón-Durand, 2009; Cutter, 2014; van Niekerk, 2014) and science research agendas (ICSU-LAC, 2010; IRDR, 2013). All the evidence assembled in successive editions of the GAR (UNISDR, 2009a, 2011a, 2013a) has confirmed how disasters are manifestations of *unresolved development problems* (Hagman, 1984) and are thus outcome-based indicators of a skewed, unsustainable development paradigm based on unlimited growth, inequality and overconsumption. Exposure and vulnerability as well as hazard itself (through climate change and environmental degradation) are socially constructed through underlying risk drivers, including globalized economic development, poverty and inequality, badly planned and managed urban development, environmental degradation and climate change.

Emerging patterns and trends of disaster loss and risk reflect the operation of these drivers. In particular, increases in extensive disaster loss and

### Box 1.3 Moving from consequence to cause in Colombia

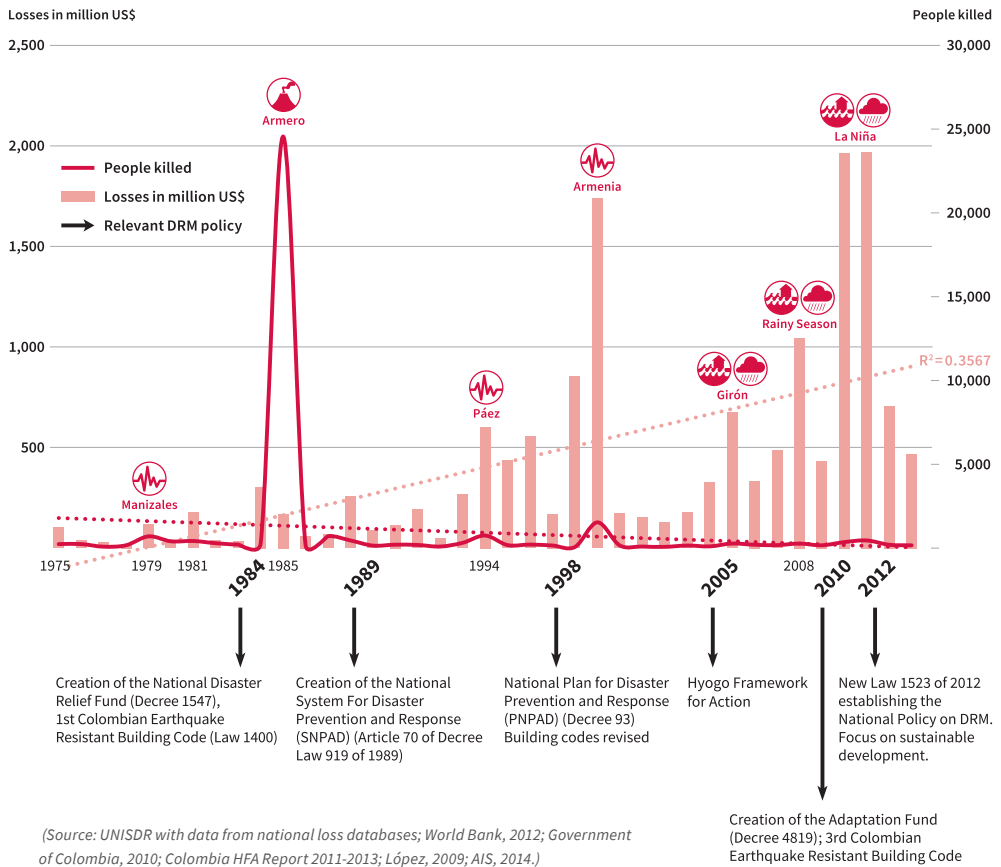
As highlighted in this chapter, the creation of the Colombian National System for Disaster Prevention and Response (SNPAD) in 1989 (World Bank, 2012) marked the emergence of a structured approach to disaster risk governance. However, while this approach led to reductions in disaster mortality, economic loss has trended upwards over the last 40 years (Figure 1.7), revealing unaddressed gaps and challenges (Cardona et al., 2005).



### ENSO losses



**Figure 1.7** Disaster risk reduction and loss trends in Colombia (in constant 2012 US\$)<sup>9</sup>



While responsibilities had been decentralized, local governments often lacked commitment as well as financial and technical capacities. Adoption and implementation of local disaster risk management plans was limited to larger urban centres, creating dependency on the national level. Risk transfer mechanisms were not in place, nor were clear risk financing strategies. This meant that specialized agencies like the Fund for the Reconstruction and Social Development of the Coffee-Growing Region (FOREC) had to be created after major disasters such as those associated with the 1999 earthquake, which weakened the national disaster risk management agency. At the same time, that agency had been moved from the President’s office to the Ministry of the Interior, reducing its political leverage and influence.

Disaster risk management was interpreted primarily in terms of disaster preparedness and recovery rather than risk prevention and reduction. The mainstreaming of disaster risk considerations into land-use planning, environmental management, and economic and social development planning was more symbolic than real. Involvement of the private sector was limited, and there was an overall lack of accountability.

In 2012, those deficiencies were addressed in a new law (INGENIAR, 2010) which makes disaster risk management a responsibility of the state and the population as a whole. This new piece of legislation is based on three key processes: risk knowledge, risk management and disaster management, with particular emphasis on prospective risk management. The ultimate responsibility for disaster risk management has returned to the President of the Republic (Government of Colombia, 2012).

With the 2012 law, Colombia has taken a second step in pioneering governance arrangements for disaster risk management. The coming years will show whether these arrangements are effective or not.<sup>10</sup>

damage provide empirical evidence that disaster risk is an endogenous indicator of failed or skewed development, of unsustainable economic and social processes, and of ill-adapted societies; socially constructed problems driven by underlying processes whose neglect manifests as a predictable—and always tragic—*kata-strophe*.

The HFA certainly created space for addressing the underlying risk drivers in Strategic Goal 1, *the integration of disaster risk reduction into sustainable development policy and planning*, as well as Priority for Action 4, which aims to *reduce the underlying risk factors*. In other priorities for action, the HFA was equally incisive. In Priority for Action 1, for example, the HFA called upon governments to *demonstrate the strong political determination required to promote and integrate disaster risk reduction into development programming*. And in Priority for Action 2, it advised institutions dealing with urban development to *provide information to the public on disaster reduction options prior to constructions, land purchase or land sale*.

However, this has been the path less travelled in most countries. The HFA has more generally been approached through an underlying conception of disasters as externalities to be managed; as exogenous and unforeseen shocks that affect normally functioning economic systems and societies; as *dis-astrum* rather than *kata-strophe* (Lavell and Maskrey, 2014). The slogan of the HFA advocates building resilience *to* disasters rather than building resilience *in* development.

Interpreting disasters as exogenous shocks lies at the root of the disaster management cycle, which—as its name implies—revolves around disasters as *events*. While the disaster management cycle was and still is seductive due to its simplicity and internal logic, it encouraged and justified the syncretic expansion of emergency management organizations into other aspects of disaster risk management, such as prevention,

reduction and recovery. Responsibilities for these other aspects, as described in the HFA and the preceding international frameworks, were merely *added on* to the governance arrangements for emergency management.

As such, disaster risk reduction continues to be principally understood and practised as disaster management and as a set of instrumental and administrative mechanisms to *protect development against* tangible external threats. Logically, if disaster risk is conceptualized as an exogenous threat, then instruments can be designed to protect against it. For example, terms like *financial protection* point towards protecting public finances against external threats, rather than recognizing that the way those finances are used either reduces or generates disaster risk. By definition, interpreting disaster risk in this way weakens responsibility and accountability for risk generation.

Ultimately, this approach to disaster risk reduction encapsulates a fundamental contradiction: it aims to protect the same development paradigm that generates risk in the first place. As such, if increased investments are made to protect development without addressing the underlying risk drivers at the same time, more and more effort will lead to diminishing returns and flagging progress. Disaster risk will continue to be generated faster than it can be reduced.

The HFA has generated an enormous investment in and commitment to disaster risk reduction by stakeholders at all levels, including national governments, municipal authorities, utility providers, non-governmental organizations, scientific and technical institutions, regional and international organizations, and the private sector. There have been numerous and sometimes spectacular successes in addressing specific risks, such as the dramatic reduction in tropical cyclone mortality in Bangladesh.



However, these very real achievements in reducing disaster risk under the HFA are now rowing against a fast-rising tide of risk construction and accumulation. And given the growing evidence of systemic risk at the planetary scale, there is now a very real possibility that disaster risk will reach a tipping point beyond which the effort and resources necessary to reduce it will exceed the capacity of future generations.



If disaster risk is an endogenous indicator of a flawed development paradigm, then progress towards the policy objective of disaster risk reduction will depend on the transformation of that paradigm. If the world is to be fit to survive by the middle of the twenty-first century and if a global *kata-strophe* is to be averted, it will be necessary to take firm strides along the path less travelled in the HFA and to imagine a different way of approaching disaster risk management.

## Notes

- 1 Source: United States Geological Survey, <http://earthquake.usgs.gov/> (accessed 27 November 2014).
- 2 Sources for all 1896 Japanese tsunami data: [http://earthquake.usgs.gov/earthquakes/world/events/1896\\_06\\_15.php](http://earthquake.usgs.gov/earthquakes/world/events/1896_06_15.php); <http://ngm.nationalgeographic.com/1896/09/japan-tsunami/scid-more-text>; <http://www.sozogaku.com/fkd/en/cfen/CA1000616.html> (accessed 27 November 2014).
- 3 <http://ptwc.weather.gov/> (accessed 1 July 2014).
- 4 Source for all internationally reported disaster loss data (unless stated otherwise): Centre for Research on the Epidemiology of Disasters (CRED), EM-DAT, <http://www.cred.be/>.
- 5 [http://www.nasa.gov/mission\\_pages/hurricanes/archives/2005/h2005\\_katrina.html](http://www.nasa.gov/mission_pages/hurricanes/archives/2005/h2005_katrina.html) (accessed 27 November 2014).
- 6 <http://www.bloomberg.com/visual-data/best-and-worst/most-income-inequality-us-cities> (accessed 27 November 2014).
- 7 <http://www.presidency.ucsb.edu/ws/?pid=16117> (accessed 23 November 2014).
- 8 Centro de Coordinación para la Prevención de los Desastres Naturales en América Central (CEPREDEMAC), Caribbean Disaster Emergency Management Agency (CDERA), Secretariat of the Pacific Community (SOPAC), South Asian Association for Regional Cooperation (SAARC), El Proyecto Apoyo a la Prevención de Desastres en la Comunidad Andina (PREDECAN).
- 9 Unless stated otherwise, all graphs and figures on economic loss valuation from national loss databases used in this report are in constant 2012 US dollars.
- 10 With additional information from personal communication with Omar Dario Cardona (August and September 2014).





**Part I**

# Unfinished business

As the HFA comes to its close, all the indications are that its expected outcome, to achieve “*The substantial reduction of disaster losses, in lives and in the social and economic assets of communities and countries*”, has only been partially achieved.

Disaster mortality remains high: 1.6 million people have died in internationally reported disasters since the start of the IDNDR in 1990, making for an average of around 65,000 deaths per year. Yet this number is far less than the average of 1.24 million deaths in traffic accidents every year<sup>1</sup> or the average of 1 million who die from tuberculosis every year. From that perspective, disaster mortality could be considered a less critical global problem than disease or accidents.

Economic losses from internationally reported disasters have also grown steadily since 1990, reaching an estimated annual average of US\$200 billion (Munich Re., 2013). However, this is only a fraction of global GDP, which was close to US\$75 trillion in 2013,<sup>2</sup> and fails to ring the same alarm bells as the US\$4 trillion in losses to the banking sector during the global financial crisis of 2007-2009 (IMF, 2009).

Part of the reason why disaster losses have not created the same political or economic

imperative to address the risks of disease or financial risks may be the way in which they are measured. In reality, disasters affect households, communities and countries due to the combined impact of mortality, morbidity and damaged or destroyed housing, infrastructure and agriculture. Separate measurements of mortality and economic loss fail to capture the full dimensions of disaster.

To address this problem, and for illustrative purposes, the concept of human life years can be used to provide a better representation of disaster impact, as it provides a metric describing the time required to *produce* economic development and social progress. The loss of human life years, be it through disasters, disease or accidents, is therefore a way of measuring setbacks to social and economic development (Box I.1).

When disaster losses are expressed using human life years as a common currency (Noy, 2014), their potential scale comes into clearer focus. Between 1980 and 2012, more than 1.3 billion life years were lost worldwide in internationally reported disasters (ibid.), making for an annual average of 42 million life years. Expressed in this way, disaster loss is roughly equivalent to the 43 million life years lost annually from tuberculosis, about 20 per cent lower than the life years lost

**Box I.1** An innovative way to measure disaster impact

The standard way in which disaster damage is measured involves a separate examination of the number of fatalities, injuries, and people otherwise affected, and the financial damage that natural disasters cause. A new way to aggregate measures of disaster impact aims to overcome many of the difficulties previously identified in the literature, including the difficulty of assessing overall disaster impact, the need to conduct cost-benefit analyses that take different disaster impacts into account, and the problem of assessing damage relative to its value in different countries.

Despite some conceptual differences, the new approach proposed is similar to the World Health Organization’s calculation of Disability Adjusted Life Years (DALYs) lost from the burden of diseases and injuries.<sup>3</sup> All measures of disaster impact are converted into “life years” to allow a worldwide comparison of trends in disaster losses. The advantage of this new measurement is that it accounts for the more general impact of disasters on human welfare and enables a comparison of these impacts across the globe.<sup>4</sup>

(Source: Noy, 2014.)

from malaria and about half the 90 million years lost from HIV/AIDS.<sup>5</sup>

Major disasters such as the Christchurch earthquake or the Bangkok floods in 2011 can cause a significant number of lost life years to accumulate in a single country. New Zealand lost a total of almost 200,000 life years in the February 2011 earthquake, equivalent to about 17 days per inhabitant. In Thailand, 4.76 million life years were lost in the 2011 Chao Phraya River floods; this figure translates into about 26 days per person (Noy, 2015).

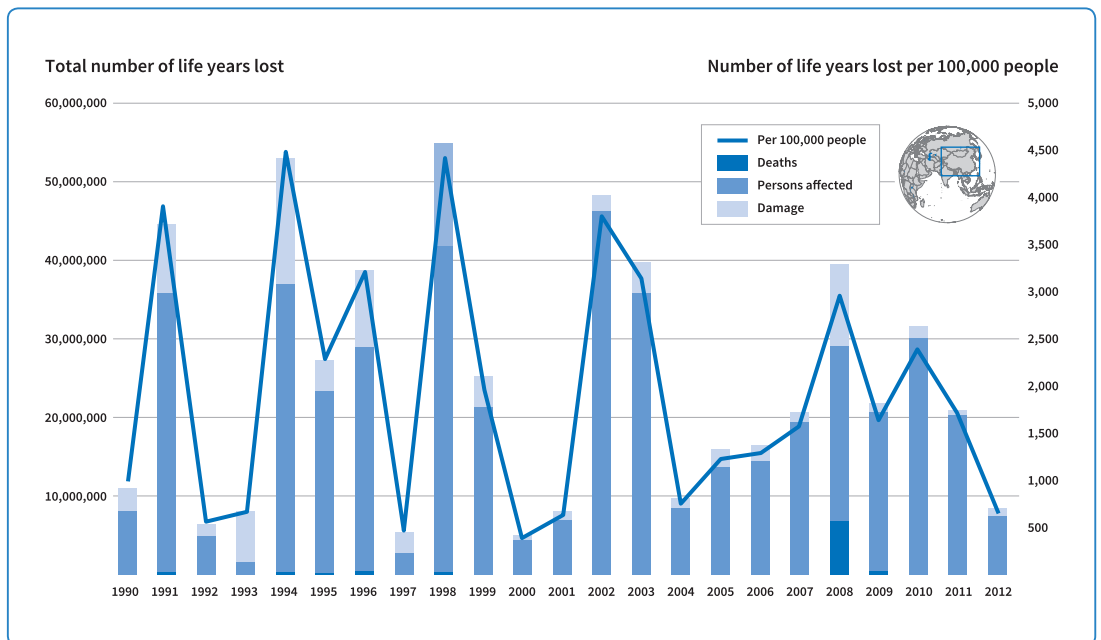
In low and middle-income countries, the losses are generally higher than in high-income countries. In China, 557,438,270 life years were lost between 1990 and 2012, which equals a per capita loss of 162 days (Figure I.1). In Turkey, total life years lost in the same period amounted to more than 4 million, or 25 days per person (Noy, 2015).

These figures are even higher when the loss of

life years from nationally reported disasters is included. Globally, the additional life years lost due to extensive disasters are estimated to add another 20 per cent to internationally reported disasters, and this increase can be as high as 130 per cent in low-income countries. In Indonesia, for example, when lost life years are calculated using national loss data, the total for the period from 1990 to 2012 amounts to more than 25 million life years lost, or 42 days lost per person. Small island developing states, such as the South Pacific island nation of Tuvalu, experience significantly larger per capita losses, amounting to 4 years per person since 1980 (Noy, 2015).

As an illustration, this data underlines that disaster loss is as much a critical global challenge to economic development and social progress as disease is. However, the figures also show that it is a challenge unequally shared. Over 90 per cent of the total life years lost in disasters are spread across low and middle-income countries (Figure I.2).

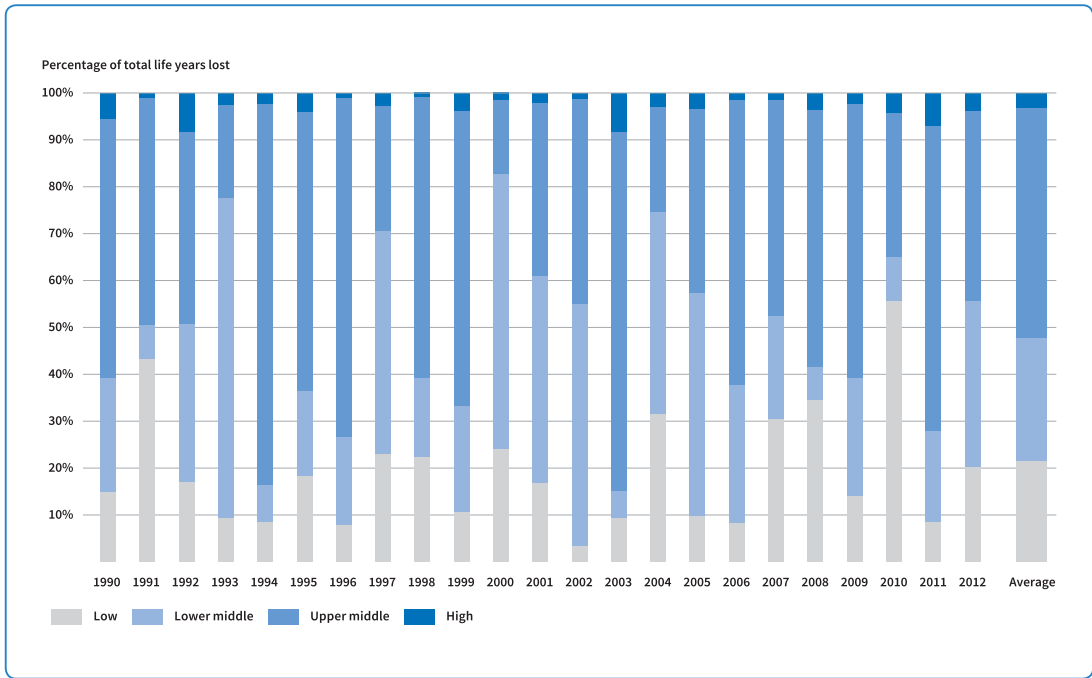
**Figure I.1** Loss of life years in China, 1990-2012



(Source: Noy, 2015.)



**Figure I.2** Share of life years lost across income groups



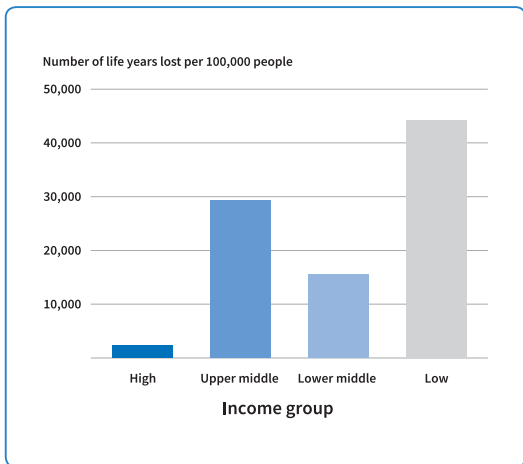
(Source: Noy, 2014.)

In particular, more life years are lost per capita in low-income countries than in any other income group (Figure I.3).

These findings suggest that while disaster risk is a universal problem that affects all regions and

income groups, as a development challenge it continues to be concentrated in low and middle-income countries. As explored in detail in the different chapters of this part of the report, these are the countries that will need to increase capital investment and social expenditure substantially if they are to achieve the Sustainable Development Goals and whose capacity to do so will be challenged by increasing disaster risk.

**Figure I.3** Lost life years relative to population, 1990 - 2012



(Source: UNISDR with data from Noy, 2014.)

**Notes**

- 1 WHO Factsheet No. 358, March 2013: <http://www.who.int/mediacentre/factsheets/fs358/en/>.
- 2 World Bank data: <http://data.worldbank.org/indicator/NY.GDP.MKTP.CD/countries/1W?display=graph>.
- 3 [http://www.who.int/topics/global\\_burden\\_of\\_disease/en](http://www.who.int/topics/global_burden_of_disease/en) (accessed 3 January 2015).
- 4 For details on the methodology, please see Noy, 2014.
- 5 Calculated using data on DALYs from the WHO: [http://www.who.int/healthinfo/global\\_burden\\_disease/estimates/en/index2.html](http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html).

## Chapter 2

# Reducing disaster losses: A partial success



**Twenty-five years after UN Member States adopted the International Decade for Natural Disaster Reduction (IDNDR) and ten years after the adoption of the HFA, global disaster risk has not been reduced significantly. While improvements in disaster management have led to dramatic reductions in mortality in some countries, economic losses are now reaching an average of US\$250 billion to US\$300 billion each year.**

## 2.1 Saving lives

**The last decade has seen dramatic reductions in disaster mortality in selected countries and regions. But not all countries have been able to reduce the vulnerabilities associated with disaster mortality faster than the hazard-exposed population has increased.**

The super-cyclone that impacted the State of Odisha, India on 29 and 30 October 1999 killed 9,843 people. Fourteen years later, in October 2013, no more than 47 died when the equally powerful Cyclone Phailin swept through the same area. This dramatic reduction in disaster mortality has been attributed to improvements in disaster risk management effected by the Odisha State Government (GFDRR, 2013a; UNEP, 2013).



The Odisha State Disaster Management Authority (OSDMA) was established shortly after the super-cyclone in 1999 (GFDRR, 2013a). Subsequently, 200 cyclone shelters were built and early warning systems were developed, including communication networks that enabled warnings to reach both exposed communities and fishermen out at sea. Embankments were built to protect against storm surges and coastal flooding. When cyclones are predicted, reservoir levels are now lowered in order to mitigate anticipated inland flooding. At the same time, the vulnerability of urban areas has been assessed and building codes introduced (GFDRR, 2013a; UNEP, 2013). In addition, the accuracy of forecasts made by the

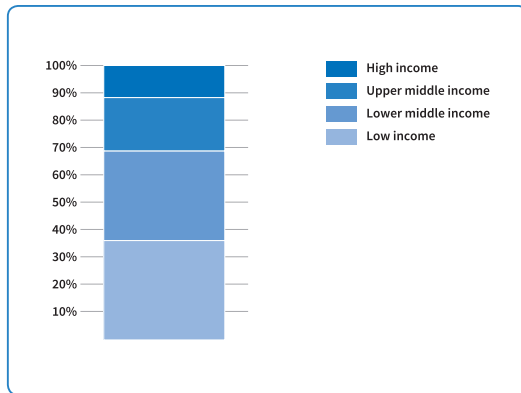
Indian Meteorological Department has greatly improved. In 2013, warnings were disseminated four days before Cyclone Phailin made landfall, which points to a significant improvement compared to the two days' warning given in 1999 (UNEP, 2013). Finally, the cyclone made landfall in a pre-electoral period, meaning that both the national and state governments deployed all available resources to ensure that the disaster was well managed and its impacts minimized.

The case of Odisha is indicative of a trend which was modelled in GAR11 (UNISDR, 2011a) and in which improving development conditions and strengthened disaster management lead to dramatically reduced mortality, at least in those events for which warning is possible. Globally, the modelled mortality risk associated with floods and tropical cyclones was estimated to have peaked in the year 2000 before trending down.<sup>1</sup> In East Asia and the Pacific,<sup>2</sup> for example, the number of people exposed to floods and tropical cyclones each year is estimated to have increased by around 70 per cent since 1980, while modelled mortality risk is estimated to have halved (UNISDR, 2011a). However, in sub-Saharan Africa, estimates indicate that modelled flood mortality risk has grown consistently since 1980 (UNISDR, 2011a) because increasing population exposure has not been accompanied by a commensurate reduction in vulnerability. Not all countries have been able to reduce the vulnerabilities associated with disaster mortality faster than the hazard-exposed population has increased.

Disaster mortality risk is closely correlated with income and the quality of governance. Since 1990, almost 90 per cent of the mortality recorded in

internationally reported disasters has occurred in low and middle-income countries (Figure 2.1).

**Figure 2.1** Distribution of disaster mortality by income group, 1990-2013



(Source: UNISDR with data from EM-DAT.)

Faced with similar numbers of people exposed and hazards of the same severity, lower-income countries with weaker governance can expect mortality rates to increase by several orders of magnitude (UNISDR, 2009a). This was tragically confirmed in the case of the estimated 138,366 people killed when Cyclone Nargis struck Myanmar in 2008.



Many countries have made significant progress in human development, in poverty reduction and in achieving the Millennium Development Goals (MDGs). Between 1990 and 2010, the proportion of people living below the poverty line more than halved, dropping from around 43 per cent to just over 20 per cent.<sup>3</sup> Since 1990, the number of people living on less than US\$1.25 per day has fallen from 51 per cent of the population to 30 per cent in Southern Asia and from 56 per cent to 48 per cent in sub-Saharan Africa (United Nations, 2014a). In the same period, under-five mortality fell from 178 to 109 per 1,000 births in sub-Saharan Africa and from 116 to 61 per 1,000 births in Southern Asia (ibid.).

Disaster mortality can be expected to fall as development conditions improve and vulnerability is reduced. There is a greater chance that roads will exist to allow evacuation, that affected people can receive timely medical assistance and that greater levels of literacy and primary education will strengthen people's understanding of warnings and disaster preparedness plans. Rising incomes and strengthened governance have also gone hand in hand with enhanced disaster management.

As discussed in Part II of this report, advances in early warning systems, ranging from more accurate monitoring of weather events to vastly increased mobile phone access and real improvements in disaster preparedness and response, have meant that whereas people often used to be caught off guard by hazard events, there are now contingency plans which enable timely evacuation to shelters and safe areas.

The experience of Odisha is not an isolated case. Several other low and middle-income countries have also made spectacular progress in reducing their mortality risk since the beginning of the IDNDR (Box 2.1).



Tsunami early warning systems can also be a highly effective way of saving lives. One tangible outcome since the endorsement of the HFA has been the creation of the Indian Ocean Tsunami Warning and Mitigation System.<sup>4</sup> However, the effectiveness of the system has not been tested by tsunamis of the kind that occurred in 2004.

Despite some notable exceptions,<sup>5</sup> early warning is rarely effective in the case of earthquakes. People do not die in earthquakes; they die in buildings that collapse or catch fire in earthquakes, and there is rarely time to evacuate to safe areas and shelters. Consequently, many of the

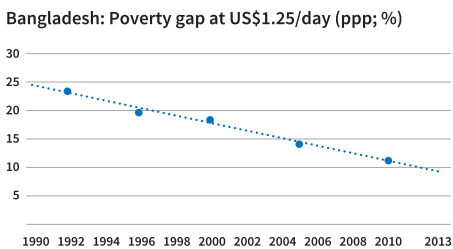
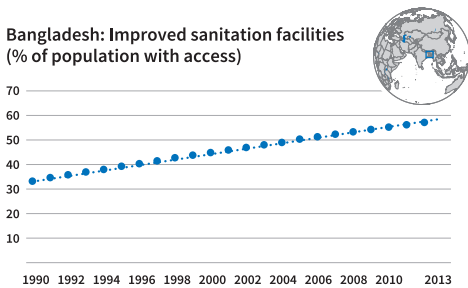
In general, countries that have managed to reduce disaster mortality significantly have also managed to enhance disaster management within a broader context of improving development indicators.

In Bangladesh, for example, an innovative cyclone shelter programme has helped the country dramatically reduce tropical cyclone mortality since the 1970s. In the past five decades, Bangladesh has been struck by three severe tropical cyclones: Bhola (1970), Gorky (1991) and Sidr (2007).



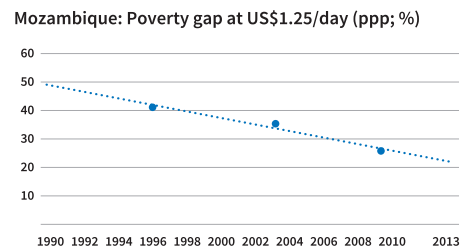
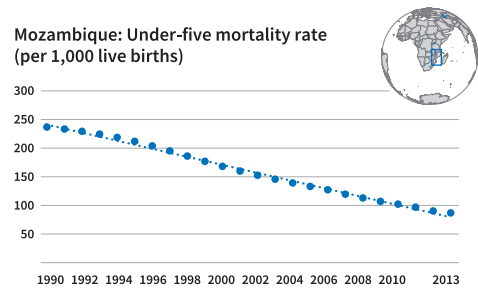
Bhola caused an estimated 300,000 deaths; Gorky was responsible for more than 138,866. The death toll for Sidr, however, was only 4,234. At the same time, Bangladesh's major success in reducing mortality from tropical cyclones is supported not only by cyclone shelters but also by a slow but steady improvement in the provision of basic education, health and sanitation, and by a reduction in the number of people living below the poverty line (Figure 2.2).

**Figure 2.2** Progress in selected human development indicators in Bangladesh



(Source: UNISDR with data from the World Bank.)

**Figure 2.3** Decreasing poverty and under-five mortality in Mozambique



(Source: UNISDR with data from the World Bank.)

In February and March 2000, Mozambique saw heavy flooding that affected more than 4.5 million people and killed at least 800. While the floods in January 2013 were not as severe as in 2000, the numbers of people killed and affected were reduced by around 90 per cent. A steady reduction in extreme poverty in Mozambique has gone hand in hand with a dramatic decline in the under-five mortality rate, which is a key indicator of Goal 4 of the MDGs (Figure 2.3). The country has also succeeded in reducing disaster mortality significantly over the last 20 years.

Similarly, hurricanes in Cuba in 1926 and 1932 caused approximately 600 and 2,500 deaths, respectively. In contrast, Hurricane Dennis in 2005 killed only 16 people, and Hurricane Sandy in 2012 claimed only 11 lives.

improvements in disaster management which have been so effective in reducing disaster mortality from floods and storms have not been as effective in the case of earthquakes.

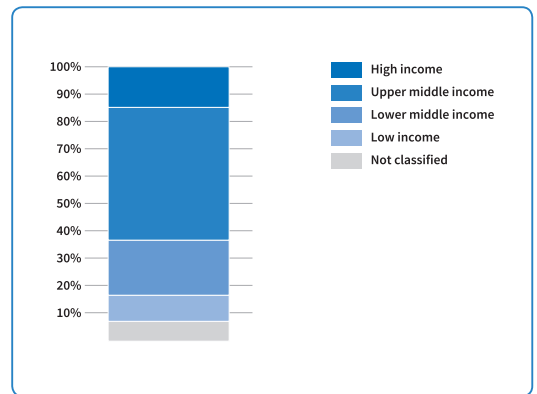
Since 1990, around 85 per cent of internationally reported earthquake mortality has occurred in low and middle-income countries (Figure 2.4). In these countries, the number of exposed buildings increases exponentially with rapid economic development and urban growth. However, the quality of urban governance, including the application of building codes and planning standards, is generally weaker than in high-income countries (UNISDR, 2009a).

For example, even in an upper middle-income country like Turkey, the 1999 earthquake—in which 17,000 people were killed—revealed that 65 per cent of apartment blocks in Istanbul and other cities had been built in violation of local building codes. Thus the high death toll highlighted the codes' ineffective implementation system, partly enabled by widespread corruption that provided building inspectors with incentives to look the other way and allow deficient construction (Moullier, 2014).

In low-income countries in particular, a considerable proportion of development takes place in the informal sector, which by definition is unregulated. The situation is most critical in countries like Haiti that rarely experience major earthquakes and thus have low levels of risk awareness (Neumayer et al., 2012), thus reducing the likelihood of risk-sensitive urban planning and building regulation even further.

As a result, while economic development may lead to declining weather-related mortality, it may actually bring about increases in earthquake mortality, as rapidly increasing exposure outpaces those reductions in vulnerability achieved through improved building and planning standards. As a country's income rises,

Figure 2.4 Earthquake mortality by income group, 1990-2013



(Source: UNISDR with data from EM-DAT.)

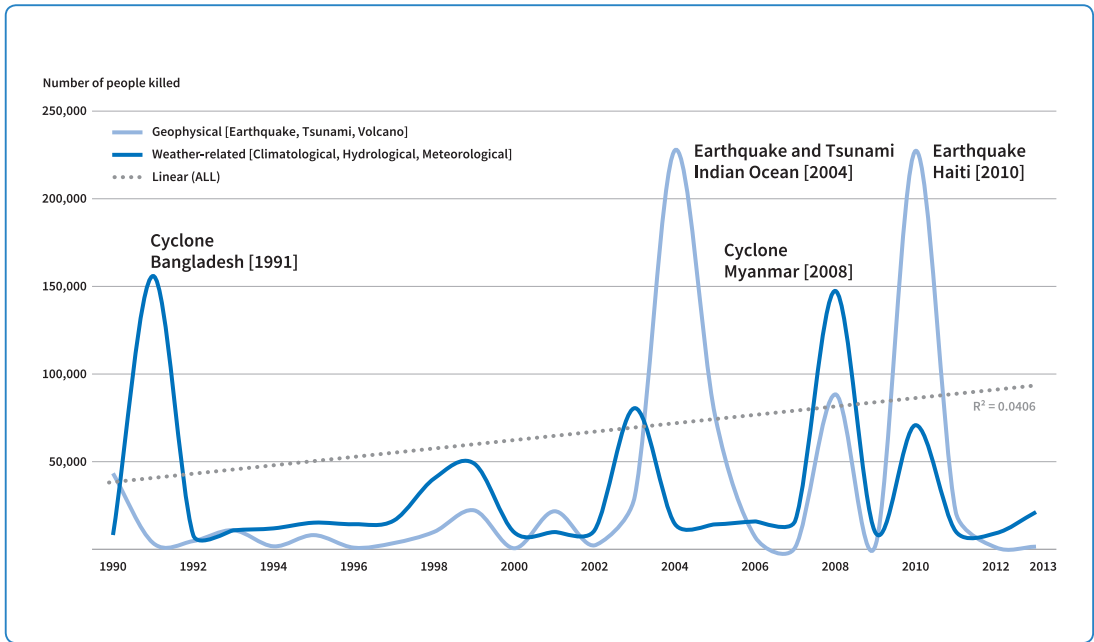
these standards tend to improve. However, this does not translate into a visible reduction in mortality in the short term. It may take decades for the outcome of improved planning regulations and building standards to translate into reduced disaster losses, as a critical mass of new, risk-sensitive building and urban development has to be achieved. Therefore, countries that introduced a new seismic building code under the HFA may not see the results of their efforts until the middle of the century. As a result, while the number of buildings in areas exposed to earthquakes has increased considerably since 1990, the extent to which this has been offset by reductions in vulnerability is unclear.

Trends in earthquake mortality were not modelled in GAR11 due to issues with the underlying data. Given the infrequency of major earthquakes, it is not easy to find longitudinal comparisons between the impacts of similar events in the same region as was possible in the case of Odisha or Bangladesh. Events such as the 1906 San Francisco earthquake or the 1923 Tokyo earthquake have fortunately not repeated themselves to date.

At the same time, most disaster mortality is concentrated in very intensive disasters (Figure 2.5). More than 45 per cent of the total disaster



Figure 2.5 Mortality from disasters concentrated in few intensive events



(Source: UNISDR with data from national loss databases.)

mortality since 1990 is concentrated in only four events (Cyclone Gorky in Bangladesh in 1991, the Indian Ocean tsunamis in 2004, Cyclone Nargis in Myanmar in 2008 and the Haiti earthquake in 2010). While mortality might appear to be on the rise, this trend is not statistically significant and changes arbitrarily depending on the time period chosen and the specific intensive disasters occurring in that period.<sup>6</sup>

## 2.2 Economic loss reduced?

**Absolute economic loss is rising, but in relative terms, the global increase in economic loss from disasters is not statistically significant. However, in some regions, losses have outstripped GDP growth. While absolute economic loss is concentrated in higher-income countries, in relative terms it remains a far greater problem for low-income countries.**

Most high-income countries have the regulatory quality and have made investments to significantly reduce the more extensive layers of disaster risk associated with losses occurring over short return periods. In addition, the citizens of these countries enjoy high levels of social protection, including effective emergency services and health coverage, meaning that high-income countries account for less than 12 per cent of internationally reported disaster mortality (Figure 2.1).

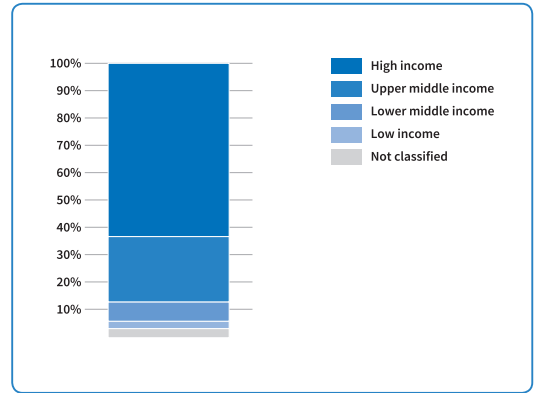
However, although investments in risk reduction and regulation have enabled a reduction of extensive risks, the value of assets in hazard-prone areas has grown, generating an increase in intensive risks. For example, investing in risk reduction measures to protect a floodplain against a 1-in-20-year flood may encourage additional development on the floodplain in a way that actually increases the risks associated with a 1-in-200-year flood.

This relationship is not linear. For example, the way in which losses increase with wealth may depend on the level of hazard exposure (Schumacher and Strobl, 2008). In countries with low hazard exposure, losses seem to rise rapidly along with economic development and subsequently fall; in contrast, in countries with high hazard exposure, losses seem to rise faster in higher-income countries than in middle-income countries. This probably reflects the fact that in countries exposed to extreme hazards and with high levels of intensive risk, vulnerability reduction is less effective in reducing risk than in countries with more extensive risks.

The trend of increased hazard exposure leading to increased economic loss risk was modelled in GAR11 (UNISDR, 2011a). For example, economic loss risk from cyclones was estimated to have increased by 265 per cent in the OECD, by 181 per cent in sub-Saharan Africa and by 150 per cent in all other regions since 1980. The increase was considered to be higher (262 per cent) in high-income countries than in upper middle-income countries (165 per cent), lower middle-income countries (152 per cent) and low-income countries (155 per cent).

These modelled trends would seem to be confirmed by historical loss data. In absolute terms, over 60 per cent of internationally reported economic losses are concentrated in OECD and other high-income countries, reflecting the concentration of economic assets (Figure 2.6).

**Figure 2.6** Economic losses from disasters by income group, 1990-2013



(Source: UNISDR with data from EM-DAT.)

According to Munich Reinsurance (Munich Re, 2013), both overall and insured losses have been increasing steadily since 1980, reaching an annual average of US\$200 billion in 2012 (Figure 2.7). This is consistent with figures from Swiss Reinsurance (Swiss Re, 2014a), which also show economic losses from disasters trending up to an annual average of around US\$200 billion.

In 2013, below-average economic losses from disasters were recorded, with estimates ranging from US\$140 billion (Swiss Re, 2014a) to US\$190 billion (Aon Benfield, 2013). The disasters with the largest economic impacts in 2013 were the Central European floods in May and June with an estimated total economic loss of US\$22 billion (Box 2.2), an earthquake in China in April with US\$14 billion, and Typhoon Haiyan in November with US\$13 billion.



While economic loss is rising in absolute terms, it mirrors increases in GDP (Neumayer and Barthel, 2010). This confirms results from other studies (UNISDR, 2009a), which show that when adjusted for inflation and expressed as a proportion of global GDP, the global increase in economic loss

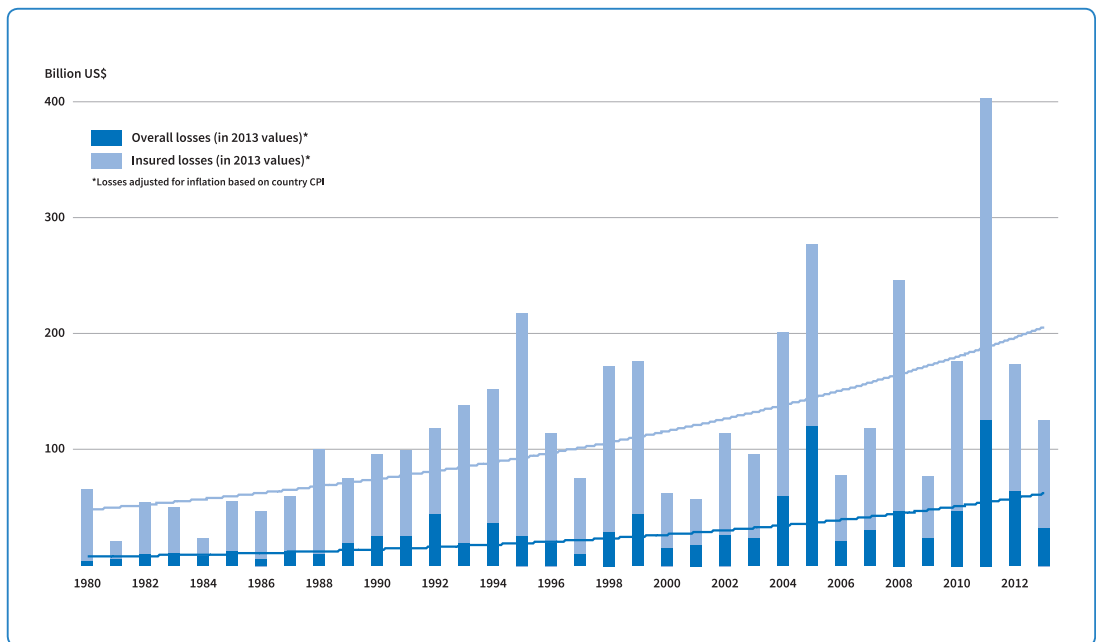
from disasters is not statistically significant.

However, it is important to note some important regional differences in this context. Between 1980 and 2010, GDP per capita grew by 703 per cent in East Asia and the Pacific and by 293 per cent in South Asia. This development outpaced the growth in exposure in both regions, meaning that economic loss risk actually diminished

in relative terms. In contrast, in income groups with more sluggish economic growth such as the OECD, economic loss risk rose faster than GDP per capita.

At the same time, while absolute economic loss is concentrated in higher-income countries, in relative terms it is a far greater problem for low-income countries (Figure 2.8).

**Figure 2.7** Overall and insured losses worldwide, 1980-2013



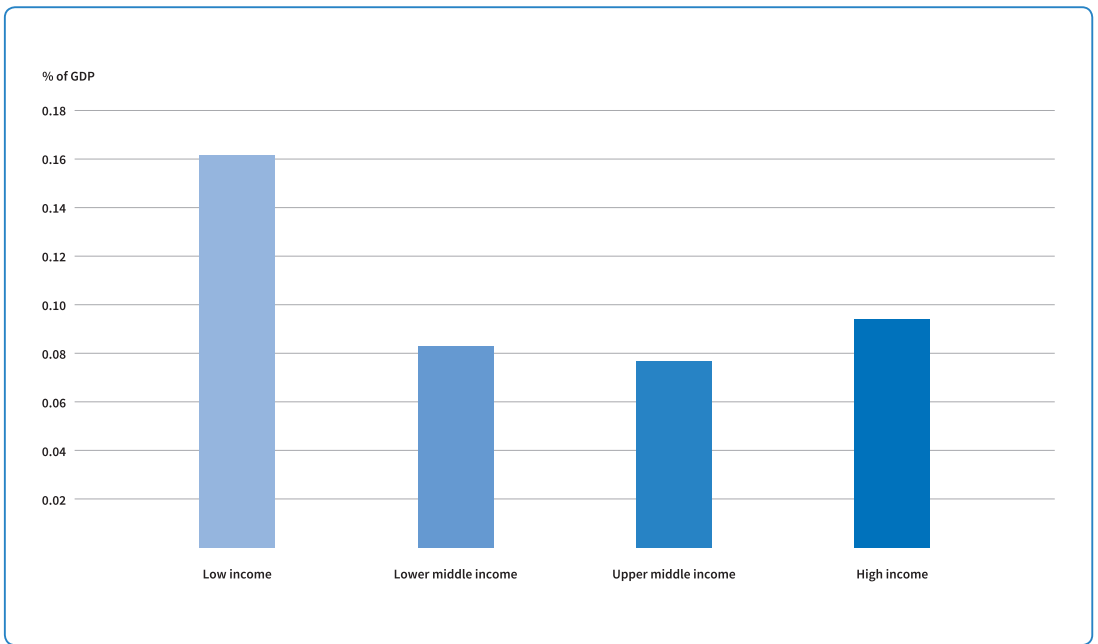
(Source: Munich Re, 2013: *Geo Risks Research*, NatCatSERVICE, as of January 2014.)

### Box 2.2 The Central European floods

During an unusually wet spring in Central Europe, groundwater levels were high and soils already were saturated when exceedingly high levels of rainfall occurred in late May and early June 2013, leading to severe flooding of the Elbe and Danube rivers and their tributaries. Rainfall levels with a 100-year return period were recorded,<sup>7</sup> resulting in the evacuation of 52,500 people in Germany alone and 25 deaths across the Czech Republic, Germany and Austria. Total economic losses across Central Europe have been estimated at between US\$14.7 billion and US\$22 billion (EM-DAT;<sup>8</sup> Munich Re, 2014; Zurich Insurance, 2014).

The events of 2002 and 2013 were by far the two greatest floods in Germany since 1900 (EM-DAT, 2014). While many areas were affected just as severely or even more so in 2013 than in 2002, the reduced loss suggests that investments were made in risk reduction (Munich Re, 2014; Zurich Insurance 2014). However, the fact that ten of Germany's eleven US\$1 billion disasters have occurred since 1990 clearly points to increasing risks.<sup>9</sup>

**Figure 2.8** Economic losses relative to size of economy (GDP) by income group, 1990-2013



(Source: UNISDR with data from EM-DAT and the World Bank.)

This confirms that those countries which need to invest the most in additional capacity, new infrastructure, social services and economic development will continue to struggle the most unless disaster risks are reduced. For these countries, development without disaster risk reduction is unsustainable.



## Notes

---

1 See Figure 2.11, GAR11 (UNISDR, 2011a), [http://www.preventionweb.net/english/hyogo/gar/2011/en/what/chapter2\\_2\\_3.html](http://www.preventionweb.net/english/hyogo/gar/2011/en/what/chapter2_2_3.html).

2 World Bank regions.

3 World Bank data: <http://data.worldbank.org>.

4 [www.ioc.tsunami.org](http://www.ioc.tsunami.org).

5 See the case study on Mexico's earthquake early warning system in Chapter 7.

6 In Figure 2.5 and the following graphs, it is possible to determine whether a trend is significant or not using the r-squared ( $R^2$ ) value, which is the coefficient of determination.  $R^2$  is a statistical measure that generally ranges from 0 to 1 and indicates how well data fits a statistical model. The higher the coefficient of determination is, the better the fit between the regression and the data.

7 <https://www.zamg.ac.at/cms/de/klima/news/wetter-beruhigt-sich-allmaehlich> (accessed 23 December 2014).

8 [www.emdat.be](http://www.emdat.be).

9 [www.emdat.be](http://www.emdat.be).

## Chapter 3

# The global riskscape



While historical losses can explain the past, they do not necessarily provide a good guide to the future. Most disasters that could happen have not happened yet.

The global expected average annual loss (AAL) in the built environment associated with tropical cyclones (wind and storm surge), earthquakes, tsunamis and floods is now estimated at US\$314 billion. This risk presents a real challenge to the global agenda of sustainable development.

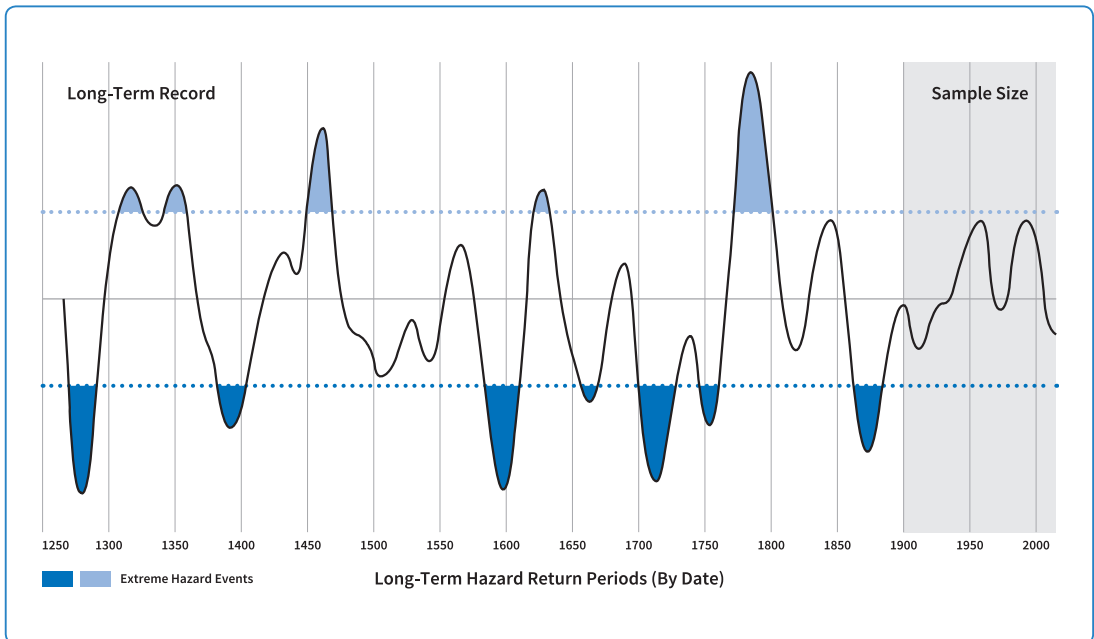
### 3.1 Accumulating contingent liabilities

While historical losses can explain the past, they do not necessarily provide a good guide to the future. Most disasters that could happen have not happened yet (UNISDR, 2013a). Probabilistic risk assessment simulates those future disasters which, based on scientific evidence, are likely to occur. As a result, these risk assessments resolve the problem posed by the limits of historical data. Even if a full century of historical data exists on extreme flooding and drought events in a country, any model derived from that data would not be able to forecast the previous extremes that had occurred over the past 1,000 years (Figure 3.1).

Probabilistic models therefore “complete” historical records by reproducing the physics of the phenomena and recreating the intensity of a large number of synthetic events. As such, they provide a more complete picture of the full spectrum of future risks than is possible with historical data. While the scientific data and knowledge used is still incomplete, provided that their inherent uncertainty is recognized, these models can provide guidance on the likely “order of magnitude” of risks.

The results of probabilistic risk models are normally presented in terms of metrics such as average annual loss (AAL). The AAL is the average expected loss annualized over a long time frame.

Figure 3.1 The small sample size of hazard records



(Source: GFDRR, 2014.)

It represents the amount that countries would have to set aside each year to cover the cost of future disasters in the absence of insurance or other disaster risk financing mechanisms.

Disaster risk should be understood as a contingent liability (described as “another category of toxic assets” in GAR13). If a country ignores disaster risk and allows risk to accumulate, it is in effect undermining its own future potential for social and economic development. However, if a country invests in disaster risk reduction, over time it can reduce the potential losses it faces, thus freeing up critical resources for development.

Global average annual loss (AAL) in the built environment associated with tropical cyclones (wind and storm surge), earthquakes, tsunamis and floods is now estimated at almost US\$314 billion.<sup>1</sup> This is the amount of money that should be set aside each year worldwide to cover the future disaster losses associated with these hazards.

If this risk were shared equally amongst the world’s population, it would be equivalent to an annual loss of almost US\$70 for each individual person of working age,<sup>2</sup> or two months’ income for people living below the poverty line.<sup>3</sup> This represents an existential risk for people already struggling for survival on a daily basis.

For higher-income groups, these losses are not existential, yet they can be compared with other ways in which household disposable income can be lost. For example, in the United States of America, electricity prices were increased by US\$0.24 per kilowatt-hour in 2011, meaning that monthly household bills increased by an average of US\$24 per year.<sup>4</sup> If the risk were shared out equally among the world’s population, and assuming an average household size of 3 people,<sup>5</sup> each household should be setting aside US\$210 a year to cover potential disaster losses—around nine times the reduction of household disposable income from rising electricity costs.

At a macroeconomic level, global AAL is almost equivalent to the entire GDP of high-income economies such as New Zealand or Kuwait, or ten times the gross national income of Niger.<sup>6</sup> It is also significantly higher than the cost of non-conflict armed violence,<sup>7</sup> which is currently estimated at US\$95 billion to US\$163 billion (Geneva Declaration, no date). Global AAL also corresponds to more than the estimated total cost of armed conflict on the African continent since 1990 (IANSAs et al., 2007) and almost 40 times the value of international investments to fight HIV/AIDS in 2013 (UNAIDS, 2014). It is significantly higher than the total investment in water and sanitation in either China or India. Even more critically, it is almost equivalent to the estimated annual global financing that will be required in areas such as transport infrastructure or education in order to meet the Sustainable Development Goals (SDGs) (UNCTAD, 2014). Unless addressed, the contingent liability represented by disaster risk will therefore threaten the achievement of the SDGs.

The AAL has been calculated as part of the new Global Risk Assessment, the first of its kind to provide worldwide coverage for multiple hazards. While an increasing number of risk assessments are now being produced for specific hazards and portfolios of exposed assets, up to now it has been difficult to estimate global disaster risk due to major geographical gaps and the fact that global assessments for single hazards use different data sets and methodology.<sup>8</sup> By using the same methodology, arithmetic and exposure model to calculate the risk for all hazards, the new global assessment (Box 3.1) enables comparisons of risk levels between countries and regions and across hazard types. In this way, it enables a better mapping and understanding of the global risk landscape, an estimation of the order of magnitude of losses in each country, and a calculation of the risk contributions from different hazards.

The global AAL data illustrates how disaster risk is distributed across countries, income groups,



Since 2011, UNISDR has spearheaded a multi-hazard Global Risk Assessment in partnership with leading scientific and technical organizations.<sup>9</sup> The objective is to provide comparable open-access disaster risk metrics across countries and hazard categories with a relatively coarse resolution as a means of raising risk awareness.

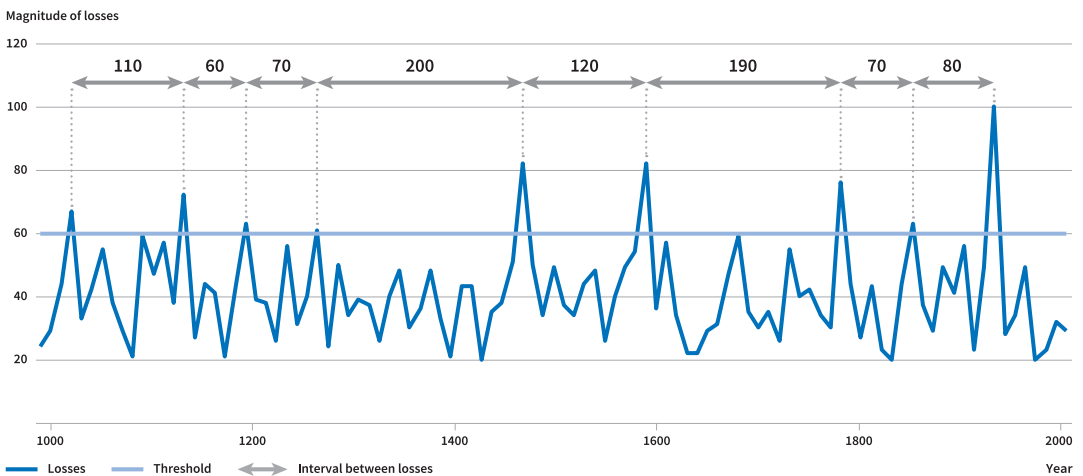
This fills a major gap in understanding risk. Most probabilistic risk assessments have been developed commercially for the insurance industry and cover specific risks, mainly in higher-income countries. However, they are rarely accessible and are based on proprietary models. While more and more public-domain risk models are now being developed, the use of different methodologies and data sets makes comparison difficult.

In the UNISDR-led assessment, probabilistic hazard models have been developed for earthquake, tropical cyclone wind and storm surge, tsunami and river flooding worldwide, for volcanic ash in the Asia-Pacific region and for drought in parts of Africa. A global exposure model for the built environment has been developed at a 1kmx1km resolution along coastlines and 5kmx5km elsewhere. Appropriate vulnerability functions have been used on the basis of expert knowledge in each region. The impact of climate change on wind hazard in the Caribbean and on drought in Africa has also been modelled. The open-source multi-hazard risk platform CAPRA<sup>10</sup> is used to calculate risk. At this point, the flood risk model is still being finalized, meaning that the estimates of flood risk presented in this chapter should be considered provisional and are likely to change.

The principal metric from the global assessment used in this report is average annual loss (AAL), also known as the pure risk premium (when normalized by exposed value or capital stock). This is the expected average loss per year considering all the events that could occur over a long time frame. It is a compact metric with a low sensitivity to uncertainty. Unlike historical estimates, AAL takes into account all the disasters that could occur in the future, including very intensive losses over long return periods, and thus overcomes the limitations associated with estimates derived from historical disaster loss data.

The other metric presented is probable maximum loss (PML), which represents the maximum loss that could be expected within a given period of time. Typically, PML is relevant to determine the size of reserves that, for example, insurance companies or a government should have available to buffer losses.

Figure 3.2 Return periods



(Source: UNISDR.)

Probability refers to the frequency of occurrence or the return period of losses associated with hazardous events. The concept of *return period* is often misunderstood. If a loss has a 500-year return period, this does not mean that the loss occurs every 500 years. If the loss occurred today, it does not mean that it will not recur for another 500 years. What it really means is that on **average** it occurs once every 500 years. For example, if there were records of losses of different intensities over 1,000 years (Figure 3.2), it can be seen that nine losses exceeded an intensity of 60 over that period. The intervals between these losses fluctuate between 60 and 200 years. However, losses of an intensity of 60 were exceeded every 100 years on average, and that is the *return period*. Expressed in a different way, the annual probability of a loss exceeding an intensity of 60 is 0.1 per cent.

The PML for different return periods can therefore be expressed as the probability of a given loss amount being exceeded over different periods of time (Table 3.1). Thus, even in the case of a thousand-year return period, there is still a 5 per cent probability of a PML being exceeded over a 50-year time frame. This metric is relevant, for example, to the planners and designers of infrastructure projects, where investments may be made for an expected lifespan of 50 years.

In the development of risk models, many different data sets are used as input components. The level of uncertainty is directly linked to the quality of the input data. On many occasions during model development, expert judgment and proxies are used in the absence of empirical data, and the results are very sensitive to most of these assumptions and variations in input data. As such, all the AAL and PML figures presented in this chapter should be considered indicators of the order of magnitude of the risks, not as exact values.

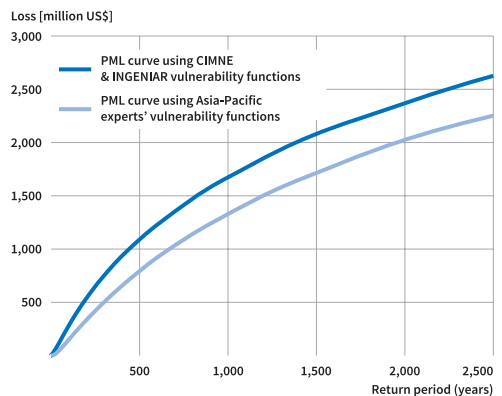
For example, PML curves developed with the same hazard and exposure models change when different vulnerability functions are used, although the order of magnitude remains the same (Figure 3.3). Better data quality and advances in science and modelling methodologies reduce the level of uncertainty, but it is crucial to interpret the results of any risk assessment against the backdrop of unavoidable uncertainty.

**Table 3.1** Probabilities for different return periods

Return Period PML	Probability of loss exceedance per year	Probability of loss exceedance in 20-year time frame	Probability of loss exceedance in 50-year time frame
25	4%	56%	87%
50	2%	33%	64%
100	1%	18%	39%
250	0.40%	8%	18%
500	0.20%	4%	10%
1,000	0.10%	2%	5%

(Source: UNISDR.)

**Figure 3.3** Sensitivity of results to input data



(Source: CIMNE-INGENIAR, 2014.)



geographical regions and hazard types. As such, it is appropriate for ranking and comparing country risk levels. However, given the limitations arising from its global resolution and lack of granularity, it is not appropriate for the development of detailed national or local disaster risk management strategies, including risk financing schemes. However, it can be used by governments to provide an initial risk profile for a country, which should in turn motivate the development of detailed assessments in specific sectors and territories as a basis for public and private investment strategies and for the design of risk financing schemes. The global AAL is extremely conservative for three reasons.

First, it does not include all hazards and relevant sectors. It only represents direct physical risk to residential and commercial buildings, schools, hospitals and other public and industrial buildings. It does not include risks to infrastructure such as roads and bridges, ports and airports, energy and electrical facilities, telecommunication facilities, dams and mines, or to agriculture. At the same time, it only includes a number of potential global hazards. If the risk of extra-tropical windstorms, ice and snow, sandstorms and tornadoes were also taken into account, the figure would again be significantly higher.

Second, extensive risk, associated with small-scale, high frequency localised events is not considered. The analysis of 85 national disaster loss data sets presented in Chapter 4 show that this risk layer may account for up to 40 per cent of economic losses, particularly in low and middle income countries.

Third, AAL does not consider indirect losses and impacts. While it is difficult to calculate a global value, evidence from specific countries shows that these indirect losses can surpass the direct costs, particularly if economic resilience is low. When compared to reference income without a disaster, impacts from large disasters can lead to

income (GDP) reductions of up to 20 per cent over a number of years following a devastating event. A much-cited example of this effect is the impact of Hurricane Mitch in Honduras in 1998.

To give a perspective on how losses to the built environment from a disaster are only a share of total losses, direct losses to the built environment in the Haiti earthquake in 2010 represented 80 per cent of total direct losses and 47 per cent of combined direct and indirect losses (Government of the Republic of Haiti, 2010). In the case of the May 2014 floods in Serbia, the losses to the built environment were 54 per cent of total direct losses and only 31 per cent of combined direct and indirect losses, to which the agriculture sector contributed 8 per cent (Government of the Republic of Serbia, 2014).

## 3.2 Capital investment and social expenditure challenged

---

**In absolute terms, global AAL is concentrated in large, higher-income, hazard-exposed economies. However, in relation to annual capital investment or social expenditure, many low and middle-income countries, and in particular small island developing states (SIDS), have the highest concentrations of risk.**

Disaster risk is not evenly distributed around the earth, but reflects the social construction of hazard, exposure and vulnerability in different countries in the context of different risk drivers (UNISDR, 2009a). Globally, the distribution of AAL reflects the value and vulnerability of the capital stock concentrated on cyclone or tsunami-prone coastlines, along seismic fault lines or in flood-prone river basins.

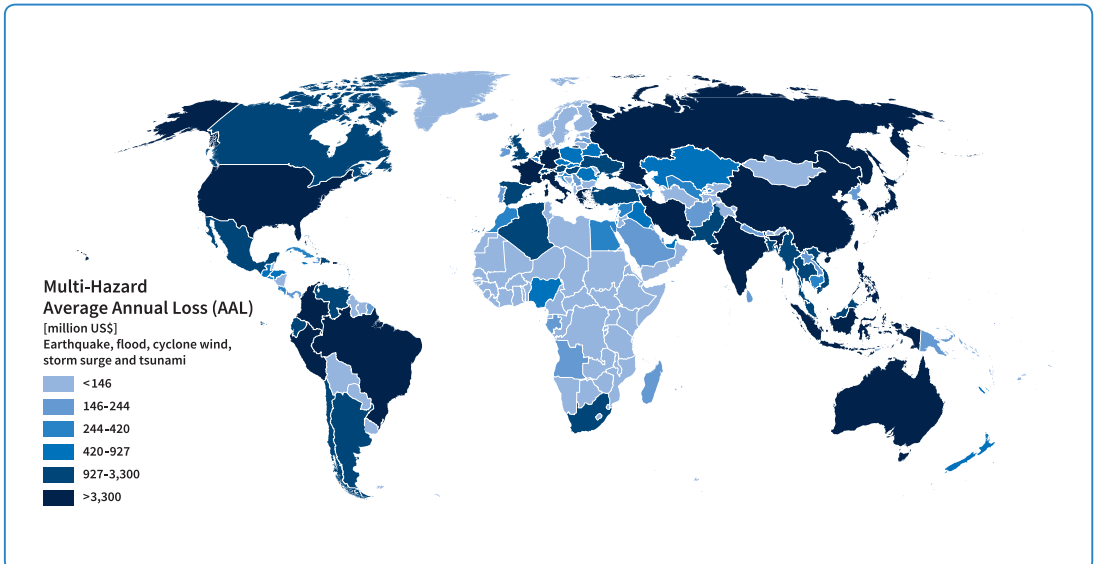
In absolute terms, global AAL is concentrated in large, higher-income, hazard-exposed economies, such as Japan and the United States of America (Figure 3.4). However, the disproportionately

high risk of lower-income countries relative to the size of their economies or the value of their capital stock has been repeatedly recognized (UNISDR, 2009a, 2011a, 2013a). In relation to annual capital investment, for example, many low and

middle-income countries, and in particular small island developing states (SIDS), have the highest concentrations of risk (Figure 3.5).

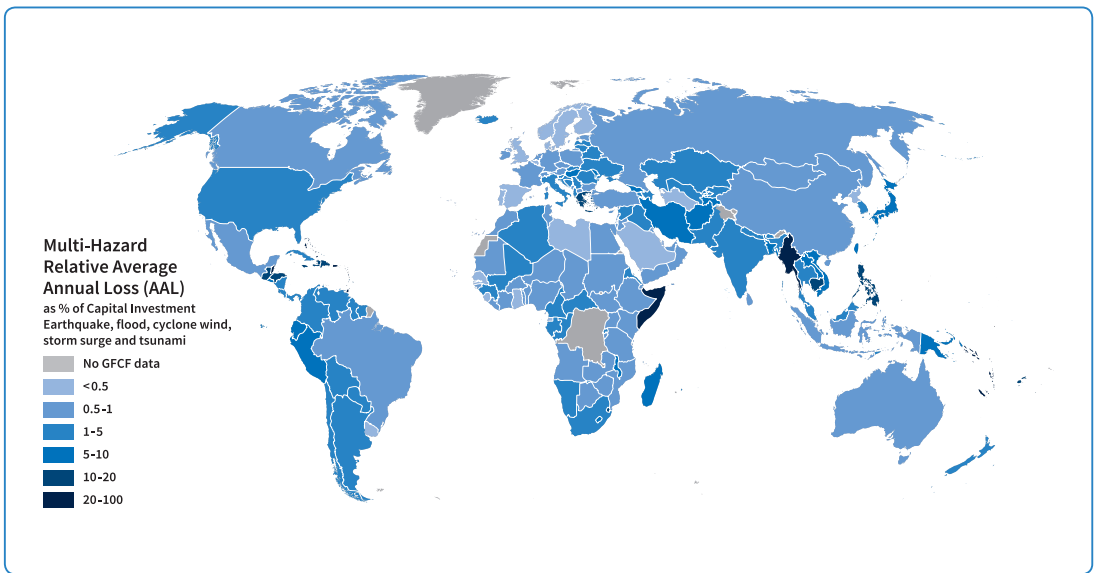
**Multi-hazard AAL** 

**Figure 3.4** Global multi-hazard average annual loss



(Source: UNISDR with data from Global Risk Assessment.)

**Figure 3.5** Global multi-hazard average annual loss in relation to capital investment<sup>11</sup>



(Source: UNISDR with data from the Global Risk Assessment and the World Bank.)

The level of disaster risk in a country is therefore influenced not only by the absolute AAL but also by the way in which disaster risk could undermine the capacity for capital investment and social expenditure.

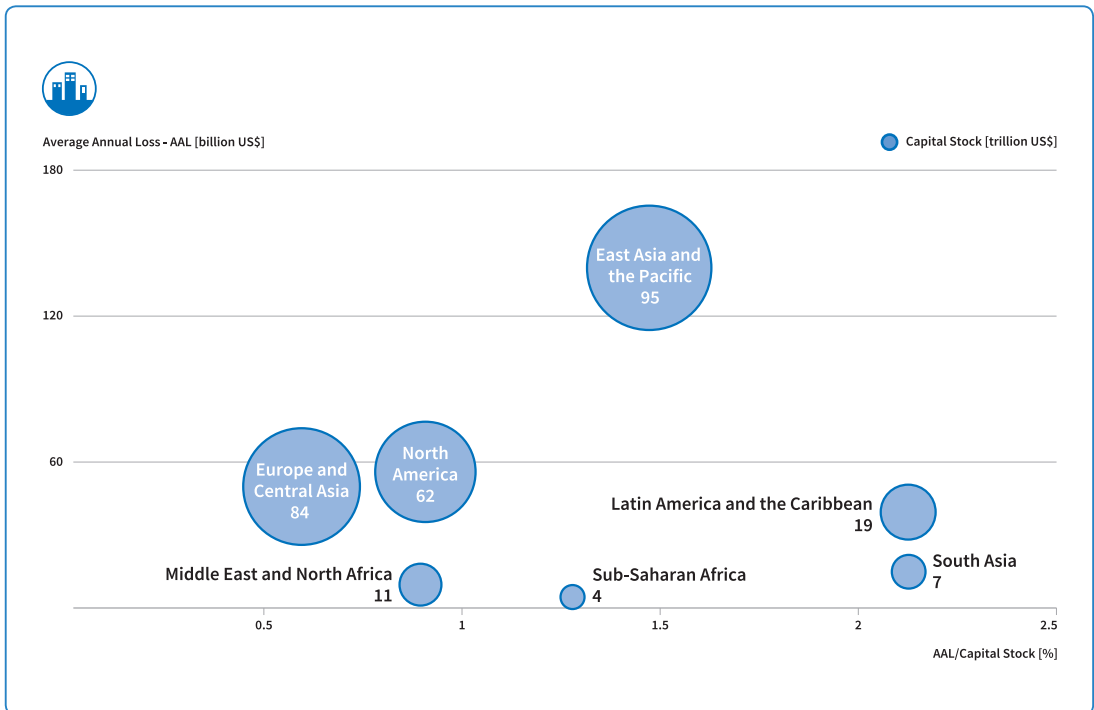
The value of the world’s capital stock<sup>12</sup> is heavily concentrated in regions like East Asia and the Pacific, Europe and Central Asia, and North America.<sup>13</sup> However, in relative terms, Latin America and the Caribbean would be expected to lose four times more of their assets each year compared to Europe and Central Asia and two times more compared to North American countries (Figure 3.6).<sup>14</sup>

When comparing different income groups, the AAL of high-income countries is around 25 times that of low-income countries. In relation to their capital stock, however, low-income countries could be expected to lose around five times more than high-income countries (Figure 3.7).

The relationship between AAL and capital stock is key to assessing the need for corrective disaster risk management, in other words investments to protect or to retrofit existing disaster-prone building stock. Countries with a very high ratio of AAL to capital stock in particular would need to invest in corrective risk management to avoid losing essential development assets. This is especially critical in countries which exhibit sluggish growth and low levels of capital investment and which would be challenged to replace capital stock lost in disasters.

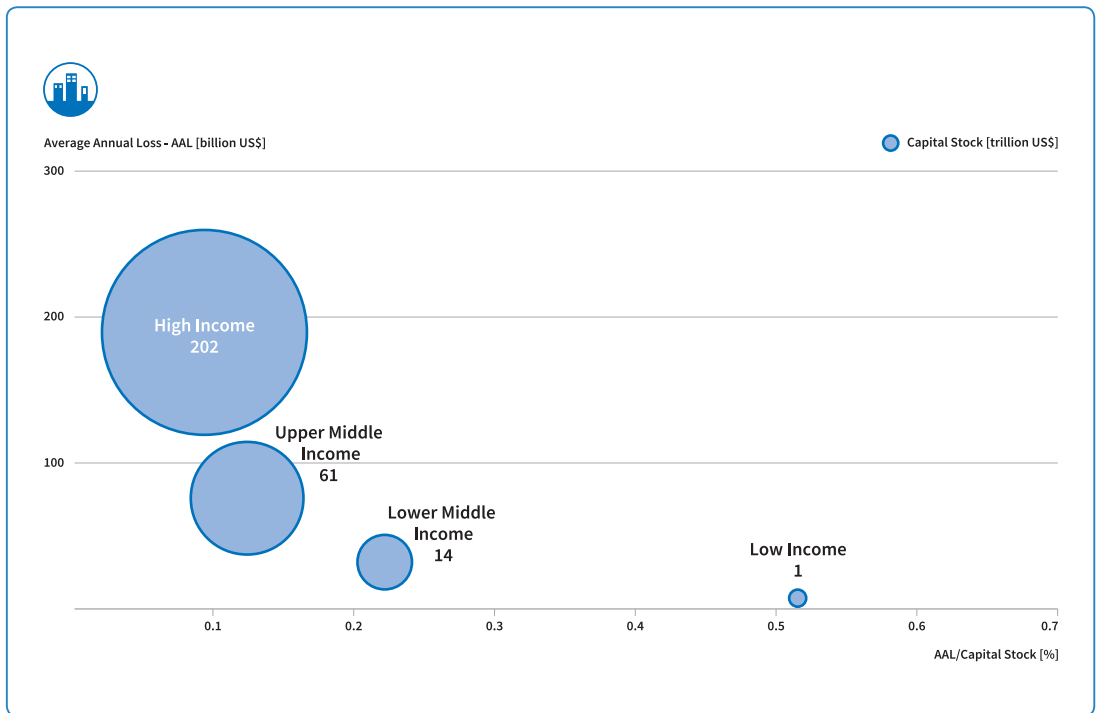
Countries also need to consider the relationship between AAL and capital investment (gross fixed capital formation, or GFCF). In general, low-income countries have less capacity for capital investment than high-income countries. However, disaster risk may represent a far higher proportion of that investment in low-income countries, challenging their potential for economic development.

**Figure 3.6** Multi-hazard average annual loss in relation to capital stock by geographical region



(Source: UNISDR with data from the Global Risk Assessment and the World Bank.)

**Figure 3.7** Multi-hazard average annual loss in relation to capital stock by income group



(Source: GAR Global Risk Assessment.)

The level of capital investment as a proportion of existing capital stock is very different across income groups, as it accounts for some 30 per cent in low-income countries compared to only 10 per cent in upper middle-income and 5 per cent in high-income countries. Thus the new investments that low-income countries make on an annual basis represent a significant proportion of their total capital stock. A high ratio of AAL to capital investment represents a threat to future development prospects. Prospective risk management then takes on critical importance in order to ensure that new investment does not increase disaster risk.

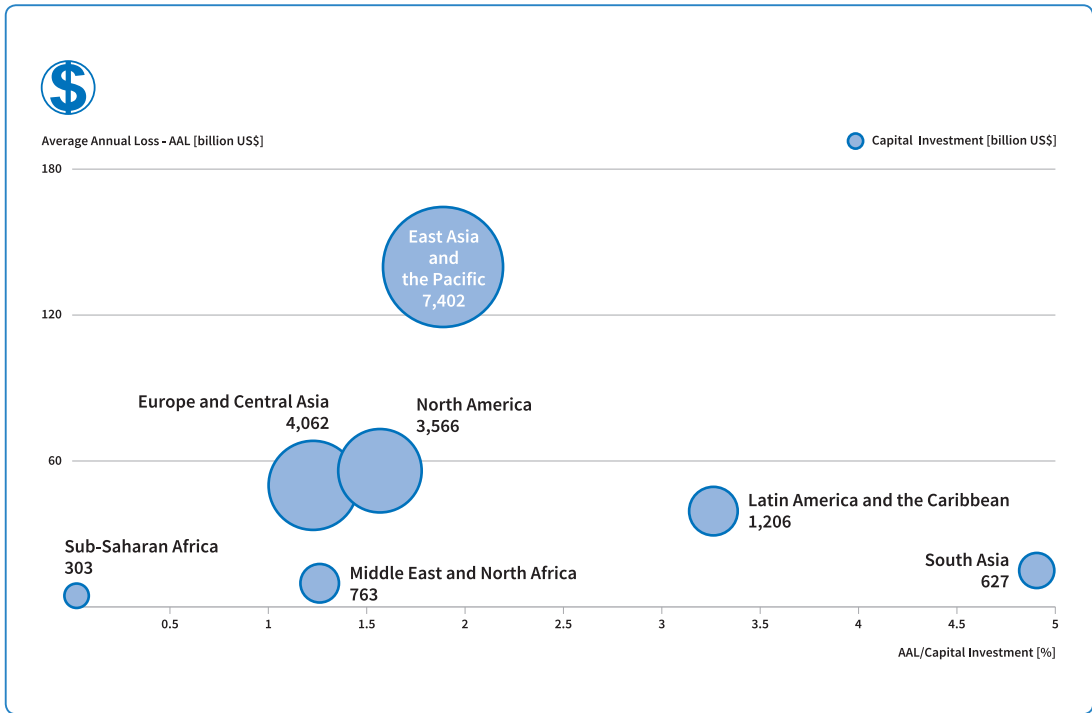
In terms of geographical regions, capital investment varies from 12 to 33 per cent of GDP,<sup>15</sup> and relative AAL varies significantly as a result. In South Asia, AAL is the equivalent of almost 5 per cent of annual capital investment, compared to only 1.23 per cent in Europe and Central Asia (Figure 3.8).

The AAL in Europe and Central Asia represents a lower percentage of annual capital investment than that of East Asia and the Pacific. However, annual capital investment in Europe and Central Asia is currently little more than a quarter of that in East Asia and the Pacific. As mentioned above, this highlights the importance of investing in corrective disaster risk management in countries with sluggish or stagnating economies, as disaster risk can erode what little growth capacity there is.

In other regions, capital investment is also exposed to significant risk. Annual capital investment in Latin America and the Caribbean is currently less than a third of that in East Asia and the Pacific; however, the AAL is equivalent to more than 3 per cent of that investment, compared to 1.89 per cent in East Asia and the Pacific. This acts as a significant brake on future development.



**Figure 3.8** Multi-hazard average annual loss in relation to capital investment by geographical region



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

In terms of income groups, annual capital investment is around 10 times greater in high-income countries than in lower middle-income countries. However, relative to capital investment, the AAL of these regions is comparable, indicating that lower middle-income countries will be more challenged to achieve their development goals (Figure 3.9).

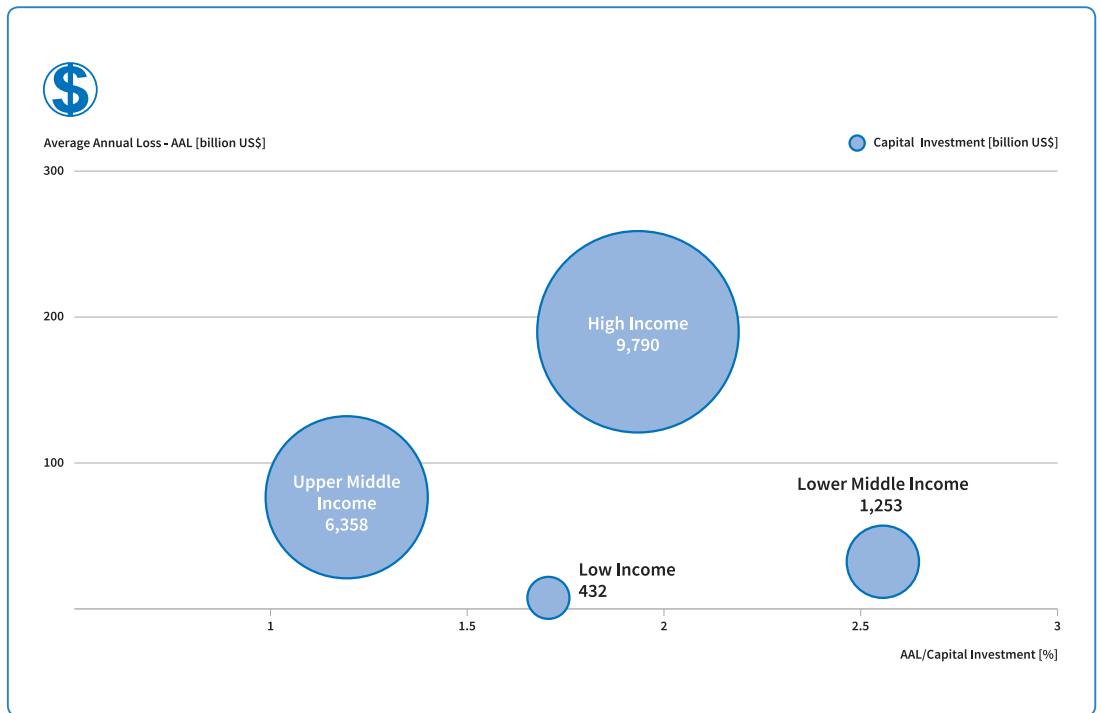
In such circumstances, it is impossible to achieve sustained, let alone sustainable, growth. For example, in Asia, Myanmar’s AAL represents 30 per cent of its annual capital investment and in the Philippines and Cambodia 14 per cent and 10 per cent respectively. In Latin America, for Honduras and Guatemala the AAL represents almost 18 per cent and around 10 per cent of new capital investment, respectively.

Disaster risk also challenges social development. While social expenditure in absolute terms is

lowest in South Asia, the region’s AAL is equivalent to more than 10 per cent of that expenditure. Disaster risk thus threatens the capacity for social expenditure precisely in those countries with the least capacity and the greatest need to invest. For example, social expenditure in sub-Saharan Africa is little more than 1 per cent of that in East Asia and the Pacific, or around 3 per cent of that in Latin America and the Caribbean. However, the AAL in sub-Saharan Africa is equivalent to almost 3 per cent of this limited investment.

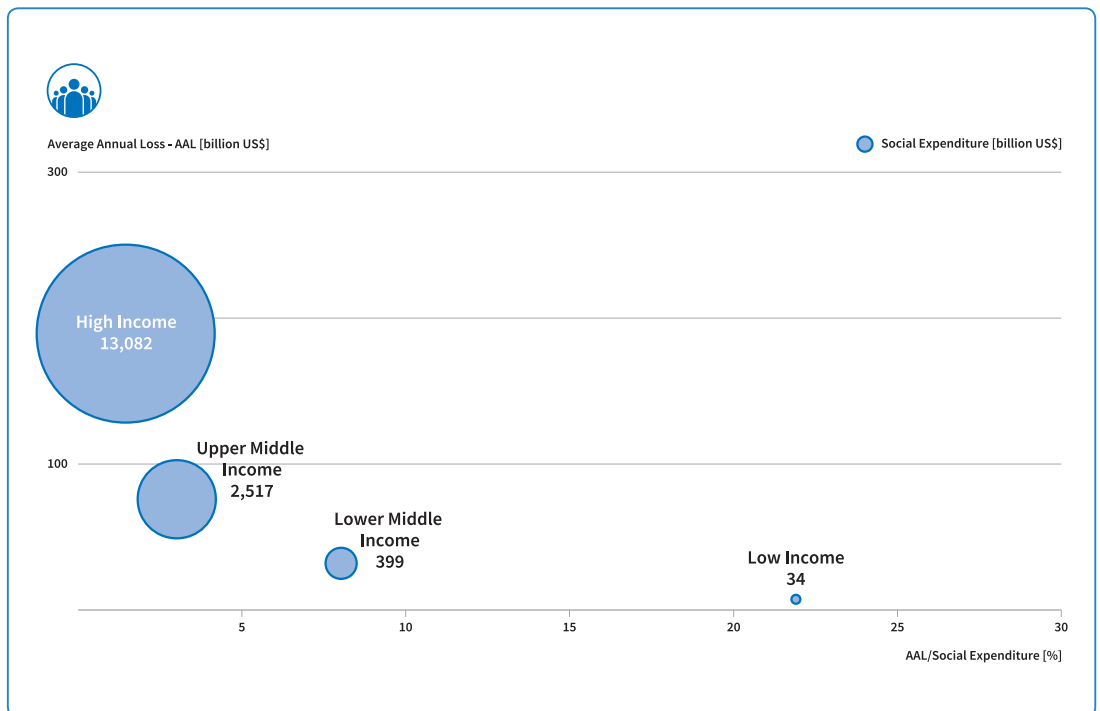
Similarly, while annual social expenditure is about 400 times greater in high-income countries than in low-income countries, the AAL in low-income countries is equivalent to about 22 per cent of social expenditure, compared to only 1.45 per cent in high-income countries (Figure 3.10). Given that spending on social protection, public health and public education investment is critical to the Sustainable Development Goals, this

**Figure 3.9** Multi-hazard average annual loss in relation to capital investment by income group



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

**Figure 3.10** Multi-hazard average annual loss in relation to social expenditure by income group



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)



**Figure 3.11** Top 15 countries: Multi-hazard average annual loss in relation to social expenditure (excluding SIDS)



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

again highlights that those objectives cannot be achieved unless disaster risk is addressed.

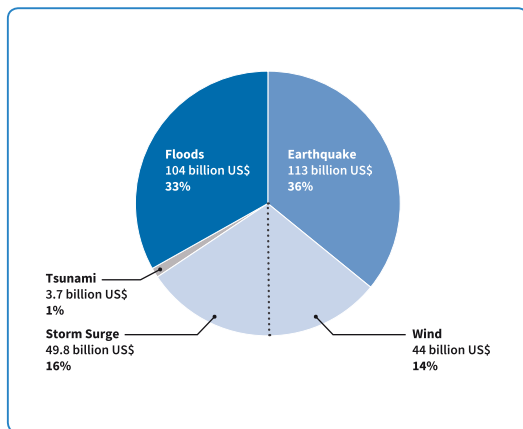
A number of larger countries like Myanmar, Madagascar, Philippines and Honduras face particularly difficult challenges in this regard, as the AAL represents almost 55 per cent of social expenditure in Honduras, nearly 69 per cent in the Philippines, more than 80 per cent in Madagascar and 200 per cent in Myanmar (Figure 3.11). In Latin American countries like Ecuador, Guatemala and Peru, the AAL represents over 15 per cent of annual social expenditure.

### 3.3 Hazard-specific risk profiles

**Different hazards can be seen to represent different risk layers and are therefore associated with various levels of frequency and impact. It is important to understand the implications of these different hazards and the way that they interrelate with drivers of vulnerability and exposure to create specific patterns of risk.**

The AAL figures used for these estimates aggregate the expected annual losses from different hazards (Figure 3.12), which in turn represent different risk layers. For example, tsunamis are usually associated with very low-frequency but high-severity impacts, while tropical cyclones have a much higher frequency and usually medium to high severity of impact. Earthquakes are lower-frequency events that can cause greater losses, i.e. generate significant damage across large areas of a country, while floods are more

**Figure 3.12** Contribution of each hazard to global AAL



(Source: UNISDR with data from Global Risk Assessment.)

regular occurrences. In contrast, tsunamis usually affect only a relatively small area beyond the coastline. These differences in frequency and spatial extent determine how the different hazards contribute to global AAL. For example, even though it contributes only 0.29 per cent to global AAL, tsunami risk may have devastating local impacts when it does occur, as the events in the Indian Ocean in 2004 and Japan in 2011 highlighted.

### Earthquakes

Earthquakes occur infrequently but can correlate with high losses across large regions. In Japan and on the Pacific coasts of the United States of America and Chile, earthquake risks are explained by major concentrations of exposed assets in areas of high seismicity. However, the vulnerability of building stock is low thanks to good construction standards, a long history of earthquakes, and strong governance. In low and middle-income countries, such as Bangladesh, China, the Dominican Republic, El Salvador, Iran, Nepal and the Philippines, the vulnerability of the building stock makes a far greater contribution to risk.

Seismic hazard depends on the magnitudes and locations of likely earthquakes, on their

frequency and on the properties of the rocks and sediments that earthquake waves travel through. Tectonic earthquakes can occur anywhere where an active fault exists, and the magnitude depends on the area of the fault that ruptures. Although earthquakes cannot be predicted, scientific analysis can provide information on the potential frequency and magnitude of events. Earthquakes can also trigger secondary hazards associated with landslides, liquefaction and tsunamis.

Earthquake risk contributes US\$113 billion to global AAL. To put this figure into perspective, it is equivalent to annual public education expenditure in all of the Middle East and North Africa, or 50 per cent of public health expenditure in Latin America and the Caribbean.

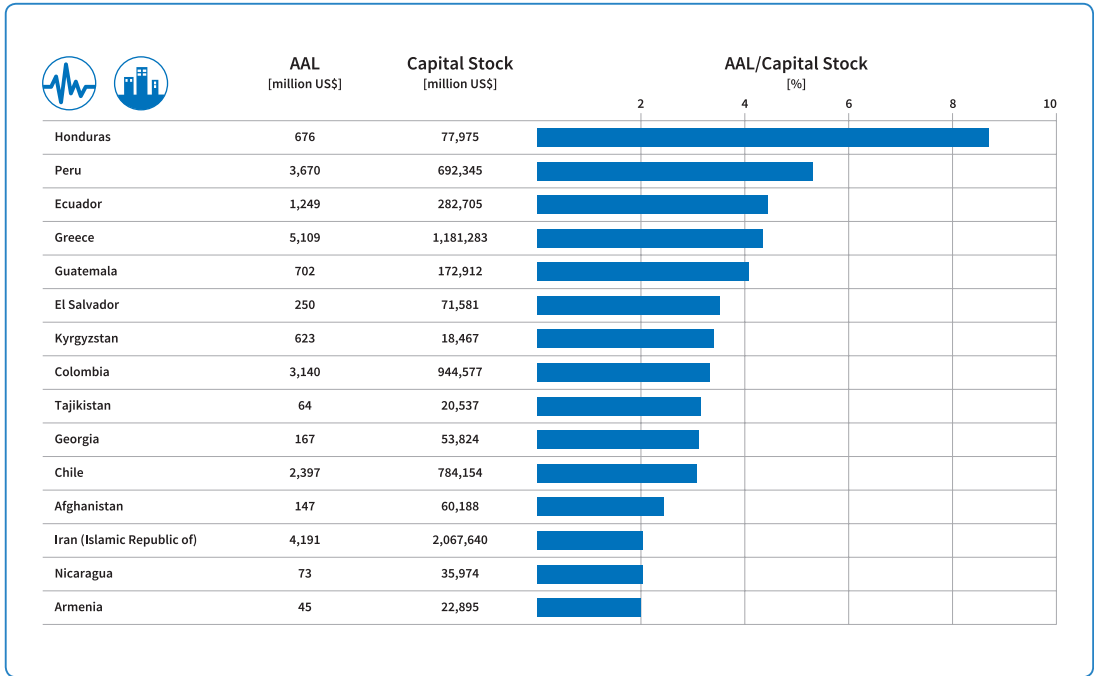
The countries with the highest absolute AAL values are the United States of America, Japan and Italy. However, relative to both capital stock and investment, the risk is significantly higher in low and middle-income countries (Figure 3.13).

In terms of geographical regions, the highest relative risks can be found in Latin America and the Caribbean and in the Middle East and North Africa. The earthquake AAL in these regions is equivalent to 1.6 per cent and 1 per cent of their capital investment, respectively, compared to 0.6 per cent in Europe and Central Asia and 0.4 per cent in North America.<sup>16</sup> These are regions where the exposed building stock is growing in contexts that may exhibit relatively weak regulatory quality and where prospective disaster risk management is critical to avoiding future disaster risk accumulation. Middle-income countries such as Honduras, Guatemala, Peru and Tajikistan all have a high ratio of AAL to capital investment.

Earthquake risk has also become a critical problem for countries that have experienced a severe economic downturn and where capital investment has dried up. For example, Greece's annual capital investment now amounts to only around



**Figure 3.13** Top 15 countries: Earthquake AAL in relation to capital stock (excluding SIDS)

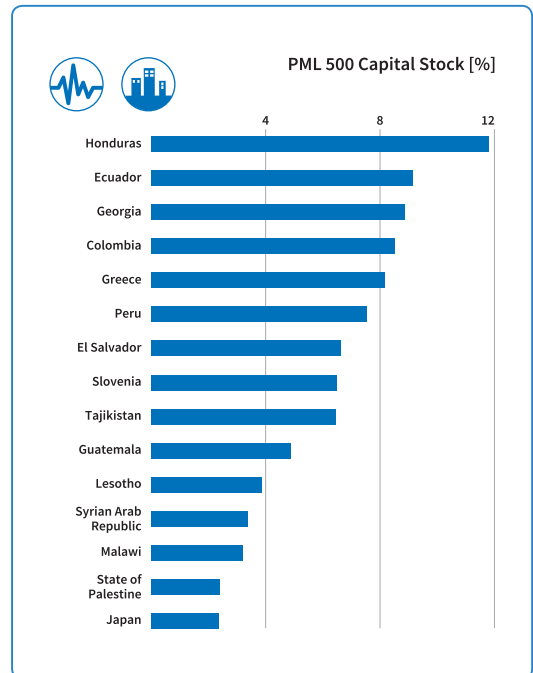


(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

2.5 per cent of its building stock. This investment is now just over half of that observed in upper middle-income countries such as Peru. As a result, Greece’s earthquake AAL has come to represent 10 per cent of its annual capital investment.

In terms of PML, over a 20-year period there is a 4 per cent probability of a loss equivalent to the value of more than 8 per cent of Greece’s capital stock (Figure 3.14) and over 300 per cent of the country’s annual capital investment. The country’s AAL is also equivalent to almost 2.5 per cent of its national income (GNI). It is unclear whether this contingent liability was taken into account when the international community provided over EUR 200 billion in loans to support the Greek economy between 2010 and 2012. In reality, earthquake risk could spill over into the financial system and become increasingly systemic.

**Figure 3.14** Top 15 countries: Earthquake PML500 in relation to capital stock (excluding SIDS)



(Source: UNISDR with data from Global Risk Assessment.)

Figure 3.14 shows the 15 countries (excluding SIDS) where the highest proportion of capital stock could be lost with a probability of 10 per cent over a fifty-year period (500-year PML). As can be seen, these potential losses are important, representing between 2 and 12 per cent of the total capital stock for these countries.

These losses are equivalent to 800 per cent of annual capital investment in Trinidad and Tobago, 100 per cent of annual capital investment in Peru and 90 per cent in Japan. To avoid systemic risk, it is important to factor contingent liabilities into international loans and other financial instruments.

**Cyclone risk profiles** 

**Tropical cyclones**

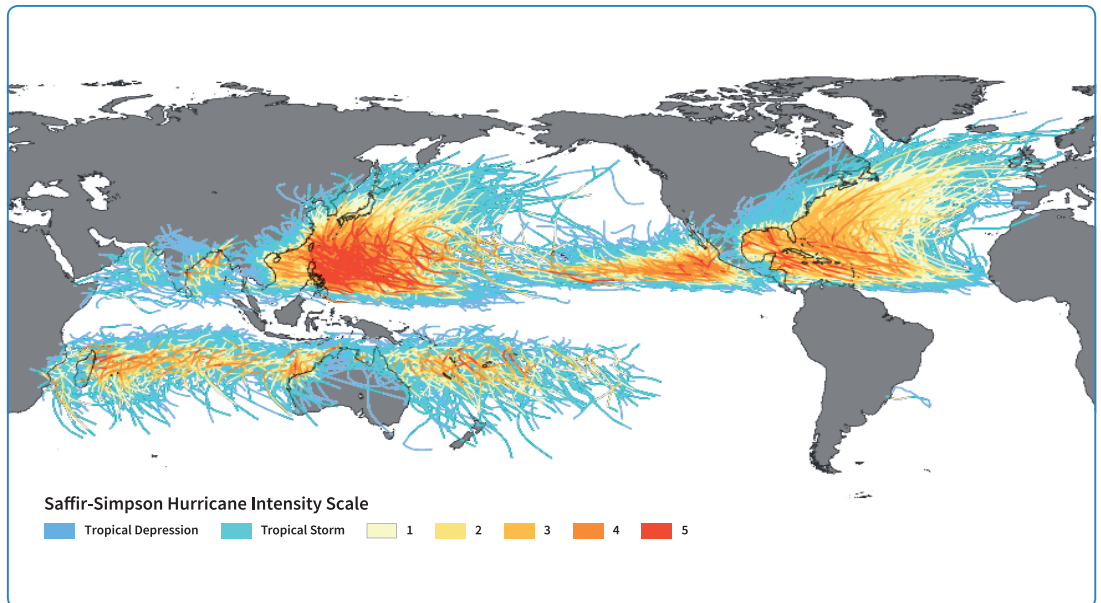
Global average annual loss from recurrent cyclone winds and storm surge is estimated at US\$80 billion, which is equivalent to 1.4 times the total public health expenditure in Africa or 85 per cent of public education expenditure in Australia and New Zealand combined.

The physical intensity of tropical cyclones is determined by their wind speeds, which affect both coastal and inland areas. Historically, the highest concentration of cyclonic wind has been in the Western Pacific (Figure 3.15). The weakest storms take place near the equator, in their first stages of development; over land, as they run out of energy; and in the mid-latitudes due to the cooler temperature of the water.<sup>17</sup> Given the concentration of economic assets and population along the coasts in many countries, risk is heavily influenced by exposure. However, in low and middle-income countries the vulnerability of building stock is an important risk factor which increases in weight in the case of low-intensity cyclones (UNISDR, 2011a).

Strong winds and low air pressure in the eye of the storm may also cause storm surges up to 10 metres high. In contrast to wind, storm surge can only contribute to significant damage along the coast, depending on the slope of the seabed in the area where the cyclone makes landfall

**Cyclone tracks** 

**Figure 3.15** Worldwide historical tropical cyclone tracks



(Source: NASA.<sup>18</sup>)



(Graham and Riebeek, 2006<sup>19</sup>). Storm surges can be severely destructive, and losses are highly dependent on exposure, especially in areas without coastal protection works.

As in the case of earthquakes, the absolute AAL from tropical cyclones (wind and storm surge) is concentrated in large countries like Japan and the United States of America, which have a large stock of exposed capital (Figure 3.16). However, this is equivalent to only 1 and 2 per cent (respectively) of their capital investment. In contrast, while the AAL in the Philippines is less than a quarter of that of the United States of America, it is equivalent to almost 12 per cent of the former's capital investment. With the exception of SIDS, the Philippines and Madagascar are the countries with the largest proportion of their capital investment at risk, again highlighting the importance of prospective disaster risk management.

Accurate estimates of storm surge risk require detailed data on exposure and the morphology of the seabed. As such, detailed risk assessments are necessary in areas prone to storm surges, such as Belize City (Box 3.2).

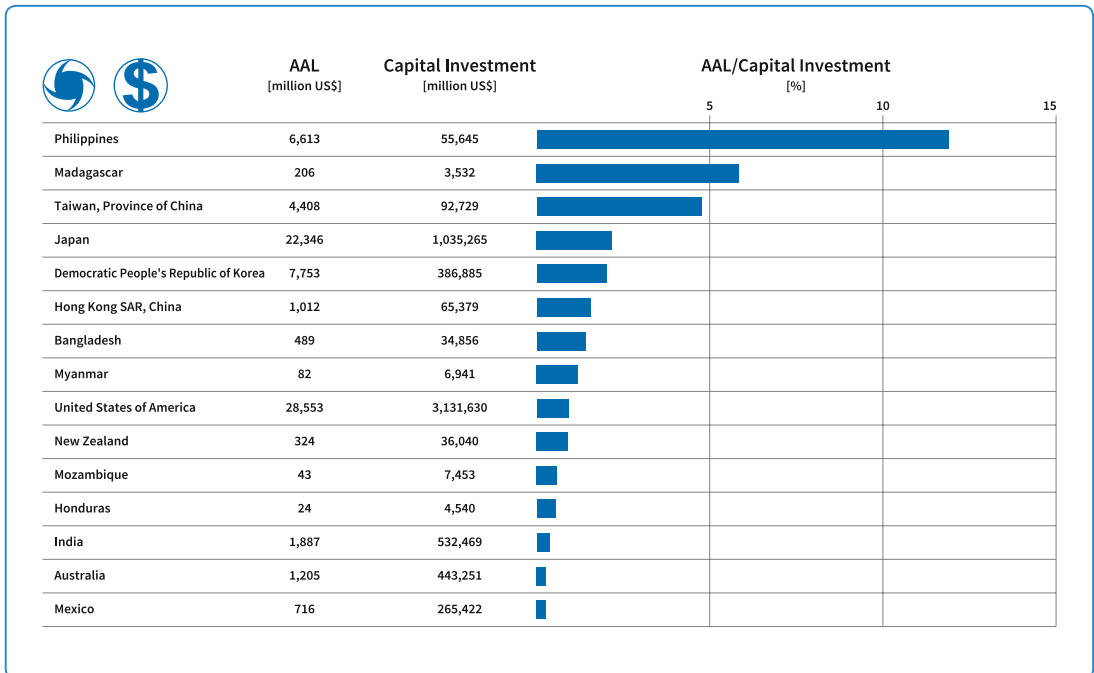
**Tsunami risk profiles** 

**Tsunami**

The global AAL for tsunamis is estimated at US\$530 million. This figure is significantly lower than that associated with other hazards due to the fact that tsunami impacts are very localized along coasts and that while tsunamis are highly destructive, they are also highly infrequent.

More than 80 per cent of tsunami events are caused by earthquakes. However, other phenomena such as submarine and sub aerial landslides or volcanic eruptions can also produce or contribute to tsunami occurrence. For example, the 1998 Papua New Guinea tsunami, which killed 2,182 people (EM-DAT, 2014<sup>20</sup>), was caused by a

**Figure 3.16** Top 15 countries: Tropical cyclone AAL in relation to capital investment (excluding SIDS)



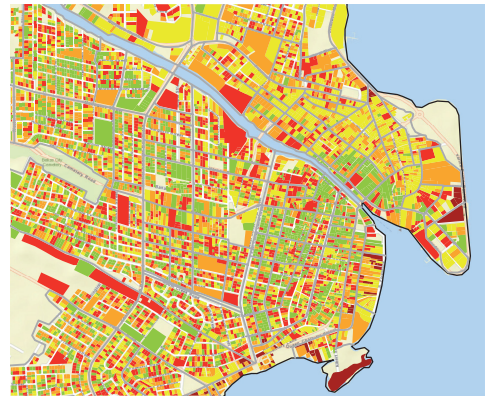
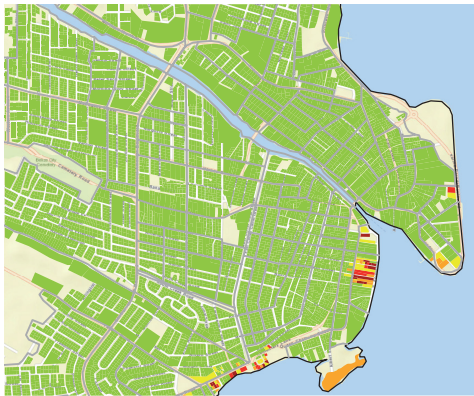
(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

**Box 3.2** Strong wind and storm surge risk in Belize City

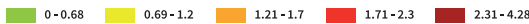
In the context of an assessment supported by the Inter-American Development Bank, tropical cyclone (hurricane) AAL in Belize City was estimated at US\$37 million (ERN-AL, 2010). Through the collection of detailed information on building classes, topography and bathymetry, it was possible to identify the areas at risk from both hurricane winds and storm surges.



In the case of storm surge (left-hand map) only low-elevation areas located within a certain distance from the shore are at risk, whereas wind hazard is distributed throughout the city (right-hand map). These results formed the basis for an emergency response plan devised by the National Emergency Management Organization (NEMO). In addition, training activities have been implemented with many institutions to evaluate the hazards and risk with a probabilistic approach.



Relative AAL [%]



Tropical cyclone risk from storm surge (AAL by building)

Tropical cyclone risk from strong wind (AAL by building)

The risks were evaluated on the basis of the current level of hazard as well as future scenarios of climate change.

Results		
Exposed Value	million US\$	1,280.48
Average Annual Loss	million US\$	37.36
	%	2.91
PML		
Return Period	Loss	
Years	million US\$	%
250	412.59	32.22%
500	461.10	36.01%
1,000	503.18	39.30%
1,500	545.25	42.58%

(Source: CIMNE-INGENIAR, 2014.)



submarine landslide, which itself was triggered by an earthquake. In areas like eastern Indonesia (Løvholt et al., 2012 and 2014) and the Caribbean (Harbitz et al., 2012), tsunamis due to landslides and volcanic eruptions are more frequent and contribute to a significant portion of the risk in those regions.

In the open ocean, the speed of tsunami waves may exceed 970 km/h. Once tsunamis make landfall, wave heights may reach 30 metres above sea level or more. The speed and the distance that tsunami waves travel inland depends on the topography of the coastal area and land cover.<sup>21</sup> The waves from the Tohoku tsunami of 2011 in Japan were as high as 10 metres and affected more than 400 km of coastline.<sup>22</sup>

Given that intense tsunamis completely destroy rather than damage physical assets in the proximity of the shore, tsunami risk is heavily influenced by exposure. This is reflected in the results

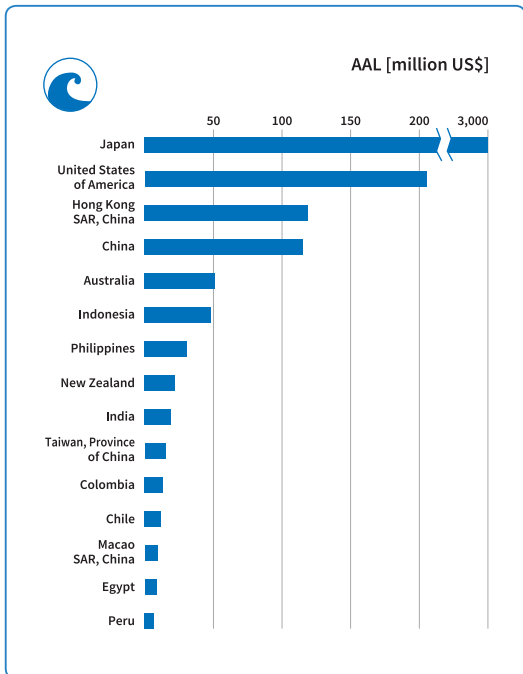
of the Global Risk Assessment, which show that tsunami risk is concentrated in a relatively small number of countries (Figure 3.17).

In terms of geographical regions, East Asia and the Pacific have the highest absolute tsunami AAL by far. Japan in particular has a far higher tsunami AAL than any other country.

As tsunami risk constitutes only a small portion of multi-hazard risk, it is not directly comparable to social expenditure or capital investment in either geographical regions or income groups.

However, the potential impact of tsunamis on the economy at the local, national, and even the global level cannot be ignored due to the cascading impacts that tsunamis can generate in countries where critical facilities such as nuclear power stations are located in coastal areas. This fact was highlighted by the Tohoku tsunami in 2011, which caused about US\$130 billion in damage to buildings and total of US\$210 billion in direct economic damage including infrastructure and the agriculture sector (GFDRR, 2012a). There is a 10 per cent probability that a number of territories and countries will lose a significant proportion of their capital stock to tsunami risk over a 50-year period (PML500). This includes territories such as Macao and Hong Kong, where capital stock is heavily concentrated along the coastline, as well as larger countries such as the Philippines or New Zealand (Figure 3.18).

**Figure 3.17** Top 15 countries: Tsunami AAL (excluding SIDS)

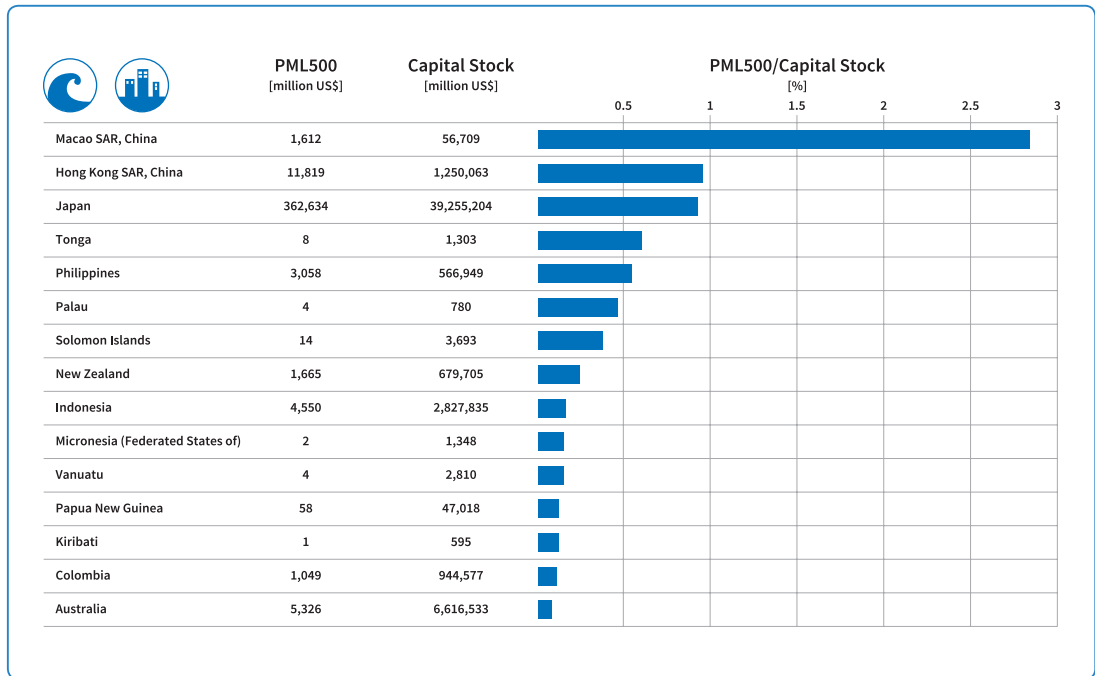


(Source: UNISDR with data from Global Risk Assessment.)

### River floods

Floods affect more people worldwide than any other hazard. There are many different manifestations of flooding, including flash floods, coastal flooding, surface water and ponding floods. In this analysis, flood risk<sup>23</sup> is calculated only considering river flooding, and the measure of intensity used is the depth of the water. For frequent small-scale floods, risks can be estimated statistically using historical data, but for major floods a probabilistic approach is required.

**Figure 3.18** Top 15 countries: Tsunami PML500 in relation to capital stock



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

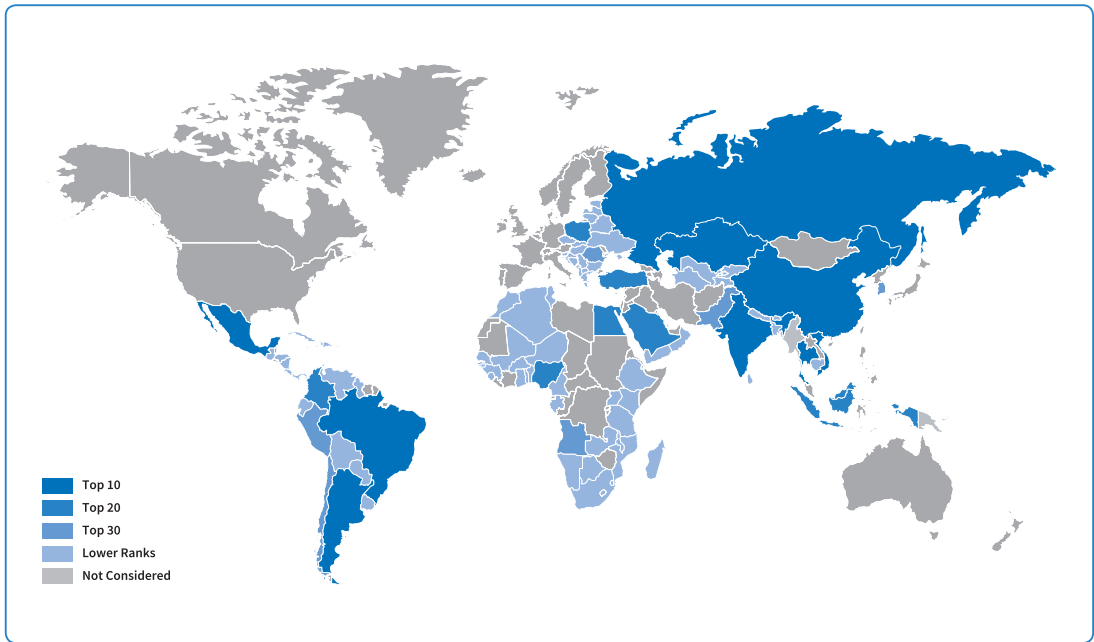
While flood risk should be managed through prospective measures such as land-use planning, the continued industrial, commercial and residential development on floodplains, together with climate change, has made flooding a very dynamic risk. Corrective measures such as flood defences can protect against losses up to a certain threshold, and countries like Japan and the Netherlands have made major investments in flood protection. However, flood defences may encourage further development on floodplains, leading to devastating consequences if a low-frequency but high-severity loss above the protection threshold were to occur. In contrast, flood risk in low-income countries often reflects a lack of capacity to invest in flood protection.

As the 2011 Chao Phraya River floods in Thailand demonstrated, flooding may produce major correlated losses that equal those arising from earthquakes or tropical cyclones. The Thailand floods

also revealed the risk to global supply chains when industries are concentrated on floodplains (UNISDR, 2013a; CEO Risk Forum, 2012). A recent analysis of “hidden hotspots” in emerging markets revealed that other countries in the world present an even greater flood loss potential than Thailand (Swiss Re, 2012): China tops the ranking, followed by Brazil, Russia and India (Figure 3.19).

Floods also cause major losses in high-income countries. While the average annual economic damage from floods in the United Kingdom, for example, is in the range of US\$250 million (Penning-Rowsell, 2014), the United Kingdom saw the second wettest year on record in 2012 (second only to 2007), with flood-related losses reaching approximately US\$1.8 billion. The RMS UK Inland Flood Model estimated that nearly half of the UK’s expected average annual flood loss comes from major river flooding, and the remainder is attributed to small river and stream flooding, flash

Figure 3.19 “Flood hot spot” rankings in emerging markets



(Source: Swiss Re, 2012.)

flooding, pluvial flooding and localized heavy precipitation (RMS, 2013). The UK government itself estimates that around 2.4 million properties are at risk of riverine and coastal flooding in any given year (National Audit Office, 2014).

Flood risk contributes US\$104 billion to global AAL. To put this figure into perspective, it is equivalent to twice the public health expenditure in the Middle East and North Africa or 30 per cent of annual public education expenditure in Latin America and the Caribbean.

The countries with the highest absolute AAL are China, the United States of America and India. However, in relation to their capital stock, a different set of countries in South-East Asia rank even higher, with Myanmar, Lao People’s Democratic Republic and Cambodia facing the highest relative AAL from riverine floods (Figure 3.20).

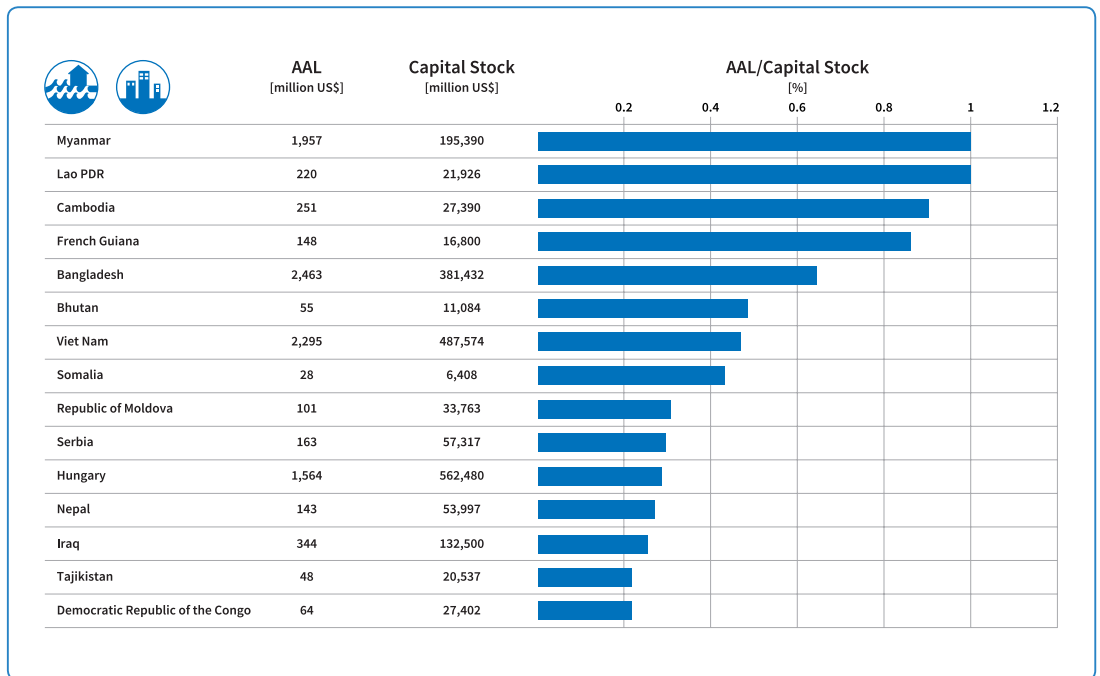
Relative to capital investment, many low-income and lower middle-income countries have high

levels of flood AAL in relation to their capital investment (Figure 3.21) because those countries have not had the capacity to make the same investments in flood defences as high-income countries. For example, the AAL for flooding in Myanmar and Somalia represents over 20 per cent of the countries’ capital investment. This highlights the importance of prospective risk management if new capital investment is to be protected.

The AAL from floods also represents an important proportion of social expenditure. Myanmar, for example, faces an AAL that is equivalent to around 200 per cent of its total social expenditure (Figure 3.22). Lao People’s Democratic Republic, Bangladesh, Cambodia and Bhutan are all challenged with AALs that represent around a third of their social expenditure.

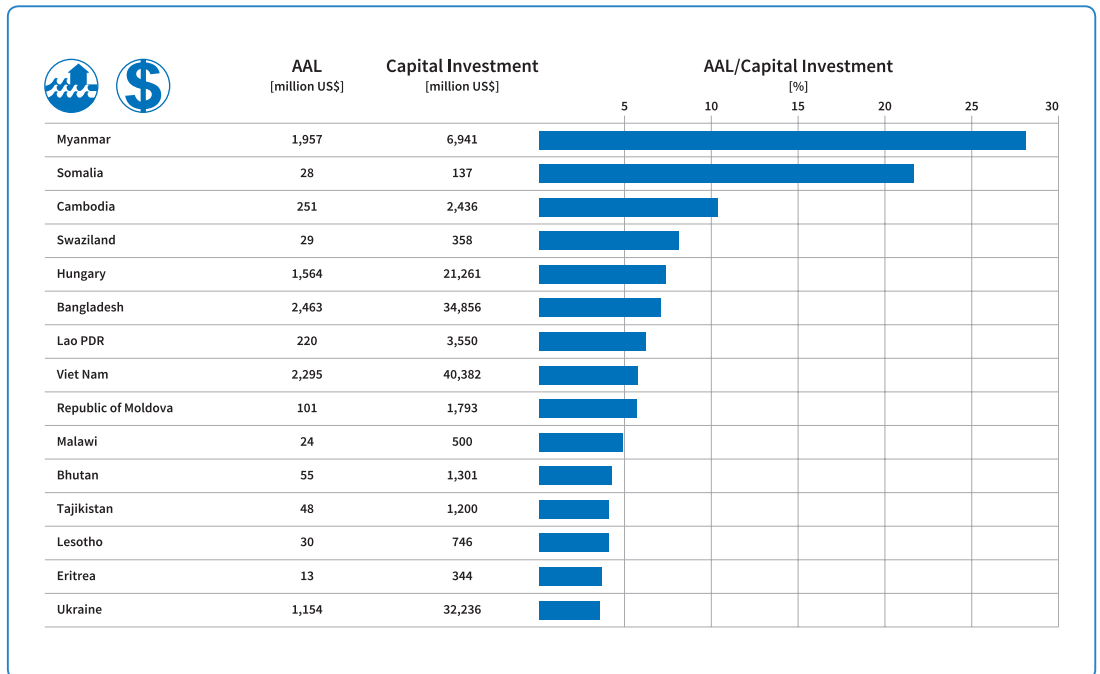
This means that floods represent a significant challenge to both capital investment and social development in many low-income and lower

**Figure 3.20** Top 15 countries: Flood AAL in relation to capital stock (excluding SIDS)



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

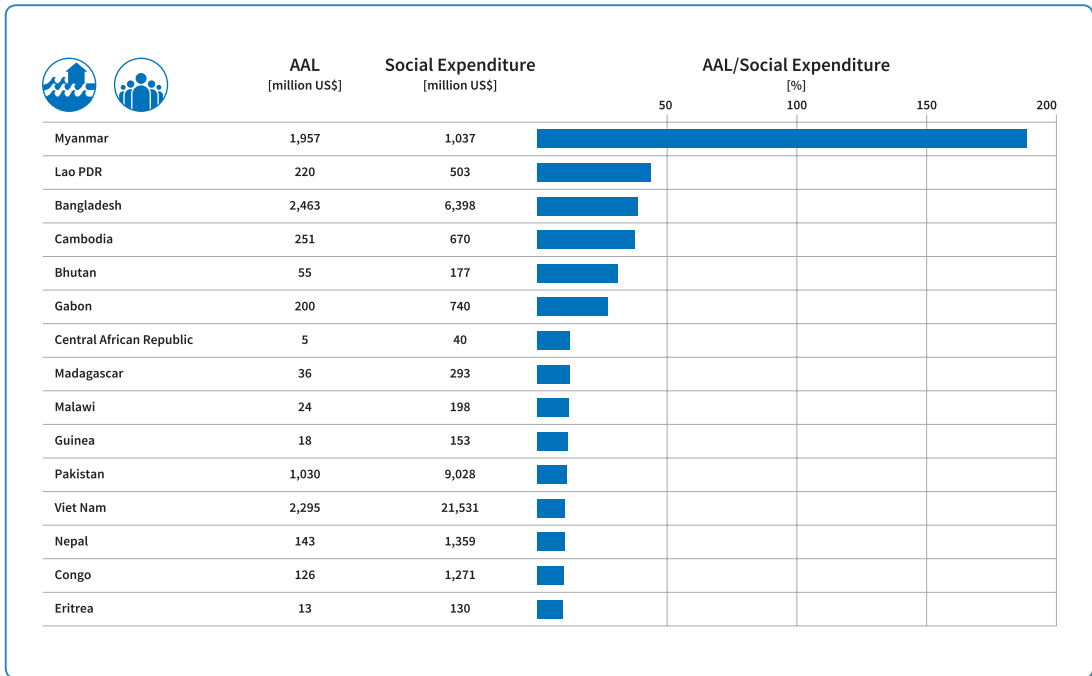
**Figure 3.21** Top 15 countries: Flood AAL in relation to capital investment (excluding SIDS)



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)



**Figure 3.22** Top 15 countries: Flood AAL in relation to social expenditure (excluding SIDS)



(Source: UNISDR with data from the Global Risk Assessment and the World Bank.)

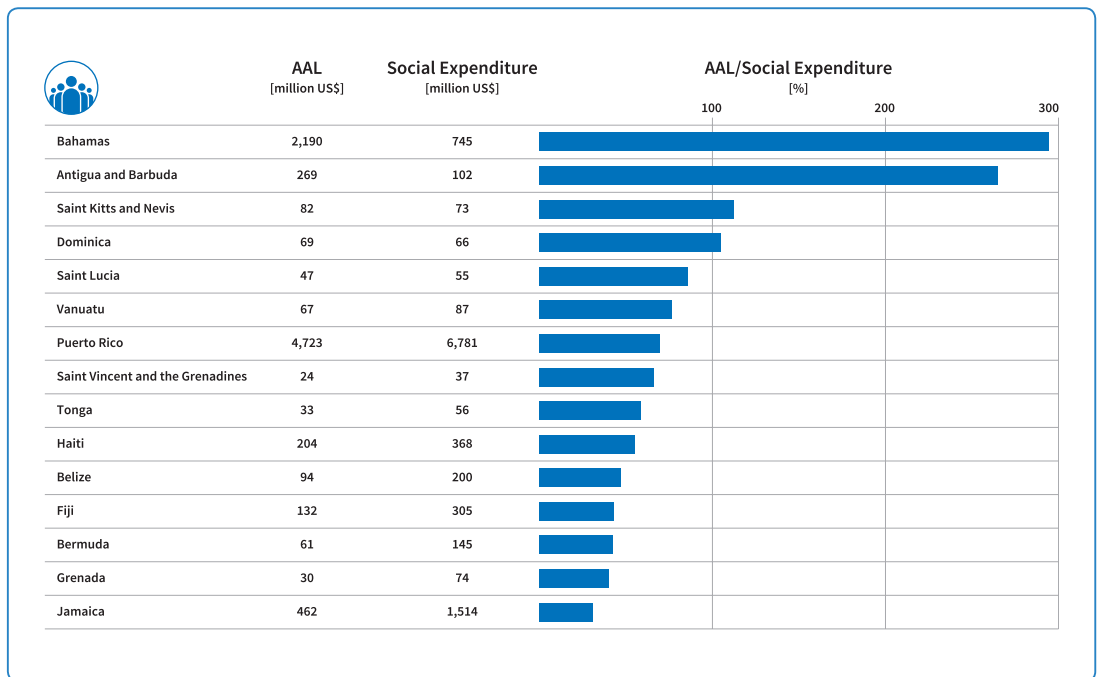
middle-income countries, which are not able to make the necessary investments in flood defences. Increased investment in flood risk management in these countries will therefore be a precondition for achieving the Sustainable Development Goals.

### 3.4 Small island developing states at risk

**Due to their size, location and characteristics of their economies, SIDS are particularly challenged by disaster risk. In relation to their capital stock, investment and social expenditure, they face the highest potential losses associated with several hazards.**

Small island developing states (SIDS)<sup>24</sup> face disproportionately high risks. For example, SIDS would be expected to lose 20 times more of their capital stock each year compared to Europe and Central Asia. Relative to capital investment or social expenditure, SIDS also top all of the regional risk rankings. Their combined AAL is equivalent to 10 per cent of their total annual capital investment, compared to less than 2 per cent in East Asia and the Pacific and around 1.2 per cent in Europe and Central Asia (see Figure 3.8 in Section 3.2 above). Similarly, the AAL in SIDS is equivalent to almost

**Figure 3.23** Top 15 SIDS: Multi-hazard AAL in relation to social expenditure



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

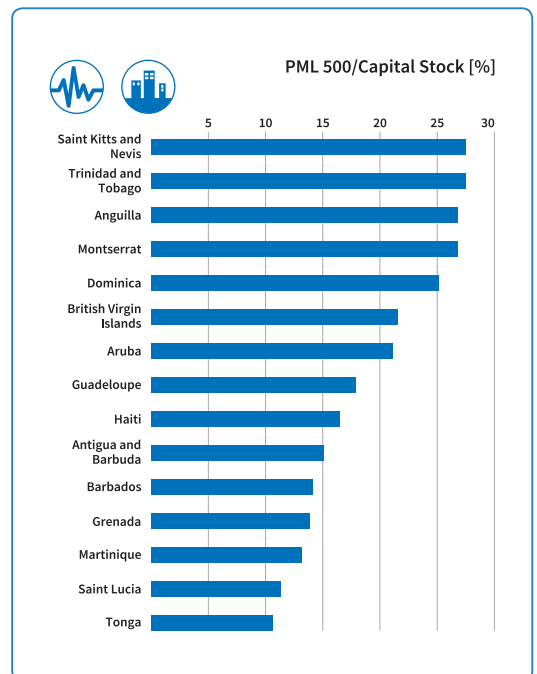
20 per cent of their total social expenditure, compared to only 1.19 per cent in North America and less than 1 per cent in Europe and Central Asia.

Individual countries such as the Bahamas and Antigua and Barbuda have an extraordinarily high ratio of AAL to social expenditure (Figure 3.23). In five SIDS, the AAL is equivalent to over 100 per cent of what these countries are currently able or willing to spend on education, health and social protection.

In the case of earthquakes, the AAL in Trinidad and Tobago represents over 20 per cent of the islands' capital investment, and in Saint Kitts and Nevis the figure is over 10 per cent. Over a 50-year period, both countries face a 10 per cent probability of losing around 27 per cent of their total capital stock in an earthquake (Figure 3.24).

In the case of tropical cyclones, nearly all of the countries with the highest AAL relative to capital

**Figure 3.24** Top 15 SIDS: Earthquake PML500 in relation to capital stock



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

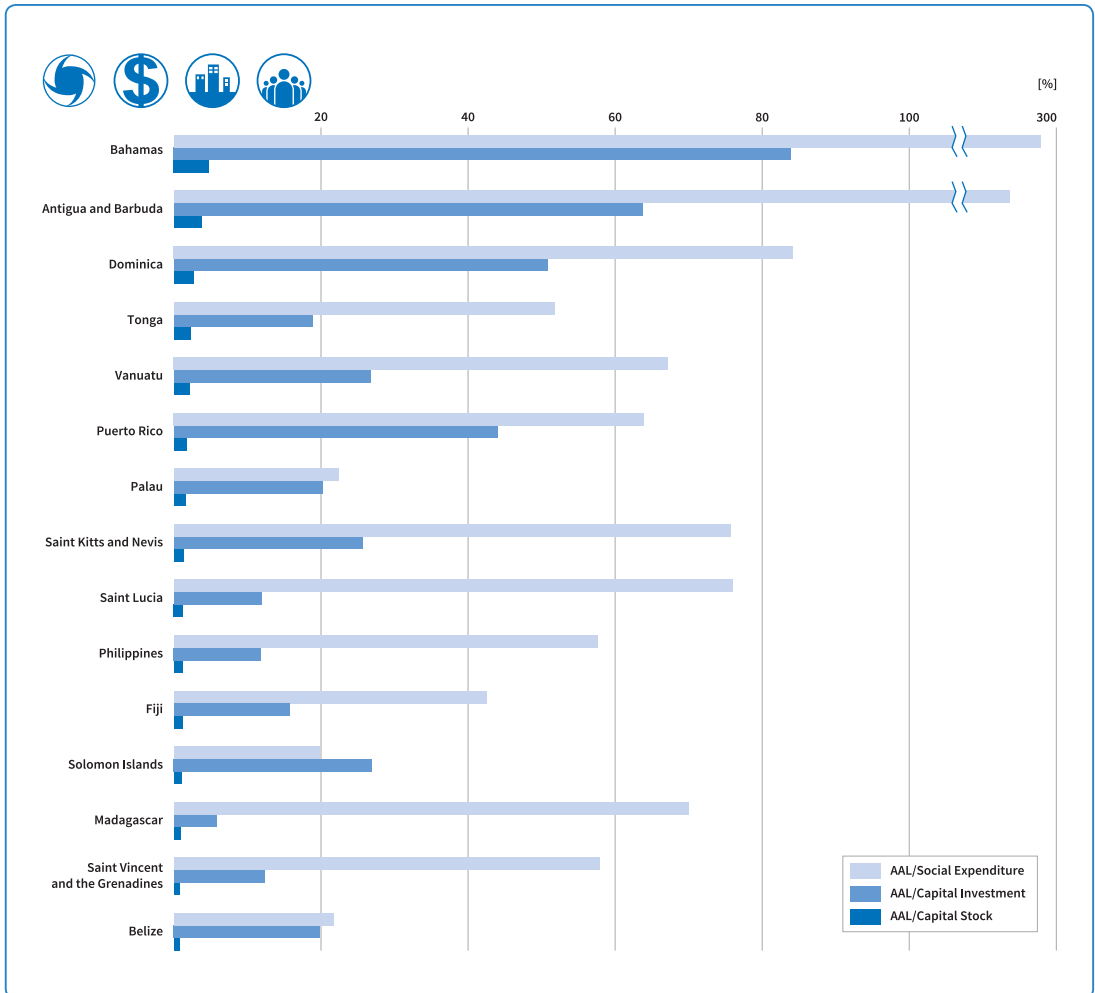


investment, capital stock and social expenditure are SIDS (Figure 3.25).

Due to high coastal exposure, storm surges make a major contribution to tropical cyclone AAL in SIDS. In contrast, it tends to represent only a small proportion of the overall cyclone AAL in large countries, where winds can affect not only coastal but extensive inland areas. While the Cayman Islands and Antigua and Barbuda have the highest relative AAL for cyclone wind, the highest relative risk with respect to storm surge is found in the Bahamas, Montserrat and Dominica (Figure 3.26).

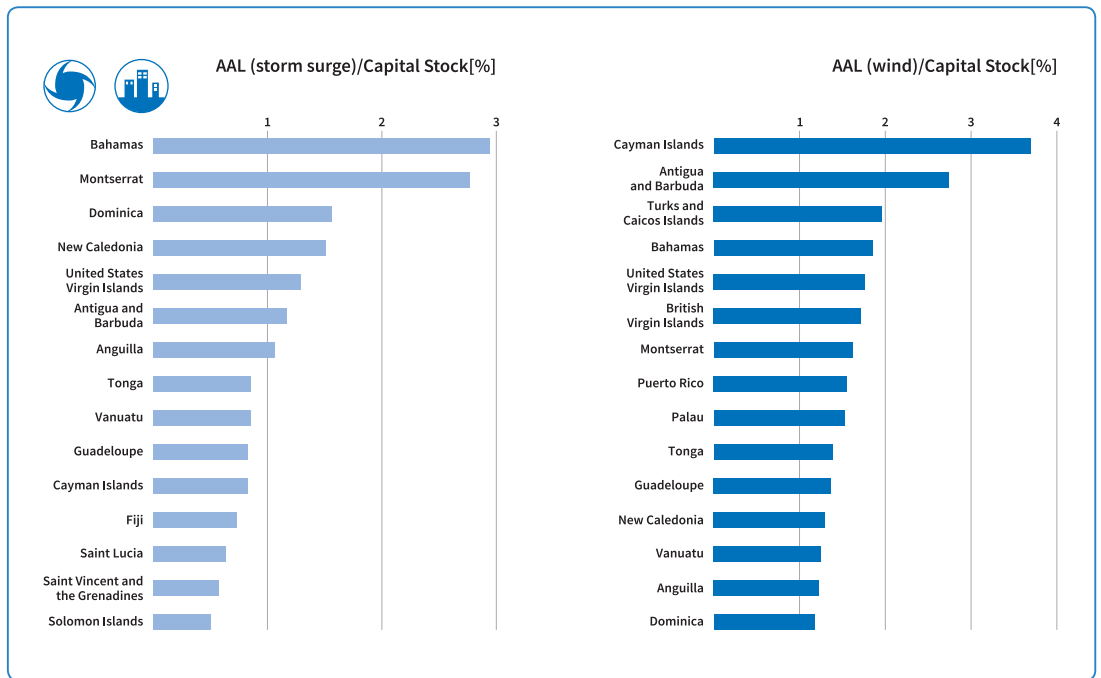
In terms of tsunami risk, SIDS such as Tonga, Palau, Solomon Islands and Vanuatu also rank at the top in terms of average annual loss relative to their capital stock. While the AAL may seem relatively low in comparison to other hazards (Figure 3.27), tsunami risk levels are significant in both absolute and relative terms in coastal zones that are directly exposed. As a great deal of critical infrastructure and primary transport facilities are located in coastal zones in SIDS (UNISDR, 2013a), tsunami impact can be significant.

**Figure 3.25** Top 15 countries: Tropical cyclone AAL in relation to social expenditure, capital investment and capital stock



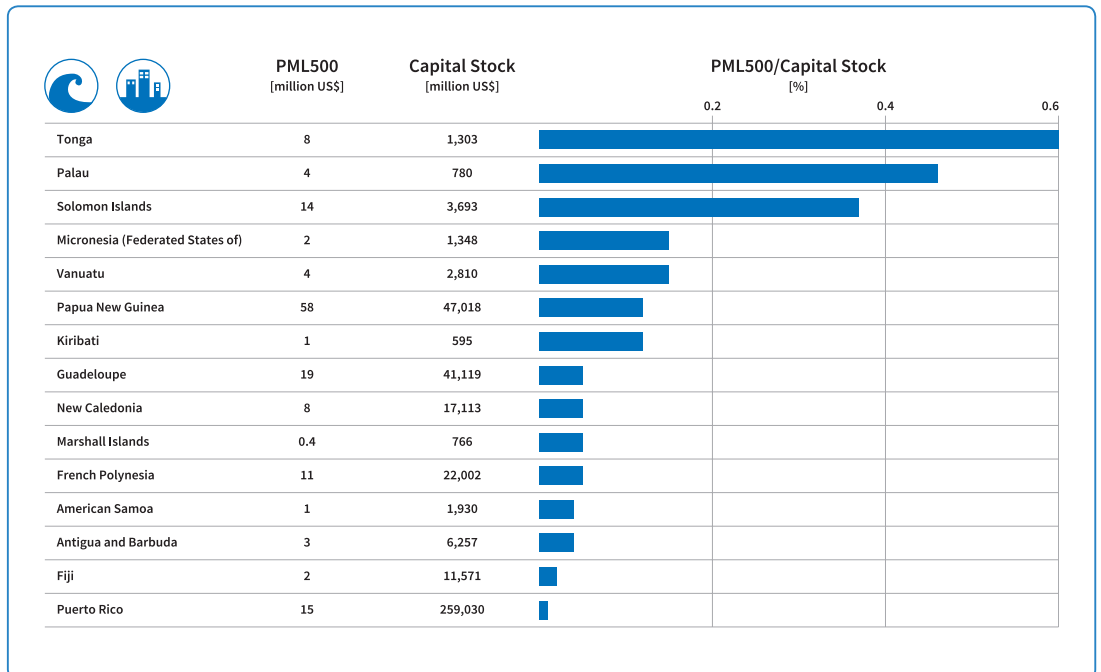
(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

**Figure 3.26** Top 15 SIDS: Tropical cyclone AAL (storm surge and cyclone wind) in relation to capital stock



(Source: UNISDR with data from Global Risk Assessment.)

**Figure 3.27** Top 15 SIDS: Tsunami PML500 in relation to capital stock



(Source: UNISDR with data from Global Risk Assessment.)



### 3.5 The additionality of climate change

While climate change can result in lower expected losses in selected regions, for some parts of the world, changing hazard patterns and higher levels of vulnerability due to climate change are expected to increase overall losses. In the Caribbean, these losses will be significant.

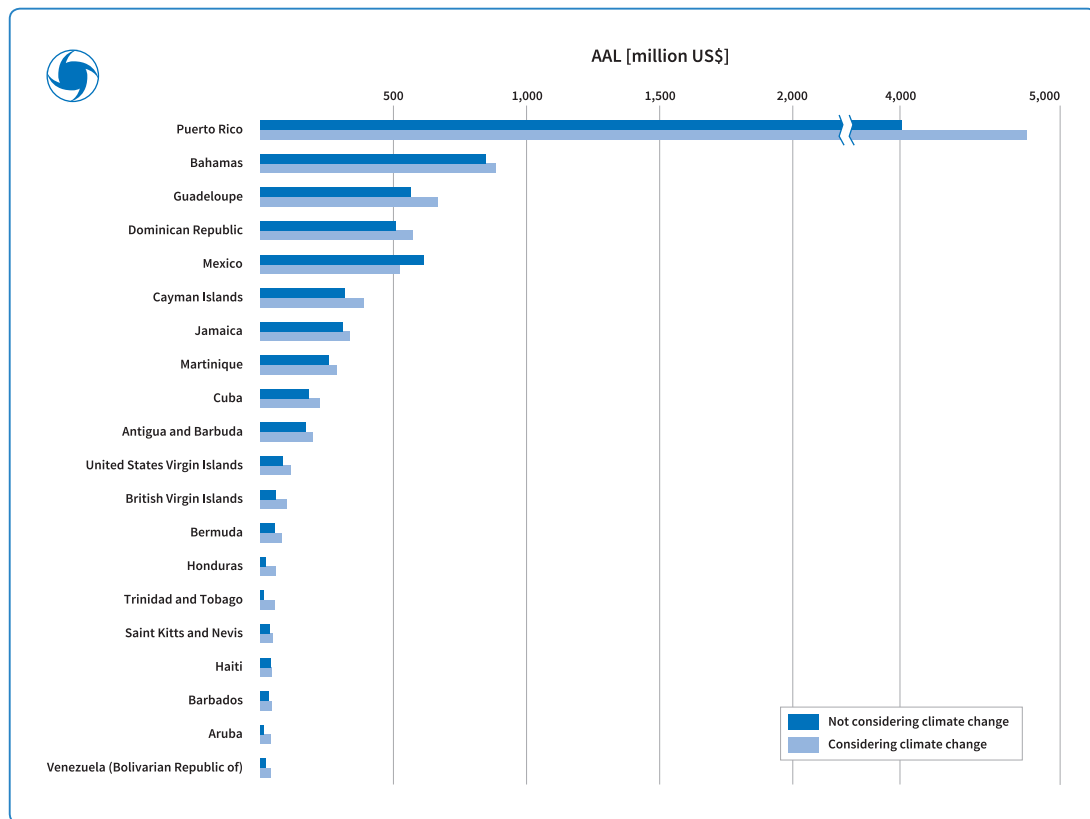
The Intergovernmental Panel on Climate Change (IPCC) has highlighted that there is *low confidence* in any observed long-term (i.e., 40 years or more) increases in tropical cyclone activity (intensity, frequency and duration), after accounting for past changes in observing capabilities. It is likely

that the global frequency of tropical cyclones will either decrease or remain essentially unchanged. However, average tropical cyclone maximum wind speed is likely to increase, although increases may not occur in all ocean basins (IPCC, 2012).

In the Caribbean, the risk associated with tropical cyclone winds was recalculated using possible future cyclone trajectories in the North Atlantic basin simulated using climate change scenarios up to 2055 (CIMNE-INGENIAR, 2014a) but assuming constant exposure and vulnerability.

In most countries, the AAL increases under the climate change scenario (Figure 3.28). For the Caribbean basin as a whole, climate change contributes an additional US\$1.4 billion to the expected average annual losses associated with

Figure 3.28 AAL from tropical cyclone wind for Caribbean and Central American countries, with and without climate change



(Source: CIMNE-INGENIAR, 2014.)

wind damage alone, excluding changes in the AAL associated with storm surge due to sea level rise. Given that Caribbean countries are collectively responsible for only a small proportion of global greenhouse gas emissions, the additional AAL of US\$1.4 billion raises important questions regarding accountability for risk generation and regarding who should pay for these additional losses.

In some countries, the additionality of climate change is very significant. One example is Anguilla, where the AAL attributable to cyclone wind doubles with climate change, or Trinidad and Tobago, which faces a fivefold increase due to climate change. In contrast, Mexico would actually see a reduction in AAL, highlighting that the effects of climate change are not evenly distributed but will affect different countries in different ways.



## 3.6 Volcanic risk

**New results from volcanic risk assessments show that while expected losses may be lower than those from other hazards at a global scale, in affected regions, they can be significant. Further, the impacts from volcanic ash fall can affect economic activity and the environment far beyond the locality of the hazard event.**

There are 1,551 volcanoes on land that are known to have been active in the last 10,000 years (the Holocene), with a total of 9,444 eruptions. Since 1950, an average of 31 volcanoes have erupted each year. Most active volcanoes are located at the boundaries between tectonic plates, where the earth's crust is either created or consumed (GVM, 2014a).

Volcanoes are associated with multiple hazards, including pyroclastic flows and surges; volcanic

ash and tephra (large quantities of intensely fragmented rock); ballistics (rocks ejected by volcanic explosions); lahars and floods (fast-moving and destructive mixtures of volcanic debris and water); debris avalanches, landslides and tsunamis; volcanic gases and aerosols; lava flows; earthquakes; and lightning. Each hazard affects people, agriculture, the built environment and transport (e.g. aviation) in very different ways. For example, people living close to a volcano may be at direct risk from pyroclastic flows, avalanches or lahars. At the other extreme, volcanic ash clouds in the atmosphere and ash fall on the ground can have impacts hundreds to thousands of kilometres from their source.

At present, more than 800 million people in 86 countries live within 100 km of a volcano that could potentially erupt (GVM, 2014a). The countries with the greatest number of people exposed are Indonesia, the Philippines and Japan. However, in some small countries, a higher proportion of the population is exposed, for example over 90 per cent in Guatemala and Iceland (GVM, 2014a).

Five major eruptions in historical time dominate the mortality records directly associated with volcanoes. All five major events have occurred since the late 1700s, with mortality ranging from 15,000 to 60,000 per event.<sup>25</sup> However, volcanic eruptions have also contributed indirectly to severe mortality, for example by inducing climate variability in other regions and thus causing famine (UNISDR, 2011a).

According to the Population Exposure Index,<sup>26</sup> only 4 per cent of volcanoes in the world account for 61 per cent of the exposed population worldwide. The top ten "high exposure" volcanoes are concentrated in Indonesia, Mexico, the Philippines and Japan. Based on the number of active volcanoes in the country, the hazard level<sup>27</sup> posed and the size of the exposed population living within 30 km of each volcano, around 95 per cent of the population exposed to



volcanic hazard is concentrated in six countries: Indonesia, the Philippines, Japan, Mexico, Ethiopia, Guatemala and Italy. Around two-thirds of the total exposed population is concentrated in Indonesia.

For example, in Naples, Italy (Figure 3.29), over 2 million people live in close proximity to three active volcanoes (Vesuvius, Campi Flegrei and Ischia).



**Figure 3.29** Satellite image of the Naples area



(Source: GVM, 2014a.)

Relatively small countries, such as SIDS (Figure 3.30), have the highest proportion of their populations exposed to volcanic hazard.

However, given that most volcano-related mortality has occurred in a small number of eruptions, volcanic disaster risk is highly idiosyncratic and difficult to model. For example, the relatively modest eruption of Nevado del Ruiz in Colombia in 1985 resulted in the death of more than 23,000 people in towns up to 45 km away as a result of lahars.

Despite population growth, the number of fatalities per eruption has declined dramatically in

the last few decades, suggesting that mortality has been reduced thanks to improved volcano monitoring, hazard assessment and awareness, early warning, forecasts, communication and preparedness around specific volcanoes. In fact, it is estimated that such measures have saved about 50,000 lives over the last century (Auker et al., 2013). However, some “high exposure” volcanoes remain unmonitored. For example, there are 5.7 million people living within 10 km of Mexico’s Michoacán-Guanajuato volcanic field, which currently has no dedicated ground monitoring system.

### Economic loss risk from volcanic eruption

Volcanic eruptions are associated with increasingly large economic impacts. For example, the losses from the November 2010 eruption of Merapi in Indonesia are estimated at US\$3.12 billion (Surono et al., 2012). The 2010 eruption of the Eyjafjallajökull volcano in Iceland caused serious disruptions to air traffic in the North Atlantic and Europe as fine volcanic ash in the atmosphere drifted thousands of kilometres from the volcano. The resulting global economic losses from this modest-sized eruption accumulated to about US\$1.7 billion for the aviation industry alone (UNISDR, 2013a) and have been estimated to reach a total of US\$5 billion including the effects on global businesses and supply chains (Ragona et al., 2011).

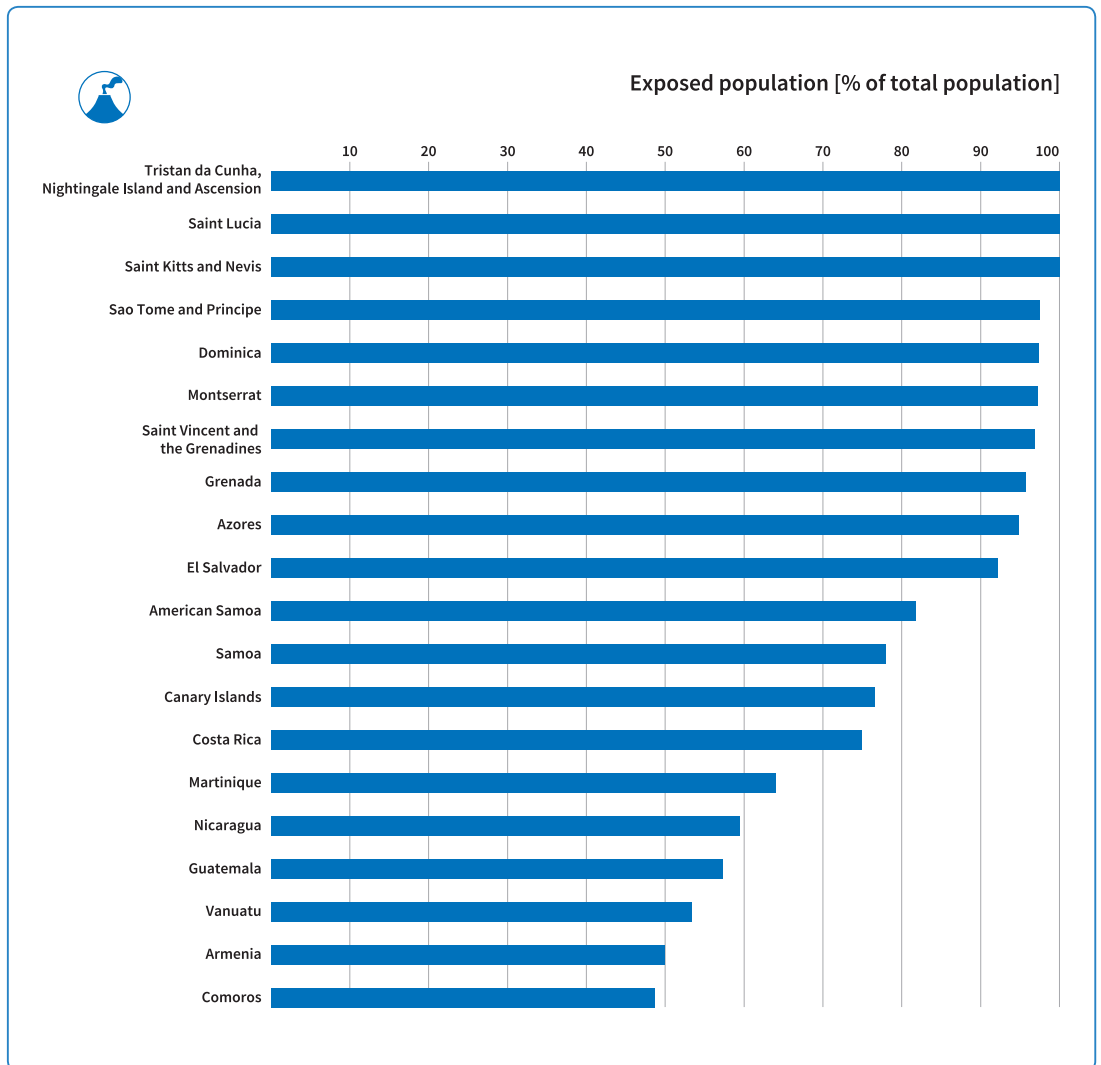
Volcanic ash is the most widespread of all volcanic hazards. Volcanic eruptions generate convective plumes of gas, ash and rock fragments which can spread over hundreds of kilometres, depending on the size of the eruption and the speed and direction of prevailing winds. Depending on the intensity of volcanic ash fall (i.e. from 1 mm to 200 mm) and the exposed environment, impacts may be diverse and range from traffic and aviation disruption to health problems, soil and water contamination, crop failure, damage to machinery, and collapsing roofs.

The probability of ash fall can be estimated based on the geographical distribution of volcanoes and their eruption potential as well as the prevailing winds in different seasons (Figure 3.31).

are higher in smaller countries like Vanuatu and Papua New Guinea (Figure 3.32).<sup>28</sup>

Risk from ash fall can be estimated using the same approach as for other hazards. In the Asia-Pacific region, Japan has the highest AAL associated with structural damage due to volcanic ash at more than US\$11 billion, followed by Indonesia with almost US\$6 billion. However, relative losses

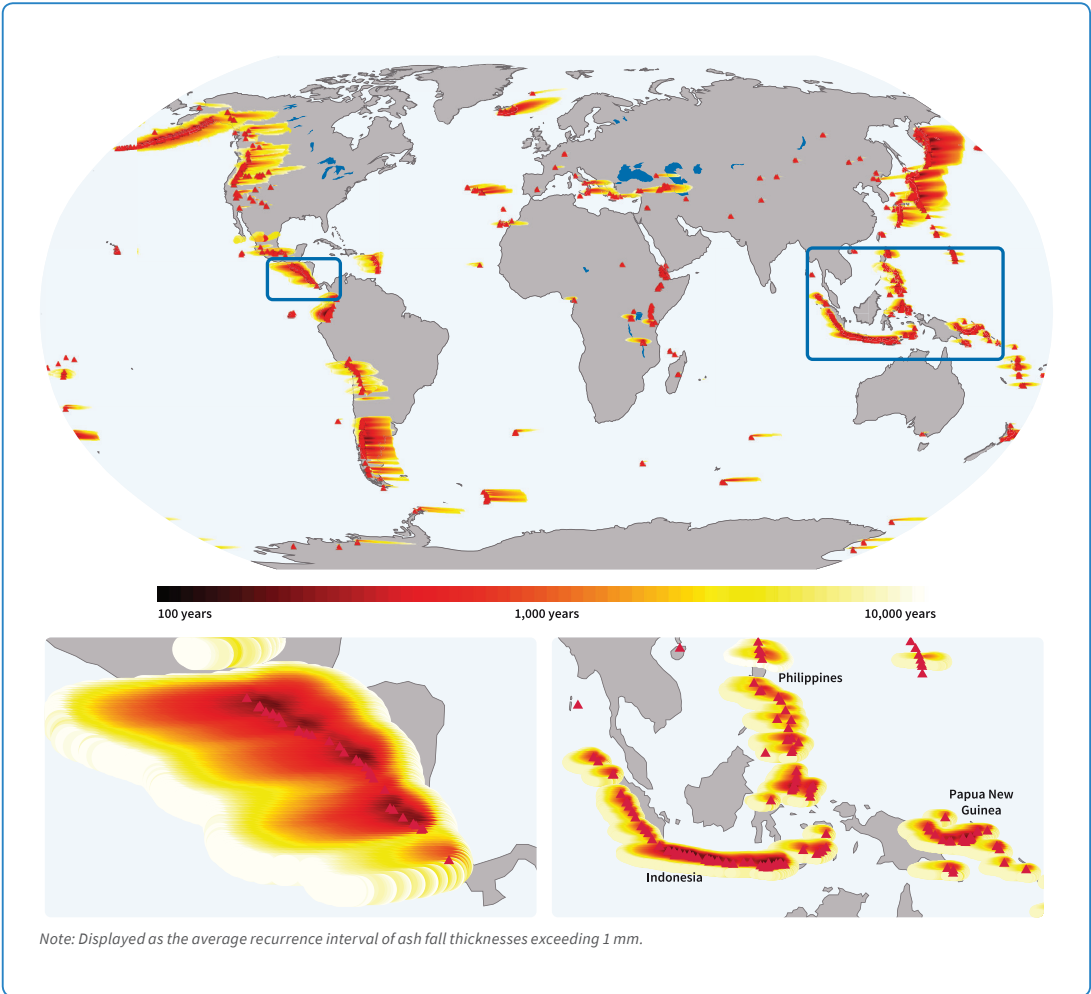
**Figure 3.30** Top 20 countries and territories: relative population exposed to volcanic hazard



(Source: UNISDR, based on data from GVM, 2014a)

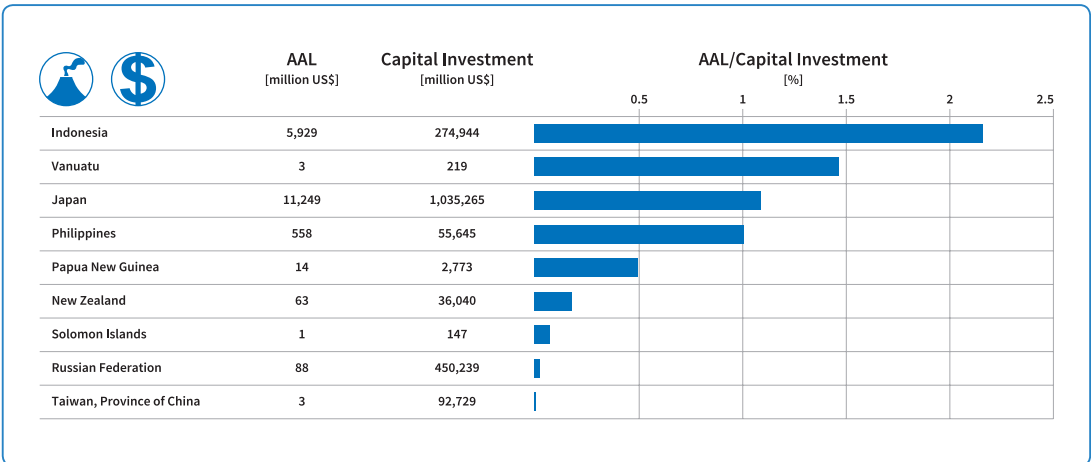


**Figure 3.31** Global map of probabilistic ash fall hazard and regional maps for South-East Asia and Central America



(Source: GVM, 2014b.)

**Figure 3.32** Volcanic ash fall AAL in relation to capital investment, Asia-Pacific region<sup>29</sup>



(Source: UNISDR, based on data from Geoscience Australia, 2014 and CIMNE-INGENIAR, 2014.)



## 3.7 Agricultural drought risk

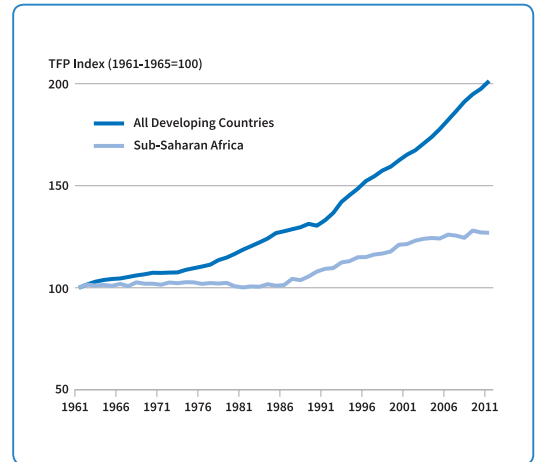
In several countries, losses from agricultural drought not only pose risks to the national economy but can also lead to devastating effects on the rural population. With climate change, patterns of agricultural drought can be expected to change.

Agricultural drought is probably the most socially constructed of all disaster risks (UNISDR, 2011a). Besides insufficient rainfall, agricultural drought is associated with other factors such as temperature and wind, which influence evaporation, transpiration and the soil's capacity to hold moisture. However, while agricultural drought hazard occurs when there is insufficient moisture in the soil to meet the needs of a particular crop at a given time and location, it is also associated with factors such as land degradation, inappropriate land-use and cropping patterns, over-extraction of ground water, and overgrazing. Low-income rural households and communities may have no alternative but to farm or graze marginal, drought-prone and degraded land. And with little capacity to mobilize assets, they are vulnerable to even small shortfalls in production and have low levels of resilience.

The direct impacts of agricultural drought are reduced crop, rangeland and forest productivity, reduced water levels, increased fire hazard, damage to wildlife and fish habitats, and increased livestock and wildlife mortality. The indirect impacts include reduced income from agriculture and increased food and timber prices, which in turn lead to wider impacts such as malnutrition (especially among children), increased unemployment, migration, reduced tax revenues and the risk of foreclosures on bank loans to farmers. Although agricultural droughts can persist for several years, even a short, intense drought can cause significant damage to the local economy (FAO, 2013a).

In sub-Saharan Africa, only 1 per cent of the farmed area is irrigated (Ward et al., 2014), while 52 per cent of land is degraded to some degree (Erian et al., 2014). Despite increasing productivity, the total productivity gap between the region and developing countries as a whole is still widening (Figure 3.33).

**Figure 3.33** Total factor productivity (TFP) index



(Source: USDA Economic Research Service.)

In many low-income countries in this region, agriculture remains a critical economic sector. In many of those countries where economic activity and employment are concentrated in agriculture, such as Eritrea and Ethiopia, a significant proportion of the population is undernourished, and a significant proportion of the area covered by vegetation is affected by high levels of land degradation and agricultural drought hazard (Table 3.2).

In these countries, agricultural drought not only poses risks to the national economy but also leads to devastating effects on the rural population.

In Malawi, for example, agriculture is responsible for around 30 per cent of GDP. Estimated annual losses due to drought represent about 1 per cent



**Table 3.2** Agriculture, land degradation and drought in sub-Saharan Africa

Country	Agricultural population	Agriculture value added	Employment in agriculture	Level of food insecurity	Total vegetation cover area severely affected
	(per cent share of total)	(per cent share of GDP)	(per cent share of total employment)	(prevalence of undernourishment as per cent of population)	(per cent of area affected by land degradation and agricultural drought hazard)
Angola	69	10	5	24	1.3
Benin	44	32	43	6	4.7
Burundi	89	35	90	67	1.1
Chad	66	14	83	29	5.1
Democratic Republic of Congo	57	43	70	N/A	0.3
Eritrea	74	15	N/A	61	24.7
Ethiopia	77	42	79	37	18.3
Guinea	80	13	82	15	1.2
Liberia	62	53	49	29	7.4
Madagascar	70	29	80	27	1.4
Mali	75	39	66	7	7.1
Mozambique	76	32	81	37	1.0
Nigeria	25	33	45	7	12.2
Sierra Leone	60	44	69	29	11.3
Sudan	80	24	80	39	7.3
Tanzania	73	27	77	33	1.1
Uganda	74	23	66	30	0.7

Note: Where data is not included in the table, it is because no data was readily available.

(Source: UNISDR with data from FAO, 2014 and Erian et al., 2014.)

of GDP, and the probable maximum loss (PML) from a 1-in-25-year drought is equal to 10 per cent of GDP. In addition, a 1-in-25-year drought would exacerbate income poverty by 17 per cent, which would mean an additional 2.1 million people falling below the poverty line (World Bank et al., no date).

The picture is equally critical in West Africa. Mali, for example, faces a 10 per cent probability of suffering production losses amounting to US\$48

million or larger in 50 years for millet alone (Figure 3.34). In Senegal, millet production losses for the same return period are US\$15 million or more.

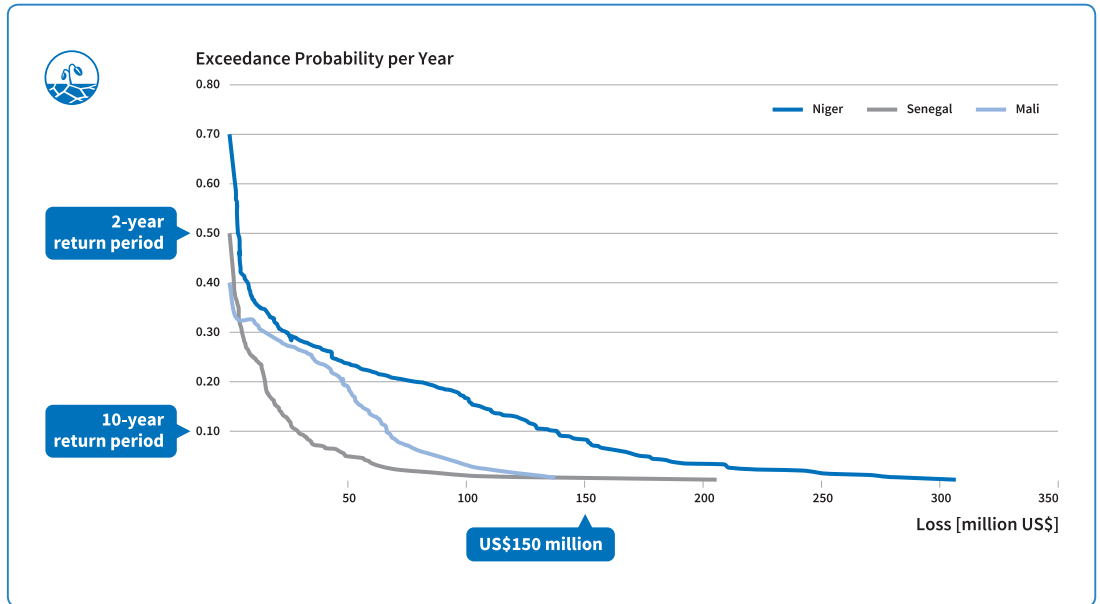
According to the IPCC, “climate change is very likely to have an overall negative effect on yields of major cereal crops across Africa, with strong regional variability in the degree of yield reduction” (IPCC, 2014). However, this regional variability would be considerable and may even involve

increases in maize production in eastern Africa (IPCC 2014).

In Kenya, Malawi and Niger, income from agriculture respectively contributes 30 per cent, 30 per cent, and 38 per cent to each country's GDP. Estimated average annual losses (AAL) vary with and without near-term climate change in all three

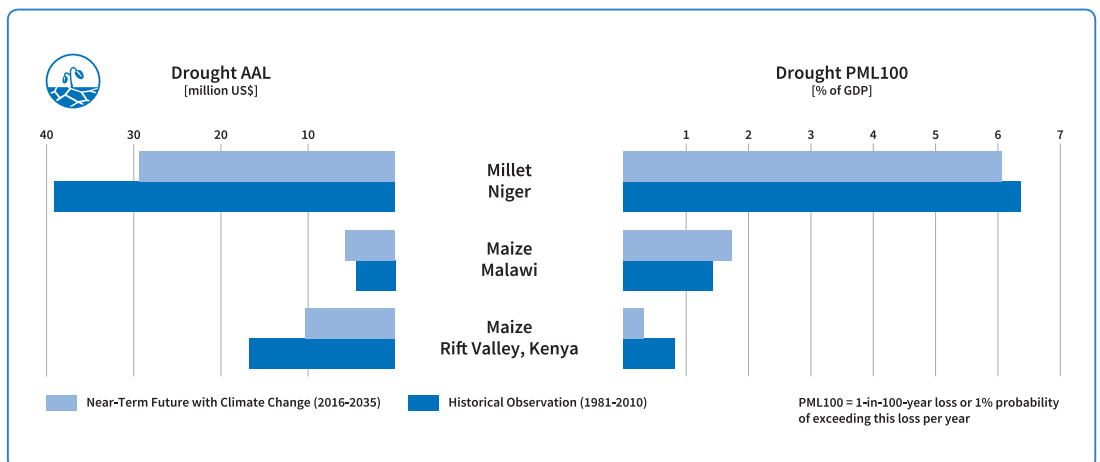
countries (Figure 3.35). While maize production in Malawi is expected to face higher AAL with climate change, Kenya and Niger show reduced AAL figures for the same climate change scenario, both in terms of absolute values and as a percentage of their GDP for maize and millet production, respectively.

**Figure 3.34** Probability of production loss in West Africa



(Source: Jayanthi, 2014.)

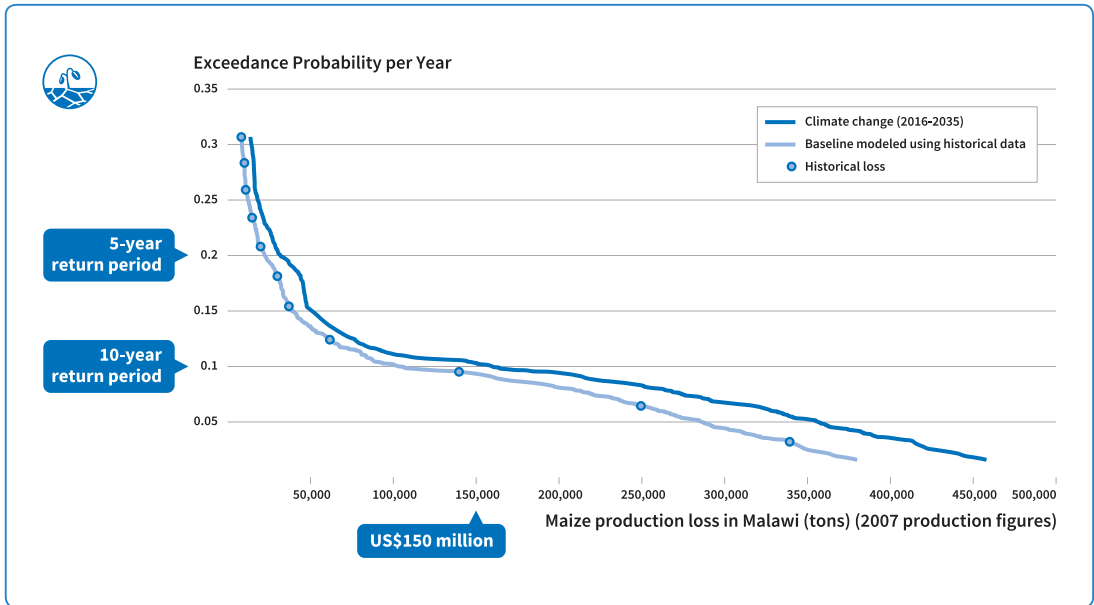
**Figure 3.35** Drought AAL and PML100, with and without climate change



(Source: Jayanthi, 2014.)



**Figure 3.36** Malawi maize production loss in tons with respect to 2007 countrywide production of maize



(Source: Jayanthi, 2014.)

**Table 3.3** Estimated maize production losses in Malawi with and without climate change

Exceedance Probability (EP)	Return Period (RP)	Baseline Losses, 1981-2010 (tons)	Baseline Losses (% of Total Maize Production in 2007)	Losses in Climate Change Scenario, 2016-2035 (tons)	Losses in Climate Change Scenario (% of Total Maize Production in 2007)
0.02	1 in 50 Years	363,800	55%	441,800	67%
0.05	1 in 20 Years	285,700	44%	355,700	54%
0.1	1 in 10 Years	102,900	16%	159,500	24%
Average Annual Loss	AAL	33,115	5%	42,055	6%

(Source: Jayanthi, 2014.)

For example, losses in maize production from a 1-in-25-year drought in Malawi are estimated to be 23 per cent higher in 2016-2035 than in 1981-2010 based on near-future climate change scenarios (Figure 3.36).

Climate change could result in significant additional losses in maize production (Table 3.3) and potentially push countries like Malawi over a resilience threshold in terms of the national economy as well as poverty.

In contrast, climate change could have a positive impact on maize and millet yields in Kenya and Niger, respectively (Jayanthi, 2014). The results also show that the impact of climate change could be different depending on the intensity of drought.

The agricultural drought risk to maize in the Kenya Rift Valley, for example, is forecast to decline in the near future (2016-2035) due to the impact of climate change. In the climate change scenario, PML100 (probable maximum loss corresponding to a 1-in-100-year drought) would fall

from 866,440 tons (baseline) to 351,225 tons. The average annual loss (AAL) is thus projected to be 48,463 tons (1.78 per cent of the total maize production in the Rift Valley Province in 2012), a full 38 per cent lower than the baseline AAL of 78,190 tons (2.86 per cent of the total maize production in Rift Valley Province in 2012; see Table 3.4).

to the observed losses for the 1981-2010 period, losses from more severe and infrequent droughts would be significantly lower (Figure 3.37). For example, a crop loss of 390,000 tons with a current probability of 1 in 20 years would have an occurrence probability of 1 in 100 years under the near-term climate change scenario.

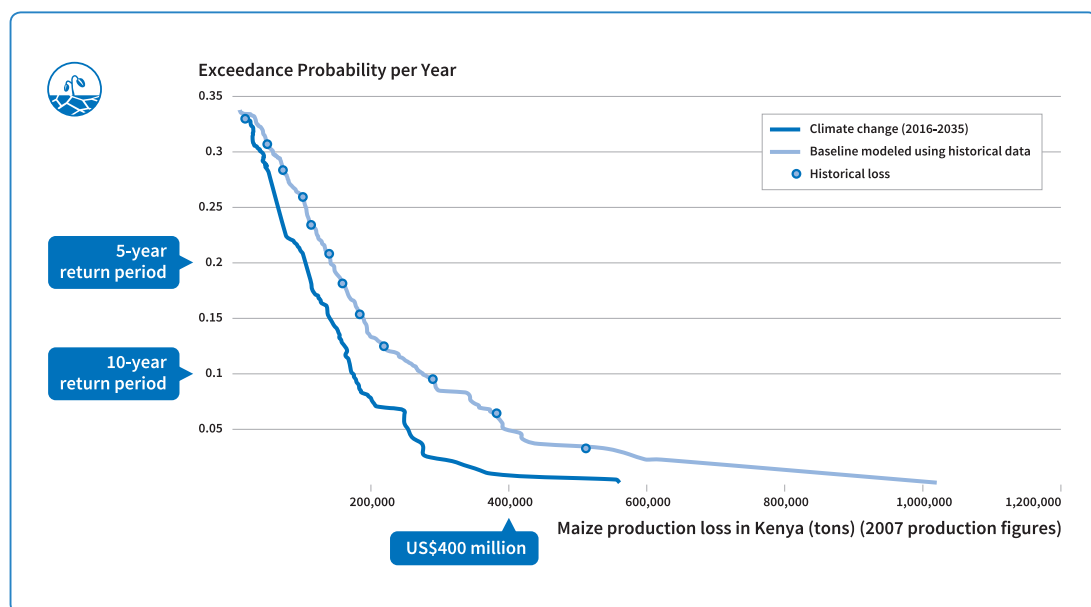
While losses due to frequent droughts (return periods shorter than 5 years) would be similar

**Table 3.4** Estimated maize production losses in the Rift Valley, Kenya with and without climate change

Exceedance Probability (EP)	Return Period (RP)	Baseline Losses, 1981-2010 (tons)	Baseline Losses (% of Total Maize Production in 2012)	Losses in Climate Change Scenario, 2016-2035 (tons)	Losses in Climate Change Scenario (% of Total Maize Production in 2012)
0.01	1 in 100 Years	866,440	31%	351,225	13%
0.02	1 in 50 Years	674,125	25%	333,145	12%
0.05	1 in 20 Years	390,680	15%	263,400	10%
0.1	1 in 10 Years	275,125	10%	179,400	7%
0.2	1 in 5 Years	141,600	5%	113,420	4%
Average Annual Loss	AAL	78,190	3%	48,463	2%

(Source: Jayanthi, 2014.)

**Figure 3.37** Probable losses in maize production in the Rift Valley, Kenya with and without climate change



(Source: Jayanthi, 2014.)



## Notes

**1** The global AAL for earthquake and tropical cyclone wind has changed compared to the figures published in GAR13 due to changes in the methodologies for seismic and tropical cyclone hazard assessments. Details on the improvements to the methodology can be found in Annex 1 and in CIMNE-INGENIAR, 2014.

**2** Persons aged 15 to 64 based on data from the United Nations; see <http://esa.un.org/unpd/wpp/index.htm>.

**3** World Bank definition of poverty line: those living on less than US\$1.25 per day.

**4** Calculations based on data from the EIA: <http://www.eia.gov>.

**5** Based on United States Government census data: <https://www.census.gov/hhes/families/data/cps2012.html>.

**6** Based on data from the World Bank: <http://data.worldbank.org/>.

**7** This is defined as armed criminal violence in situations that are not identified as conflict or armed conflict.

**8** For example, models from the Global Earthquake model (<http://www.globalquakemodel.org>) or Deltares (<http://www.deltares.nl/en>).

**9** The Global Risk Assessment was conducted in a partnership of 20 institutions. The probabilistic risk model for all hazards was developed and run by CIMNE and INGENIAR LTDA on the CAPRA modelling platform. The exposure model at the global scale was developed by UNEP-GRID and CIMNE in collaboration with WAP-MERR, EU-JRC, Kokusai Kogyo and Beijing Normal University. The hazard models were developed by CIMNE and INGENIAR LTDA (cyclones and earthquakes, with inputs from GEM for earthquakes), CIMA and UNEP-GRID (floods), NGI and Geoscience Australia (tsunamis and volcanoes), and GVM and Geoscience Australia (volcanoes). Vulnerability was modelled by CIMNE and INGENIAR LTDA for Latin America and the Caribbean, and by Geoscience Australia for the Asia-Pacific region. In other regions, HAZUS vulnerability functions developed by USGS were used. Agricultural drought risk assessments were undertaken by ACSAD and FEWSNET. Peer reviews were conducted by WMO (hydro-meteorological hazard models), UNESCO (geohazard models), and an ad-hoc group of seismic hazard and exposure experts. For more details on partners and their contributions, see Annex 1.

**10** <http://www.ecapra.org/>.

**11** Throughout this chapter, capital investment refers to gross fixed capital formation (GFCF) based on data from 2013.

**12** Capital stock refers to a country's building stock, comprising residential and commercial buildings, schools and hospitals, based on the exposure model (see Annex 1 for more details).

**13** All regions are according to World Bank country and regional classification; see <http://data.worldbank.org/about/country-and-lending-groups>.

**14** See Annex 1 for full risk results by geographical region.

**15** <http://data.worldbank.org/>.

**16** Please see Annex 1 for more details on hazard-specific risk results and graphs depicting key economic and social development metrics.

**17** The GAR15 risk model considers only tropical cyclones (i.e. hurricanes on the Saffir Simpson Scale), including strong winds and storm surges. Other tropical circulations, such as tropical depressions or tropical storms, are not considered. These kinds of events usually involve lower wind speeds, and therefore effects such as strong winds and storm surge are usually not present in those cases. Thus, although rare but potentially intense storms

near the equator can exist—as witnessed during the Category 5 Typhoon Bopha in Mindanao in 2012—tropical cyclones do not typically occur at those latitudes. This is because of the Coriolis Effect and the fact that storms rotate clockwise in the southern hemisphere and anticlockwise in the northern hemisphere without crossing over.

**18** <http://www.earthobservatory.nasa.gov/IOTD/view.php?id=7079>.

**19** Hurricanes: The Greatest Storms on Earth. <http://earthobservatory.nasa.gov/Features/Hurricanes/> (accessed 10 December 2014).

**20** <http://www.emdat.be>.

**21** <http://www.ready.gov/tsunamis>.

**22** [http://www.jma.go.jp/jma/en/Activities/jishintsunami/jishintsunami\\_low2.pdf](http://www.jma.go.jp/jma/en/Activities/jishintsunami/jishintsunami_low2.pdf).

**23** The provisional results presented here give an overview of the risks associated with river flooding. Factors other than the depth of the water also have a considerable influence on loss, which means that there is greater uncertainty compared with other hazards.

**24** Most SIDS are located in the region of Latin America and the Caribbean or East Asia and the Pacific.

**25** The five historical eruptions responsible for the majority of fatalities are: Tambora, Indonesia in 1815 (60,000 fatalities); Krakatau, Indonesia in 1883 (36,417 fatalities); Pelée, Martinique in 1902 (28,800 fatalities); Nevado del Ruiz, Colombia in 1985 (23,187 fatalities); Unzen, Japan in 1792 (14,524 fatalities).

**26** Developed by Aspinall et al. (2011), the Population Exposure Index (PEI) is one of the prominent indices used in assessing volcano risk. It is based on the population within 10, 30, and 100 km of a volcano, which is then weighted according to evidence on historical distributions of fatalities within a given distance from volcanoes. The PEI is divided into seven levels, from sparsely to very densely populated areas. The results of the index show that just 4 per cent of volcanoes account for 60 per cent of the total population exposed.

**27** A Volcano Hazard Index (VHI) has also been developed to characterize the hazard level of volcanoes based on their recorded eruption frequency, modal and maximum recorded volcanic explosivity levels, and the occurrence of pyroclastic density currents, lahars and lava flows. Only half of the historically active volcanoes have sufficiently detailed eruptive histories to calculate VHI.

**28** For this loss estimate, a simplified methodology emulating volcanic ash fall for multi-scale analysis was used for probabilistic hazard modelling of volcanic ash fall in the Asia-Pacific region (different from the model used in the production of maps in Figure 3.35).

**29** It should be noted that these values only represent the losses from structural damage, which are only a fraction of potential economic losses that can be caused by ash fall. This also does not include the losses to the aviation industry from airborne ash.

## Chapter 4

# Extensive risk



**Unlike intensive risk, extensive risk is more closely associated with inequality and poverty than with earthquake fault lines and cyclone tracks. In many cases, the hazard, exposure and vulnerability are simultaneously configured through the underlying risk drivers. This also makes extensive risk an important poverty attribute.**

## 4.1 Increasing extensive risk

**Extensive disaster risk is magnified by drivers such as badly planned and managed urban development, environmental degradation, poverty and inequality, vulnerable rural livelihoods and weak governance. As a result, it continues to increase.**

Extensive risk refers to the risk layer of high-frequency, low-severity losses. In general, this layer is not captured by global risk modelling, nor are the losses reported internationally. One key feature of the GAR (UNISDR, 2009a, 2011a, 2013a) has been to highlight the contingent liabilities associated with this risk layer, which tend to be absorbed by low-income households and communities, small businesses, and local and national governments, and which are a critical factor in poverty (UNISDR, 2009a).

Extensive risk manifests as large numbers of recurrent, small-scale, low-severity disasters which are mainly associated with flash floods, landslides, urban flooding, storms, fires and other localized events. In addition, damage from electrical storms and lightning is increasingly contributing to loss from extensive risk due to wildfires.<sup>1</sup>

Extensive disaster risk is magnified by drivers such as badly planned and managed urban development, environmental degradation, poverty and inequality, vulnerable rural livelihoods and weak governance. This risk layer is characteristic of informal urban settlements and low-income rural areas (UNISDR, 2009a).

In cities, for example, poverty forces low-income households to occupy areas of low land value that may be exposed to floods, landslides and other hazards (Wamsler, 2014). Informal settlements are usually characterized by highly vulnerable housing and a deficit of risk-reducing infrastructure such as drainage (Mitlin and Satterthwaite, 2013). At the same time, speculative urban development, which can lead to the paving of green areas in rapidly expanding cities and subsidence due to the over-extraction of groundwater, may also increase the frequency and severity of urban flooding (UNISDR, 2013a). Unlike intensive risk, extensive risk is less closely associated with earthquake fault lines and cyclone tracks than with inequality and poverty. In many cases, the hazard, exposure and vulnerability are simultaneously constructed by the underlying risk drivers. For example, all of Panama's municipal areas report extensive disaster losses even though the country lies south of the Caribbean hurricane belt and earthquakes are infrequent.

Given that extensive and intensive risk simply refer to different risk layers, any quantitative threshold between them is arbitrary. The GAR has used a statistically determined loss threshold (Box 4.1) within which a *minimum* number of disasters accumulate the *maximum* possible mortality and economic damage (UNISDR, 2011a, Annex II), though it would be equally valid to determine a threshold on the basis of return periods.

At the time when the HFA was adopted, the mortality, physical damage and economic loss from extensive risk had not been accounted for in national or international reports, except in a number of Latin American countries.<sup>2</sup> As a result,

**Box 4.1** Intensive vs extensive risk: two different footprints

The variables used to define the threshold between intensive and extensive disaster losses are mortality and housing destruction. Statistically, the threshold is fixed at:

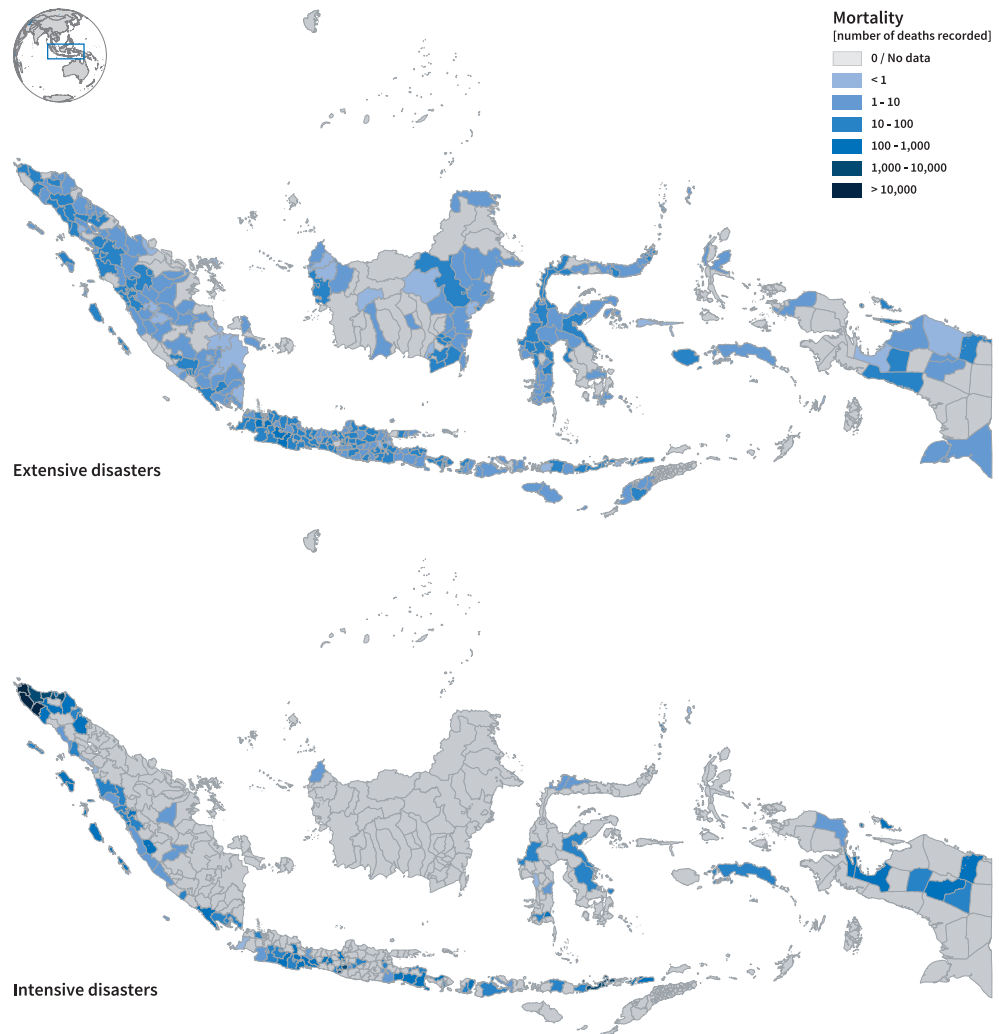
*Mortality: less than 30 people killed (extensive); 30 or more killed (intensive); or*

*Housing destruction: less than 600 houses destroyed (extensive); 600 or more houses destroyed (intensive).*

This threshold has proved robust even as the universe of national disaster databases continues to grow.

As the case of Indonesia shows, extensive and intensive disasters have very different footprints (Figure 4.1).

**Figure 4.1** The different footprints of extensive vs intensive disaster loss in Indonesia, 1990-2013



(Source: UNISDR with data from Indonesian national loss database.)



**Box 4.2** Understanding loss and risk from the bottom up: national loss accounting

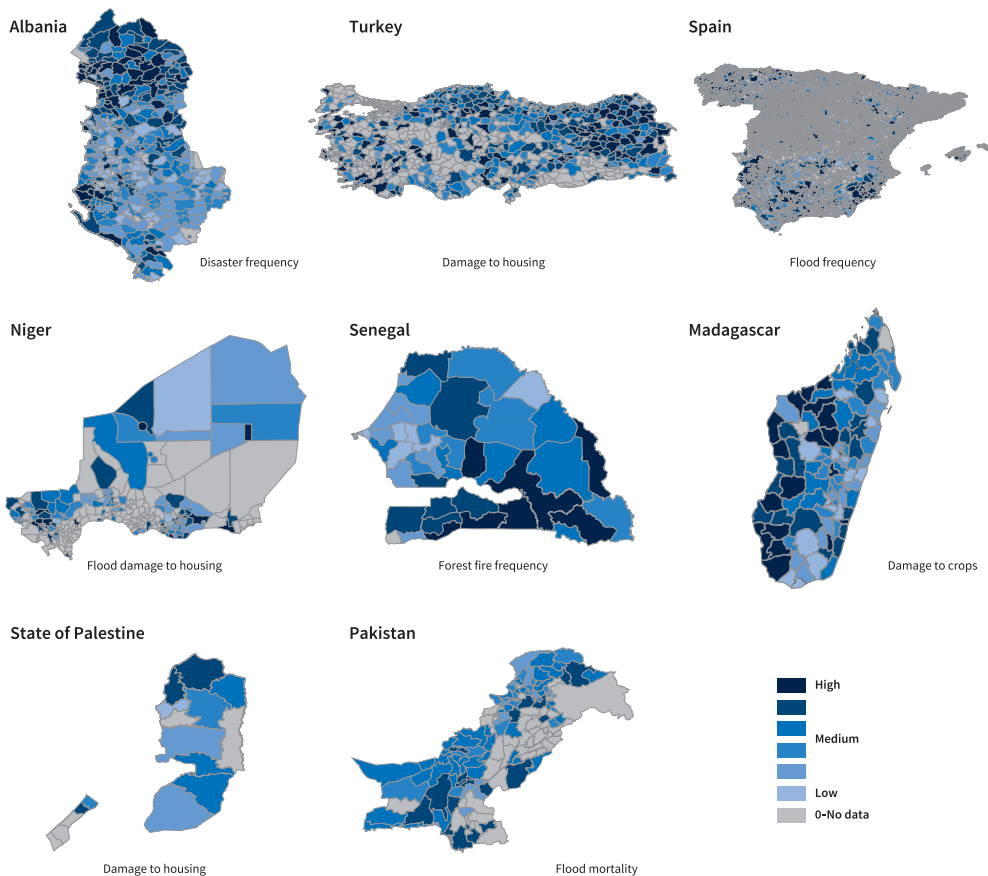
To uncover extensive risks, an increasing number of countries around the world are adopting a simple and well-defined methodology to report, analyse and display disaster occurrence and losses at the local level through a standard definition of hazards, impacts and other indicators.<sup>3</sup> Because the loss data is captured at the level of local administrative units, this makes it possible to record losses associated with huge numbers of small extensive disasters that are not internationally reported and thus do not appear in other disaster databases.

In a pattern that resembles the growth of computer processing power, the number of countries systematically collecting disaster loss data has roughly doubled every two years since these efforts began in Latin America in the 1990s.

GAR15 features data collected using the same methodology and parameters in 82 countries and 3 states (Tamil Nadu and Odisha in India, and Zanzibar in Tanzania).

Countries that have published data sets in the last two years, including: Comoros, Madagascar, Mauritius and Seychelles in the Indian Ocean; Morocco and Tunisia in North Africa; Niger, Senegal, Sierra Leone and Togo in West Africa; Barbados, Grenada, Saint Lucia, Saint Kitts and Nevis, Saint Vincent, and Trinidad and Tobago in the Caribbean; Cambodia, Pakistan and the State of Palestine in Asia; and Albania, Serbia, Spain and Turkey in Europe (Figure 4.2).

**Figure 4.2** Increase in number of national loss databases featured in Global Assessment Reports



(Source: UNISDR with data from national loss databases.)

this risk layer remained largely invisible. However, since 2007, a sustained effort to assist countries in systematically recording local disaster losses (UNISDR, 2009a, 2011a, 2013a) has generated systematic and comparable evidence regarding the scale of extensive risk from over 80 countries (Box 4.2). Given that 95 per cent of these databases have been built using a comparable approach and methodology, it is possible to analyse these local records at a global level of observation.

Table 4.1 shows that 99.1 per cent of the local-level loss reports from these 85 countries and states are manifestations of extensive risk, with 96.4

per cent resulting from weather-related events. The economic losses from extensive disasters account for more than 45 per cent of total accumulated loss.

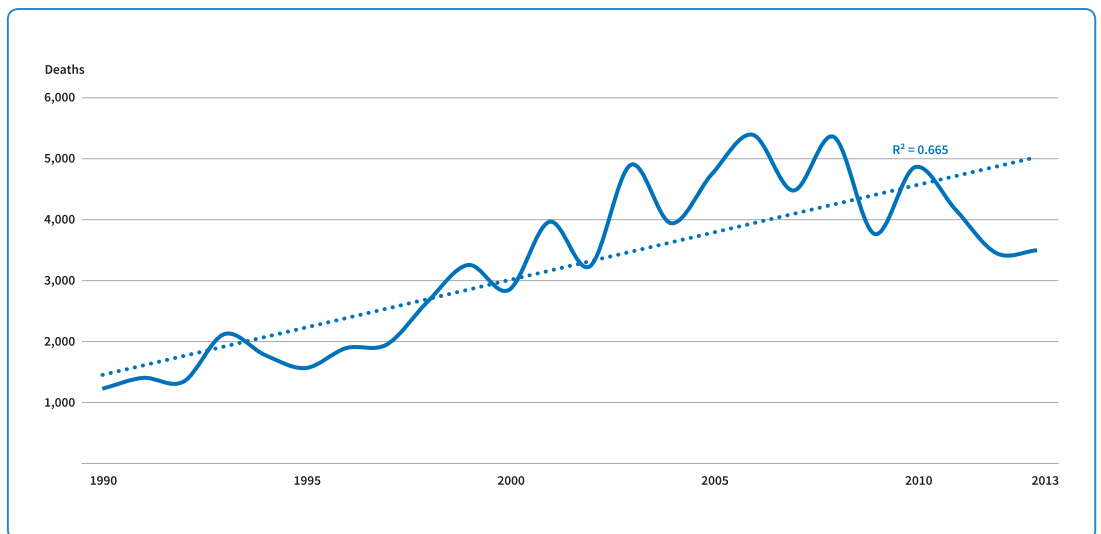
Across these countries, extensive disasters are responsible for only 14 per cent of total disaster mortality. However, since 1990 extensive mortality has increased almost fourfold in those countries that have consistent data spanning that period (Figure 4.3), and the trend is statistically significant.

**Table 4.1** National disaster loss data for 85 countries and states<sup>4</sup>

Risk Type	Event Type	Data Cards	%	Deaths	%	Houses Destroyed	%	Houses Damaged	%	Economic loss (in million US\$)	%
Extensive	Hydro-met.	335,795	97	107,114	96	1,476,291	91	10,213,834	94	187,817	95
	Geological	10,515	3	4,739	4	139,236	9	618,262	6	10,298	5.2
	Total	346,310	100	111,853	100	1,615,527	100	10,832,096	100	198,115	100
Intensive	Hydro-met.	2,449	81	265,771	33	6,395,253	63	5,301,601	27	160,923	38
	Geological	566	19	433,562	53	2,143,831	21	3,414,094	17	69,211	16
	Total	3,015	100	811,186	100	10,154,611	100	19,547,791	100	428,250	100

(Source: UNISDR with data from national loss databases.)

**Figure 4.3** Extensive mortality, 1990-2013 (65 countries, 2 states)<sup>5</sup>



(Source: UNISDR with data from national loss databases.)



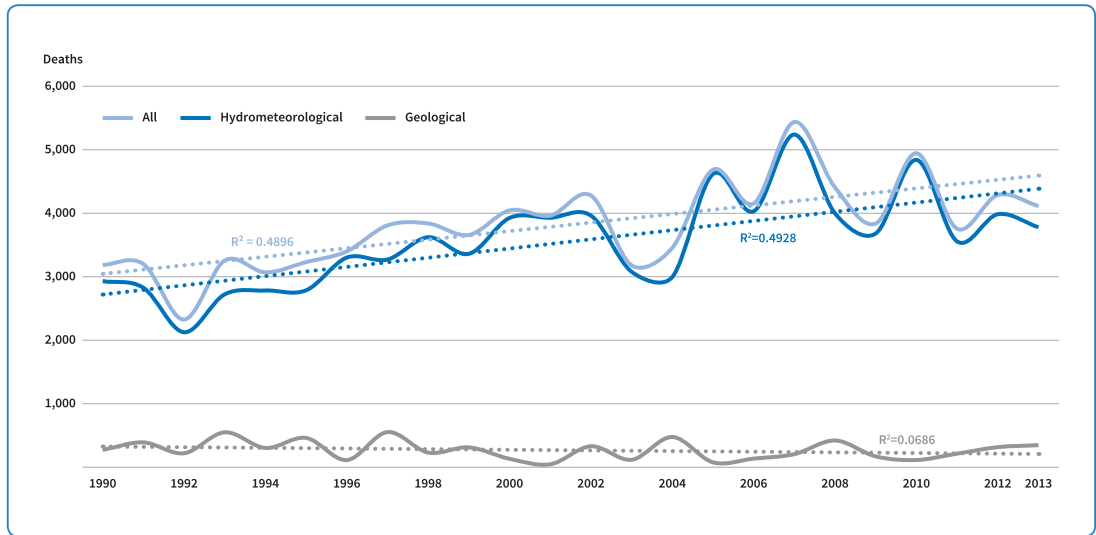
A similar trend can be observed among smaller-scale disasters in global loss data sets (Figure 4.4). There is a statistically significant trend towards increasing mortality in events with fewer than 100 deaths.

While extensive risk is responsible for only a small percentage of mortality, it is associated with a far more significant proportion of morbidity and displacement (Figure 4.6), both of which feed directly back into poverty.

Extensive disaster mortality is also increasing relative to population size (Figure 4.5).

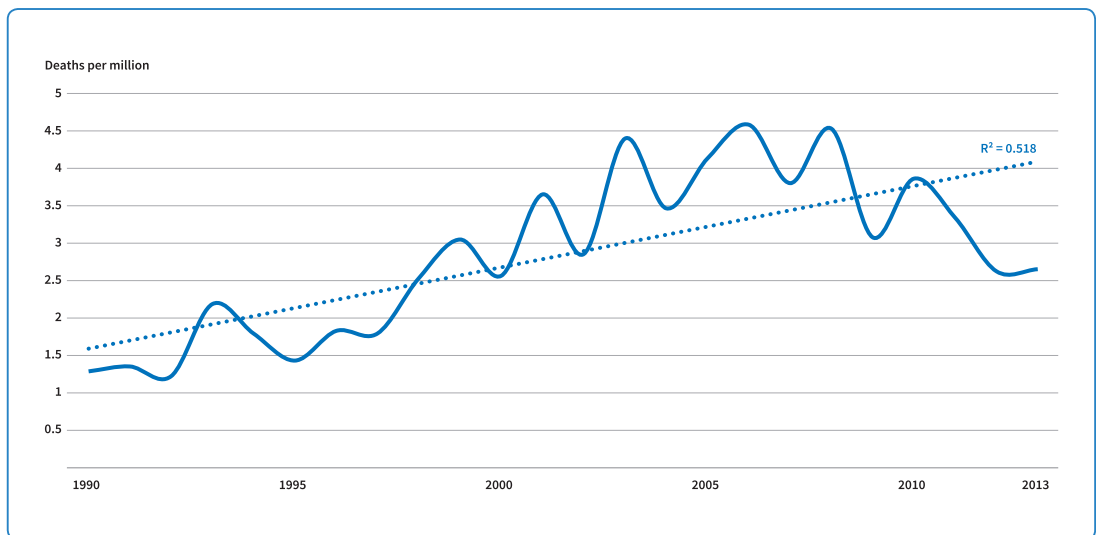
Extensive risk critically erodes development assets. Reports show that the majority of damage

**Figure 4.4** Internationally reported global disaster mortality (events with fewer than 100 deaths)



(Source: UNISDR with data from EM-DAT.)

**Figure 4.5** Extensive disaster mortality relative to population (65 countries, 2 states)



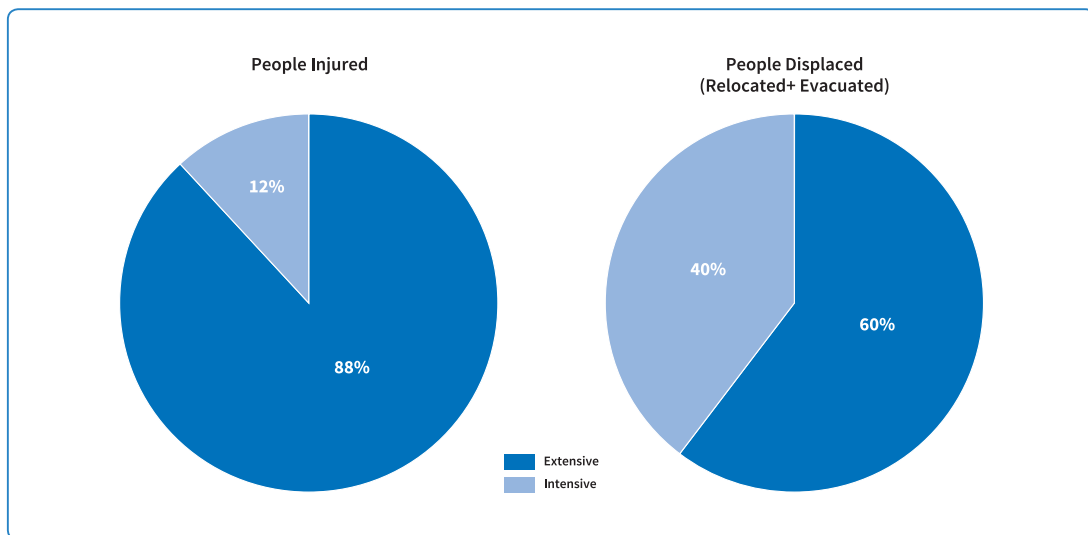
(Source: UNISDR with data from national disaster loss databases.)

and losses since 1990 have been associated with extensive disasters in those countries with consistent data sets (Figure 4.7).

This makes extensive risk a central concern for the low-income households and small businesses that depend on public infrastructure and for the local governments that provide it. These

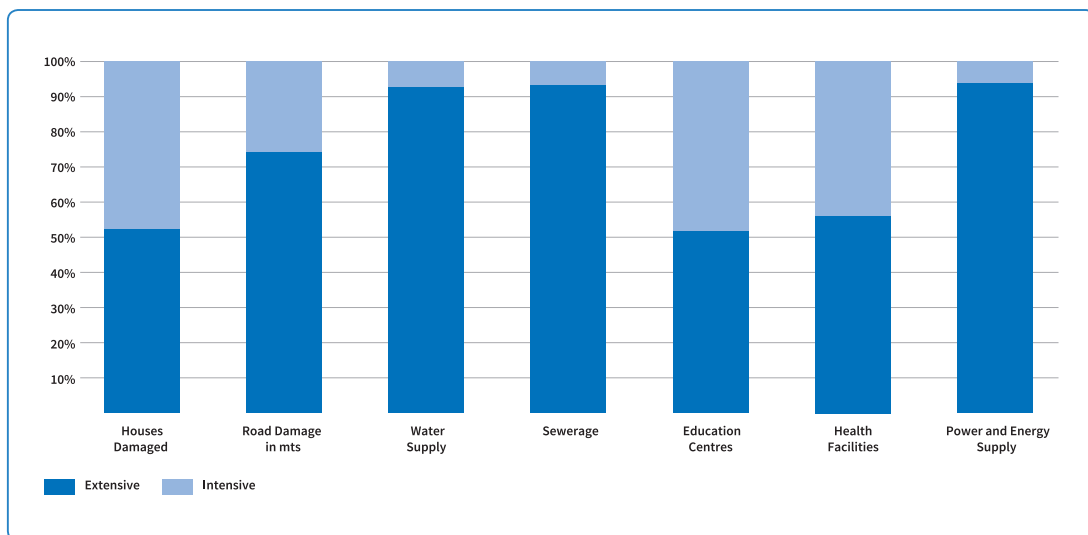
reported losses all show statistically significant upward trends from 1990 onward (Figure 4.8). In part, these trends reflect improved reporting in some countries. However, upon closer analysis, this bias has only a low to moderate influence on the overall trends.<sup>6</sup>

**Figure 4.6** Proportion of injured and displaced people reported in extensive disasters (65 countries, 2 states)



(Source: UNISDR with data from national loss databases.)

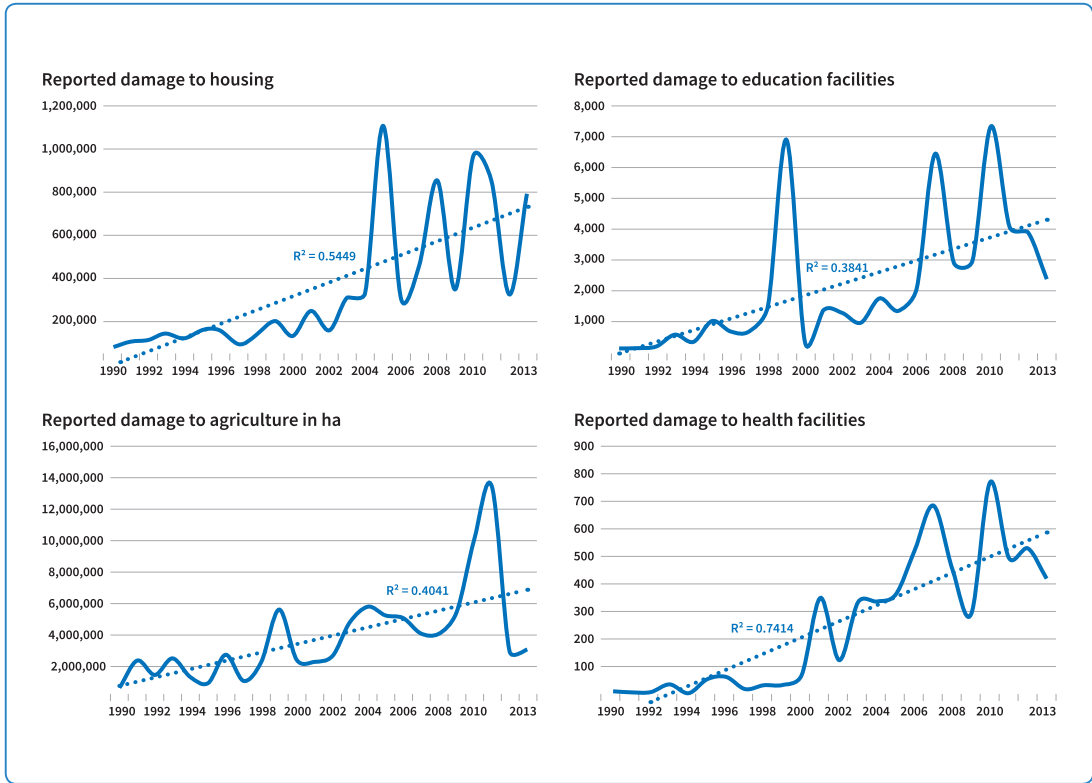
**Figure 4.7** Percentage of damage and loss from extensive and intensive disaster events (65 countries, 2 states)



(Source: UNISDR with data from national loss databases.)



**Figure 4.8** Reported damage from extensive disasters to housing, education and health facilities, and agricultural production (65 countries, 2 states)



(Source: UNISDR with data from national loss databases.)

## 4.2 Undermining development capacities and gains

**Losses from extensive disasters are responsible for most disaster morbidity and displacement, and represent an ongoing erosion of development assets. This presents a particular challenge to the achievement of development goals in areas and regions that already experience social inequality and exclusion.**

Extensive risk particularly challenges the achievement of development goals in areas and regions already characterized by social inequality and exclusion. The deficit of infrastructure in these areas is already an underlying driver of vulnerability and disaster risk and weakens resilience. The loss of this infrastructure in

disasters further aggravates the situation, generating a vicious cycle. For example, a deficit of primary health facilities increases the vulnerability of low-income households that suffer flooding. Households with poor health are likely to be less resilient to disaster loss, and the damage or destruction of those facilities in disasters further compounds the problem.

The economic value of these social assets is significant. While the economic losses from intensive disasters are usually evaluated by governments or international organizations and insured losses are assessed by the insurance industry, the economic cost of extensive risk is largely unaccounted for and ultimately reabsorbed into poverty. Estimates of the cost of those unreported disasters highlight a growing and largely unknown

economic loss since 1990 as well as an overlooked poverty factor.

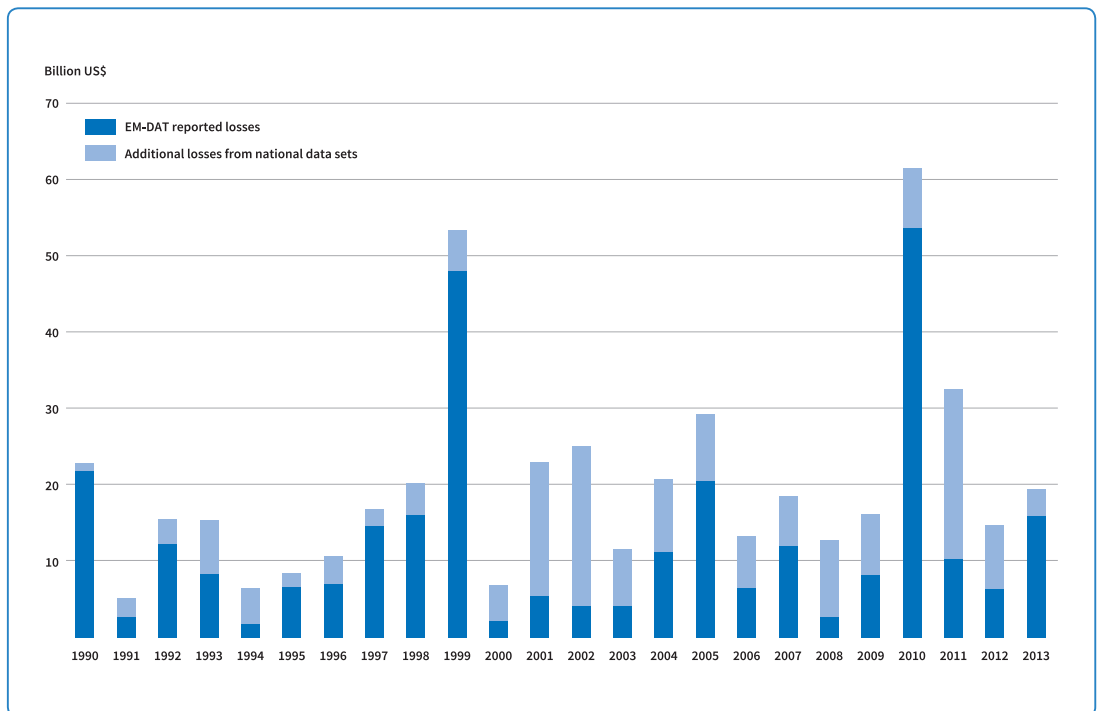
In 2012, EM-DAT reported economic losses of US\$157 billion, an estimate that is lower than those published by Swiss Re (US\$186 billion), Munich Re (US\$160 billion) and Aon (US\$200 billion). If the economic cost of assets lost in extensive disasters in 82 countries (Figure 4.9) is extrapolated globally, direct economic losses would be around 60 per cent higher than those internationally reported by EM DAT, implying a total of around US\$250 billion for 2012.

This total loss represents 0.33 per cent of global GDP, 1.4 per cent of global capital investment and an annual loss of more than US\$35 per capita.<sup>7</sup> For those 1.4 billion people living below the poverty line with an income under US\$1.25 per day,<sup>8</sup> the loss is equivalent to almost 8 per cent of their annual income.

In particular, such losses represent a serious erosion of public investment in some of those countries with the least capacity to invest. For example, the average historical annual losses from disasters in Madagascar since 2001 are equivalent to around 75 per cent of annual average public investment in the same period;<sup>9</sup> in El Salvador, they amount to almost 60 per cent, and in Vanuatu they exceed 40 per cent.

Chapter 2 showed how countries have partially succeeded in reducing mortality in intensive disasters through improvements in disaster management. In contrast, the increasing level of extensive risk shows how countries have not been able to address the underlying risk drivers. Increasing risk at the local level is the necessary counterfactual to the success in reducing disaster mortality in some countries. It is in reducing *losses in the social and economic assets of communities* where countries have gained the least traction in the HFA.

**Figure 4.9** Economic losses reported internationally and additional losses reported nationally in 82 countries, 1990-2013



(Source: EM-DAT and national loss databases.)



Increases in extensive risk threaten efforts to reduce poverty and to achieve the Sustainable Development Goals related to poverty and social development, and they highlight that understanding and practising disaster risk reduction as disaster management has not been effective in avoiding risk generation and accumulation. This theme will be explored further in Parts II and III of this report.

## Notes

---

**1** A new analysis of national disaster loss data shows that between 1980 and 2013, 41 countries reported a total of more than 6,000 events involving electrical storms which killed more than 8,700 people, injured around 4,500 people and destroyed almost 42,000 houses.

**2** <http://www.desenredando.org/public/libros/1999/edete/>.

**3** For more information on national loss databases and the data sets used in this report, see [www.desinventar.net](http://www.desinventar.net).

**4** 82 countries and 3 states (Odisha and Tamil Nadu, India, and Zanzibar, Tanzania) in total over varying time frames. For access to the loss databases and more details on the countries and states included, see [www.desinventar.net](http://www.desinventar.net).

**5** The two states referred to in Figures 4.3, 4.5, 4.6 and 4.7 are Odisha and Tamil Nadu, India.

**6** Only a very small group of countries show an increasing trend that can be associated with improved reporting, but the population of those countries (and the impact reported) is low in comparison to the majority of countries with loss databases. The group with low reporting bias accounts for more than 95 per cent of the population represented (1.6 billion) and 74 per cent of all reports in the sample. Reports of mortality impacts show similarly stable patterns, and reports on other types of impacts show slightly higher trends which suggest that better reporting should be taken as one of the causes of the increase, but with a moderate to low influence. See Annex 2 for more details.

**7** Gross Domestic Product (GDP) and Gross Fixed Capital Formation (GFCF) of 2013.

**8** Data from the World Bank Development Indicators: <http://data.worldbank.org/>.

**9** Public investment was calculated as an average of the annual percentage of public investment in relation to GDP from 2001 to 2011, based on data from the World Bank.

## Chapter 5

# Resilience challenged



**In those countries where AAL significantly exceeds key economic progress metrics, such as average annual GDP growth, national savings rates or the ratio of new capital investment to existing capital stock, it is impossible to ensure sustained, let alone sustainable, growth.**

**Where countries are not able to buffer and absorb disaster losses, economies can be severely disrupted. A significant number of countries face this challenge even for events that may happen within a 50 to 100-year time span.**

In lower-income countries, and in particular in countries like SIDS with small economies, disaster losses may challenge an economy's resilience, that is, its capacity to absorb losses and recover. There is insufficient data and evidence to show whether economic resilience has increased or decreased since the adoption of the HFA.

However, existing evidence on the distribution of risk and countries' ability to absorb losses points to critical differences related to income levels, insurance coverage, the size and pattern of economies, and the financial capacity of various countries.

## 5.1 National resilience challenges

**Economies can be severely disrupted if there is a high ratio of AAL to the value of capital stock and savings. Similarly, future economic growth can be compromised if there is a high ratio of AAL to capital investment and reserves. Social development will be challenged if there is a high ratio of AAL to social expenditure.**

### **The capacity for future development**

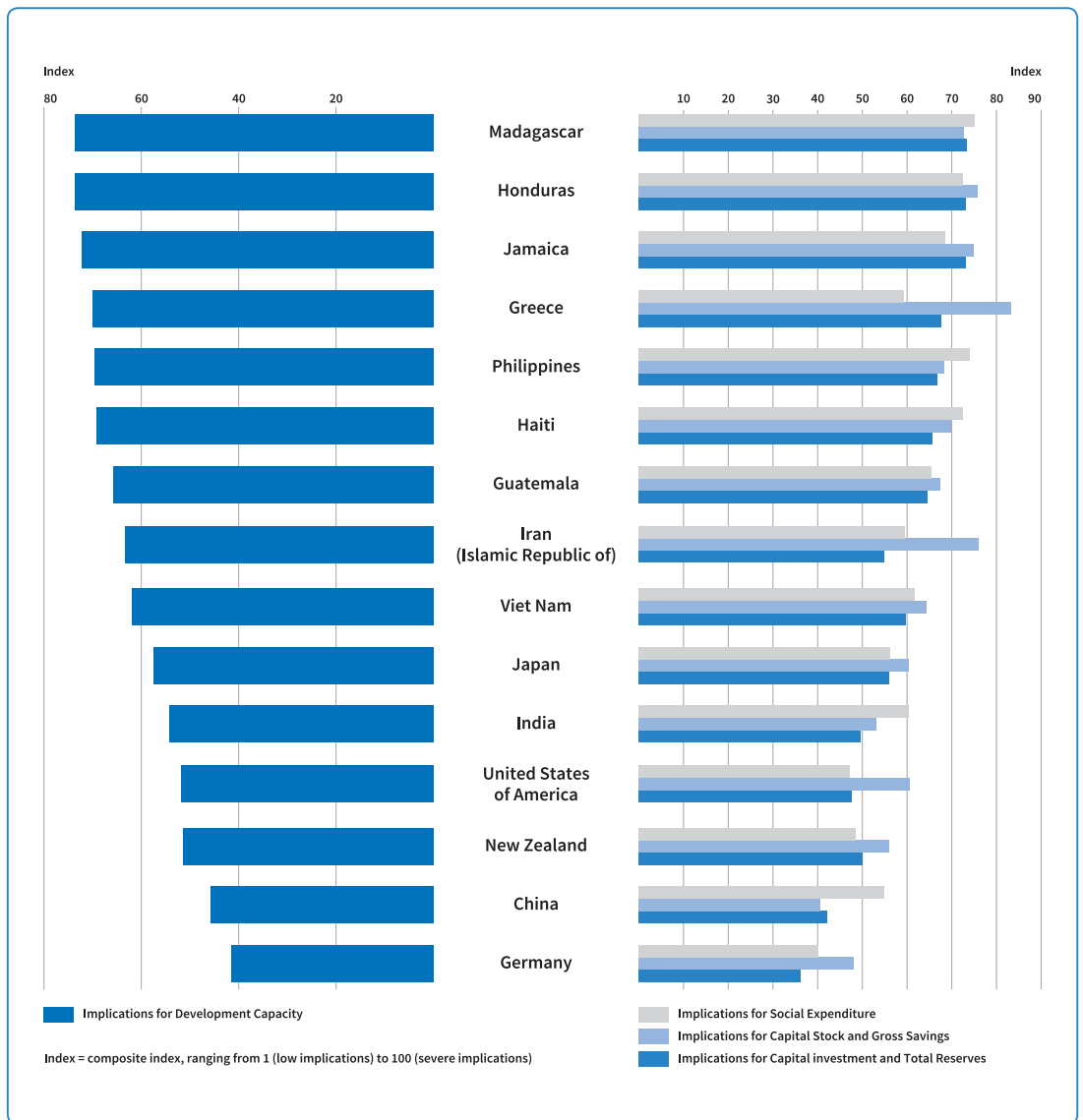
AAL can be interpreted as an opportunity cost given that resources set aside to cover disaster losses could be used for development. As highlighted in Chapter 3, in certain income groups and geographic regions, in particular in SIDS and some low-income countries, AAL estimates represent a significant proportion and in some cases surpass levels of capital investment and social expenditure. In those countries, the AAL is also often

significant with respect to other economic progress metrics, such as the existence of reserves or national savings rates. In such circumstances, it is impossible to ensure sustained, let alone sustainable, growth.

Ultimately the capacity of a country to develop sustainably will depend on the combination of these different factors. Economies can be severely disrupted if there is a high ratio of AAL to the value of capital stock and savings. Many countries will not be able to cover their AAL through domestic savings, which may impact their capacity to invest in social and economic development. Countries with high rates of domestic savings will be better able to absorb even high levels of AAL. Similarly, future economic growth can be compromised if there is a high ratio of AAL to capital investment and reserves. Social development will be challenged if there is a high ratio of AAL to social expenditure. Ultimately the countries where development and the achievement of the SDGs will be most challenged by disaster risk are those where the AAL represents a high proportion across all three domains (Figure 5.1).

This highlights that the countries with high risks to development include not only low-income countries such as Madagascar and Haiti but also middle-income countries like Honduras, Jamaica and Philippines, and high-income countries like Greece. Although Jamaica and Greece have a far lower relative AAL compared to the Philippines, Honduras and Madagascar, the negative implications for development are very similar. At the same time, while it is economic growth that

**Figure 5.1** Countries with high overall ratio of AAL to social expenditure, capital stock and savings and capital investment and reserves



(Source: UNISDR with data from Global Risk Assessment and the World Bank.)

is most threatened in Greece, it is social development that is most threatened in the Philippines.

### Fiscal resilience

Budgeting for disaster loss based on the AAL is critical but not enough. As the AAL is an annual average, it does not guarantee economic and fiscal resilience against high-level events for countries that lack the fiscal resilience to cope with

extreme but infrequent losses. Fiscal resilience is broadly defined as comprising internal and external savings to buffer against disaster shocks. Once domestic savings are exhausted, a common approach is to divert funding from discretionary budgets, which in some cases may have been previously earmarked for development spending. In other cases, countries utilize loans from international or multilateral financial institutions

for recovery, reallocating funding and reducing the available future borrowing capacity for development as well, thus hampering future growth.

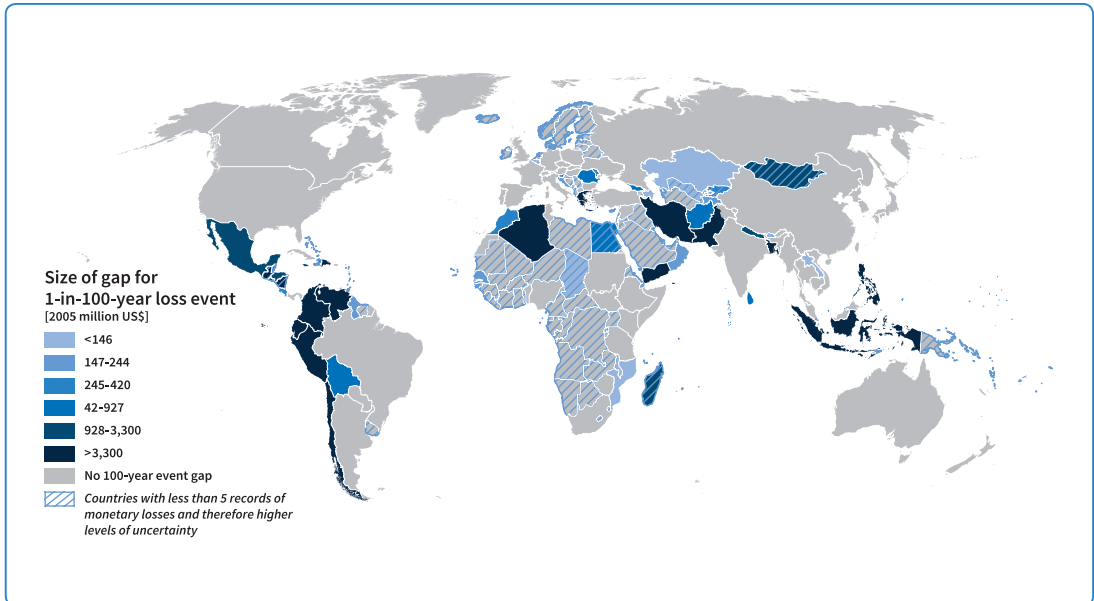
In most higher-income countries, a significant proportion of economic losses are insured. For example, in the July 2013 hailstorms in Germany and France, an estimated US\$3.8 billion of the total losses of US\$4.8 billion were insured, as were US\$1.9 billion of the total losses of US\$4.7 billion in the June 2013 floods in Canada (Swiss Re, 2014a). Furthermore, despite their size in absolute terms, these losses are rarely significant compared with annual capital investment in those countries.

In contrast, many countries with lower incomes and smaller economies, including least developed countries (LDCs) and small island developing states (SIDS), are severely challenged by rising economic loss. In such countries, most loss is uninsured and governments do not have the financial reserves or access to contingency financing that would allow them to absorb losses,

recover and rebuild. For example, while estimates of the total losses from Typhoon Haiyan vary, there is agreement that insured losses are only a small fraction of the overall loss due to low insurance penetration in the region. For example, AIR Worldwide estimates total damage at US\$6.5 billion to US\$14.5 billion, of which only US\$300 million to US\$700 million are thought to be insured.<sup>1</sup> In fact, a considerable number of countries face resource gaps for events with return periods below 100 years. For example, while Canada and the United States would only face challenges in absorbing the impact from a 1-in-500-year loss, Algeria, Bolivia, Chile, Indonesia, Iran, Madagascar, Mozambique and Pakistan would face difficulties finding the resources to absorb the impact from as small as a 1 in 3-25 year loss (Williges et al., 2014). Clearly, the financial risk to these countries is substantial. In particular, a very significant number of countries would not pass a stress test of their financial capacity to absorb the impact of a 1-in-100-year loss (Figure 5.2).<sup>2</sup>

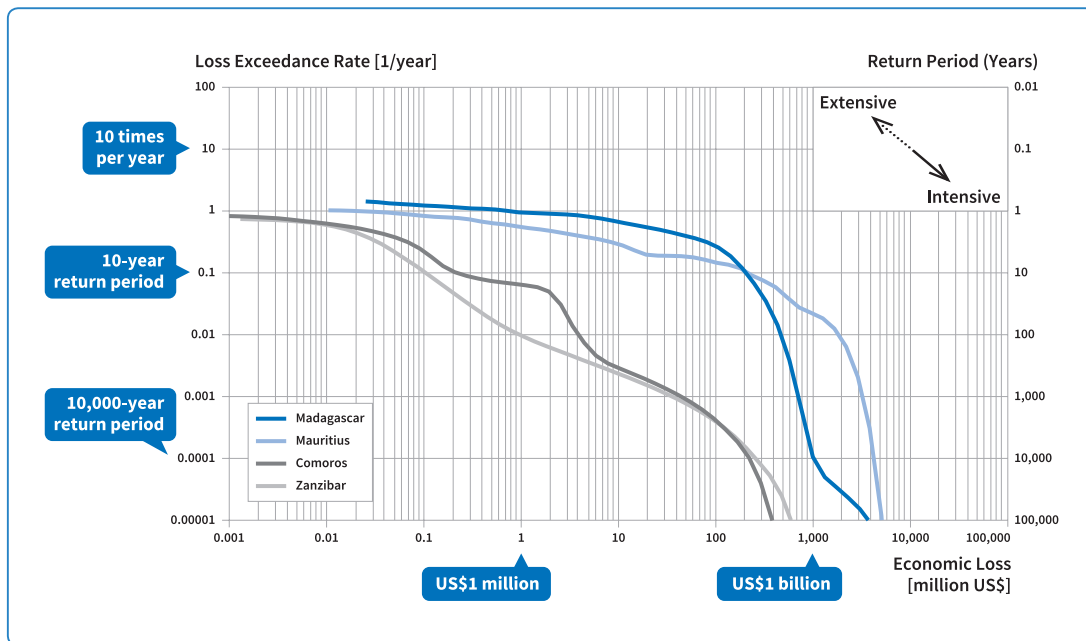
**Country financing gap** 

**Figure 5.2** Countries facing a financing gap for a 1-in-100-year loss event



(Source: Williges et al., 2014.)

**Figure 5.3** Disaster risk in Zanzibar, Mauritius, Madagascar, and Comoros



(Source: UNISDR with data from CIMNE.)

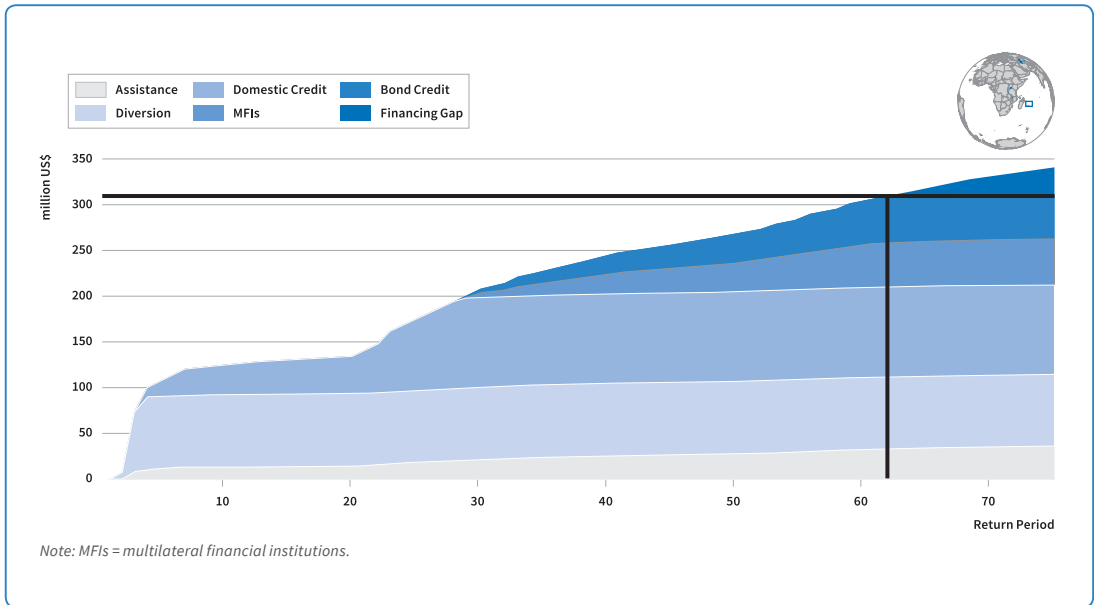
Coupled with the limited availability of reserve funds, contingent credit agreements, insurance and access to emergency financing options, the limited investments in reducing existing risk and avoiding the creation of new risk mean that many SIDS in particular are characterized by high risks and low economic resilience. In the Indian Ocean, calculating risk in Madagascar, Mauritius, Comoros and Zanzibar (Figure 5.3) has been a first step in identifying the threshold of loss levels where countries would struggle to finance a recovery. In these countries, losses with return periods of 500 years would require resources equal to 7 to 18 per cent of GDP (Williges et al., 2014).

Countries with large budget deficits are usually unable to divert funding from revenues to absorb disaster losses and therefore need to use other mechanisms, including taxation, national and international credit, foreign reserves, domestic bonds, aid and risk financing instruments. Using all these financing mechanisms, Mauritius would still face a resource gap for any losses from

cyclone wind and earthquake with a return period of 62 years or over (Figure 5.4). The corresponding return period is only 24 years for Madagascar and 28 years for Comoros (Mochizuki et al., 2014).

A limited ability to absorb losses can increase the indirect economic costs of a disaster and can slow recovery (UNISDR, 2013a). For example, disruptions in the transport sector due to post-disaster reconstruction delays can impact on a range of other sectors, such as manufacturing and retail trade. However, access to ex-ante financing arrangements can prevent this problem (Williges et al., 2014). For example, assuming that post-disaster reconstruction financing were available in Cambodia 6 months to 1 year after a disaster,<sup>3</sup> access to ex-ante financing, such as contingent credit to facilitate more rapid recovery, would help stem the decline in economic output across a range of sectors, ranging from more than US\$1 million in retail trade to almost US\$6 million in the transport sector and US\$7.5 million in manufacturing (ibid.).

**Figure 5.4** Financing gap for cyclone wind and earthquake risk in Mauritius



(Source: Mochizuki et al., 2014.)

In addition to ex-ante financing mechanisms, investments in disaster risk reduction measures are expected to significantly reduce the expected negative impact of disasters on economic growth (UNISDR, 2013a). Previous analysis has shown, for example, that a 1-in-100-year event in Honduras could produce direct losses of up to 33 per cent and additional indirect and cumulative losses of up to 24 per cent of GDP. New simulations of real GDP growth after historical disaster impacts in Honduras—with and without previous disaster risk reduction investments—show that these losses could be significantly reduced by investing in risk reduction.<sup>4</sup> Interestingly, the simulations also show that in a country such as Honduras, where high-intensity disasters occur relatively frequently, even larger investments targeted at reducing the risk of large-scale events make financial and economic sense.

In countries with very low rates of capital investment, recovery may take years if disasters destroy a significant proportion of their capital stock. Countries with small and vulnerable economies

have particularly low resilience, as their entire economy may be devastated; if they also have limited fiscal manoeuvrability, they may also have difficulties financing a recovery (UNISDR, 2009a).

The cumulative effect of disaster loss on fixed capital may be dramatic in SIDS such as Vanuatu (Figure 5.5) or small countries like Belize.<sup>5</sup> It is estimated that Belize has lost almost 18 per cent of its accumulated capital investment since 1970 due to the cumulative effects of disasters over the past 20 years. For Vanuatu, this amounts to a full 24 per cent of capital investment since 1970. However, even in higher-income small island states, economic losses can also have a highly disruptive effect on economic development. For example, the Cayman Islands suffered significant losses from Hurricane Ivan in 2004 and its economy still has not recovered fully, leading to a reduction of cumulative capital investment by almost 23 per cent since 1970.

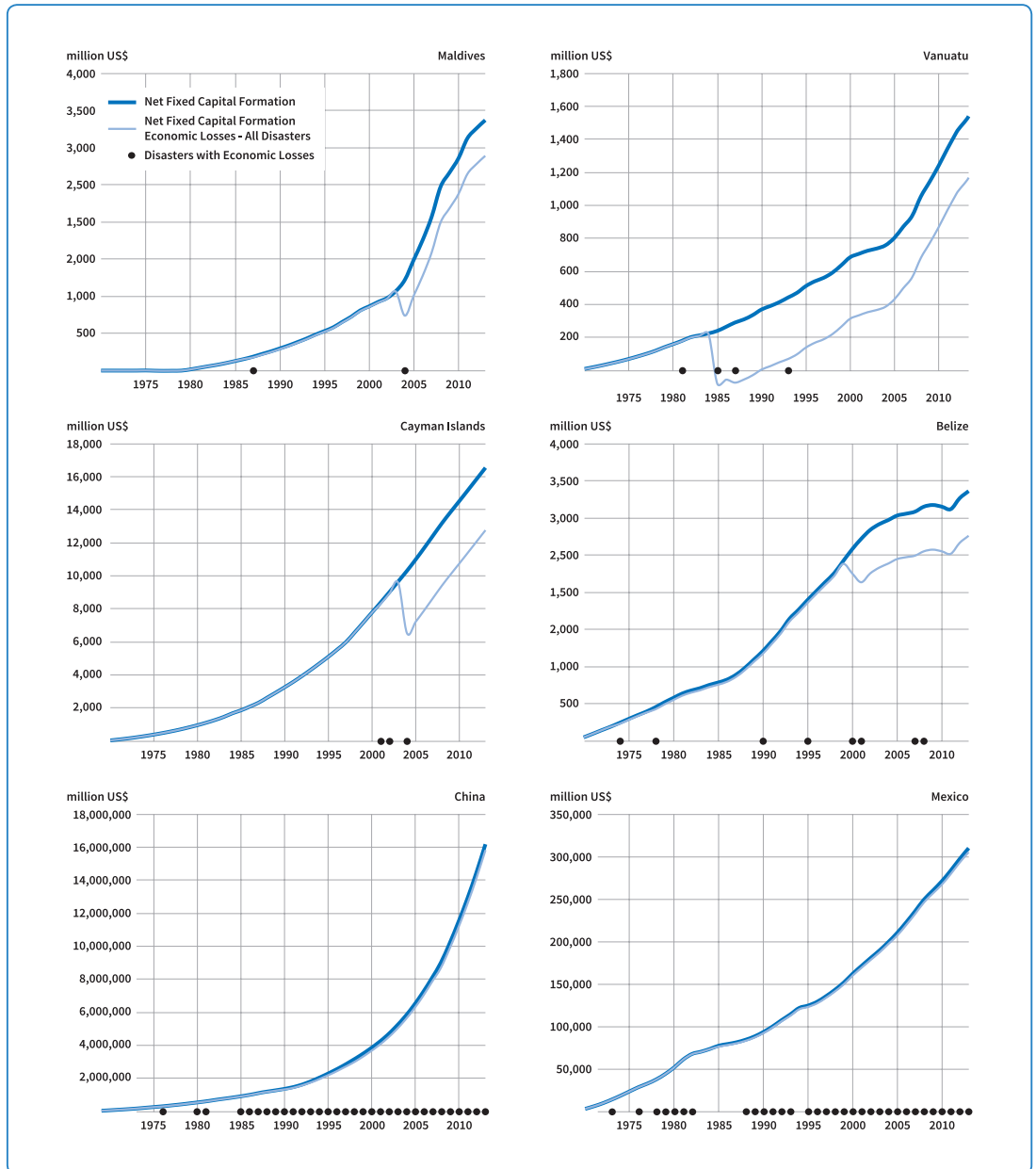
In contrast, large economies such as China or Mexico seem to have sufficient capacity to absorb

losses from a large number of events without significant effects on economic growth in the years following the event.

As the HFA draws to a close, there is also more evidence that disaster loss negatively affects

longer-term growth prospects in countries with limited liquidity and assets (Hochrainer, 2009; Noy, 2009) despite potential short-term increases in GDP due to reconstruction efforts and through large cash injections into the local economy (Kim, 2010; Cavallo et al., 2009; Albala-Bertrand, 1993

**Figure 5.5** National economic growth with and without disaster loss impact



(Source: Baritto, 2014 with data from EM-DAT and the World Bank.)



and 2006; Skidmore and Toya, 2002). For example, cyclone impact simulations for various countries show that medium-term economic performance would be adversely affected by disaster losses (UNISDR, 2013a).

## 5.2 No place to call home

**When disasters affect already vulnerable people, the resulting patterns of migration and displacement themselves can become drivers of new risks.**

La Anemona is a community of almost 200 families on the periphery of San Salvador, a community born out of disaster (Figure 5.6). When Hurricane Ida swept over El Salvador in 2009, the people of La Anemona suffered heavy losses and decided to leave their former homes. The land they chose lacks basic infrastructure, services

**Figure 5.6** La Anemona, El Salvador



(Source: Lynette Wilson/Episcopal News Service.)

and land titles, and is considered unsuitable for housing, but it was the only unoccupied land the families could find.<sup>6</sup>

Almost 90 per cent of El Salvador's land mass and more than 95 per cent of its population are considered to be at risk of disasters.<sup>7</sup> Examples of communities such as La Anemona abound, showing similar patterns of how migration and displacement themselves become drivers of new risks (Box 5.1).

### **Box 5.1** Mobility and vulnerability in Alaska

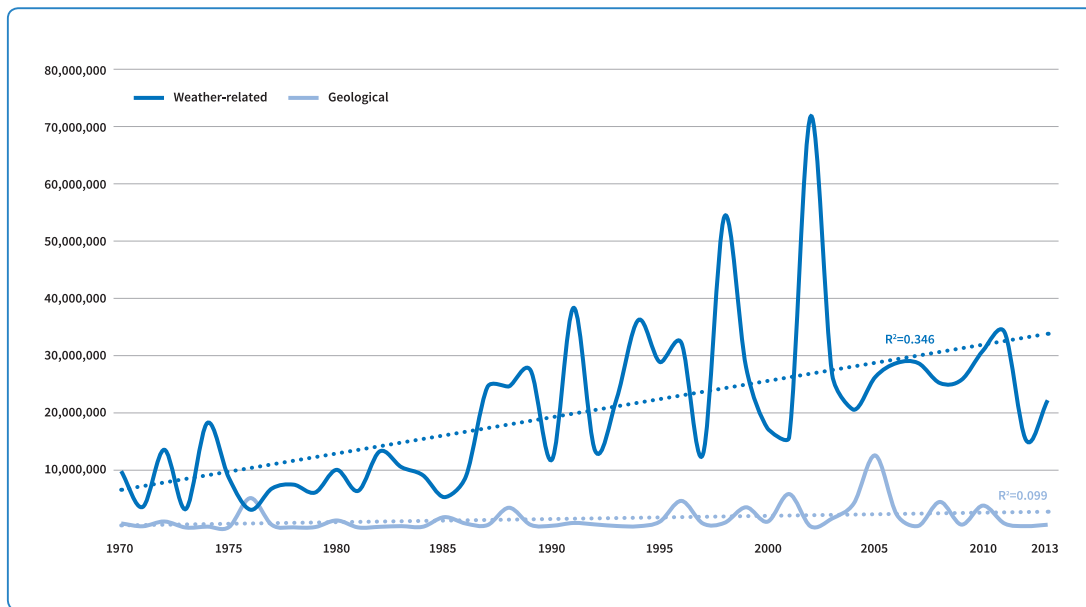
The Kigiqitamiut people, a small Inupiat community on Alaska's Bering Sea, are used to practising mobility as an adaptive strategy, having lived a nomadic existence for centuries as a fishing and hunting community. But at the beginning of the twentieth century, the government promoted their settlement (Marino, 2011), creating new risk by locking the Kigiqitamiut into a sedentary lifestyle in a hazard-exposed environment as well as creating dependency on non-local products. Over the last few decades, and despite protection measures put in place, houses and basic infrastructure have been destroyed by diminished sea ice, more frequent winds and storms, and increased coastal erosion and flooding (ibid.).



Today, climate change is adding to the challenges the community faces, and the question of relocating the entire village of Shishmaref has become a major concern, manifest in the creation of the Shishmaref Erosion and Relocation Coalition in 2001 (USGAO, 2009). But Shishmaref's relocation is not without obstacles. First, the cost is estimated at around US\$180 million for only 609 inhabitants (ibid.). While U.S. legislation has guidelines for "recovery through rebuilding", no clear guidelines exist for cases in which complete relocation is required; in Shishmaref, *in situ* reconstruction is not sustainable in the long run due to sea level rise and coastal erosion. Finally, the lack of coordination between different actors and government agencies is also an obstacle to effective relocation (Marino, 2011).

The case of the Kigiqitamiut people highlights that dramatic social changes can be expected and that economic investments will not only have to be made in small island developing states and low-income nations. In Shishmaref, a marginalized minority community in one of the richest countries in the world, future predictions of climate risk have already become reality. Other parts of the world may follow soon.

**Figure 5.7** People displaced by disasters since 1970



(Source: IDMC, 2014.)

New global data sets enable up-to-date estimates of the number of persons displaced by disasters (IDMC, 2014). The figures are not encouraging, particularly for weather-related disasters, as they show a clear upward trend over time (Figure 5.7), with 143.9 million people displaced by disasters between 2008 and 2012 alone.

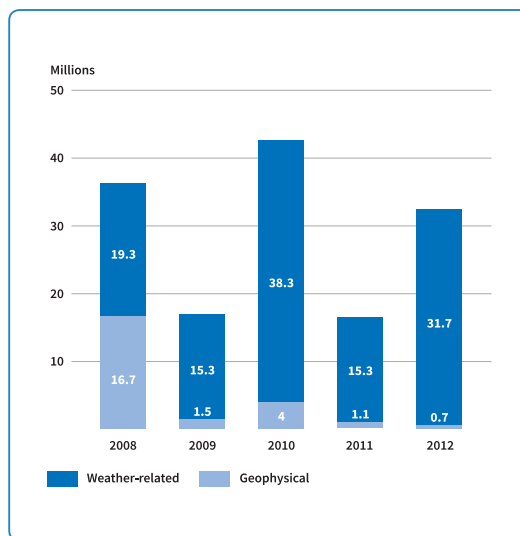
Displacement is particularly associated with weather-related disasters (Figure 5.8). International estimates of displacement trends and patterns are hampered by limited data availability. Due to the multidimensional and complex dynamics of migration and displacement, quantitative projections for future trends have low confidence levels, even though there is agreement that climate change will drive future displacement and patterns of movement (IPCC, 2014; Gemenne, 2010).

Where data is available, it highlights that disaster impacts go far beyond the immediate loss of assets. Between 2008 and 2014, for example, it is

estimated that 165 million people were displaced by disasters (IDMC, 2014).

While mobility, migration and displacement are sometimes consequences of disasters, they can

**Figure 5.8** People displaced due to weather-related and geophysical hazard events



(Source: IDMC, 2014.)



also be drivers of new disaster risk (IOM, no date). Investment and economic development in hazard-prone regions attract people to those areas. As a result, the population in hazard-exposed regions is growing proportionally faster than elsewhere (UN-HABITAT, 2010; UNISDR, 2011a; Lall and Deichmann, 2011).

Human mobility has always been a strategy to manage environmental risk and natural resources (Oteros-Rozas, 2012; Warner et al., 2012; Castillo, 2011). But increasingly, everyday social and political risks add to the pressures on marginal groups in society to migrate (Schensul and Dodman, 2013). Local displacement can also drive up hazard exposure and vulnerability by increasing the pressure on already fragile resource bases (de Sherbinin et al., 2007; UNISDR, 2009a; Peduzzi, 2010), and urban displacement is a particularly important driver of disaster risk (IPCC, 2014). Where informal settlements are demolished to make way for the development of shopping malls, luxury apartments and hotels (Menon-Sen and Bhan, 2008), people are often displaced to other hazard-prone locations.

Thus displacement and migration put a spotlight on the critical role that vulnerability will continue to play in driving disaster risk upwards over the years to come.



### No country for old men

Aside from migration and displacement, demographic change will continue to shape risk patterns and trends, including future complex and systemic risks. Ageing populations in OECD countries, but also in some emerging economies, mean that an increasing share of people affected will be over 60, which will increase fatalities, longer-term impacts on well-being and the livelihoods of a large part of the population.

Evidence from recent events indicate that this trend is already showing its effects: 71 per cent of lives lost during Hurricane Katrina and around 50 per cent of fatalities from Hurricane Sandy were people aged 60 and over (Parry, 2013). During heat waves such as the one experienced in Europe during 2003, most lives lost are those of the elderly (OECD, 2014a).

## 5.3 The international resilience challenge

**The increasing gap between demand for response to disasters and available global funding highlights the need for effective disaster risk reduction. Resource gaps in a number of countries are significant even for relatively frequent events.**

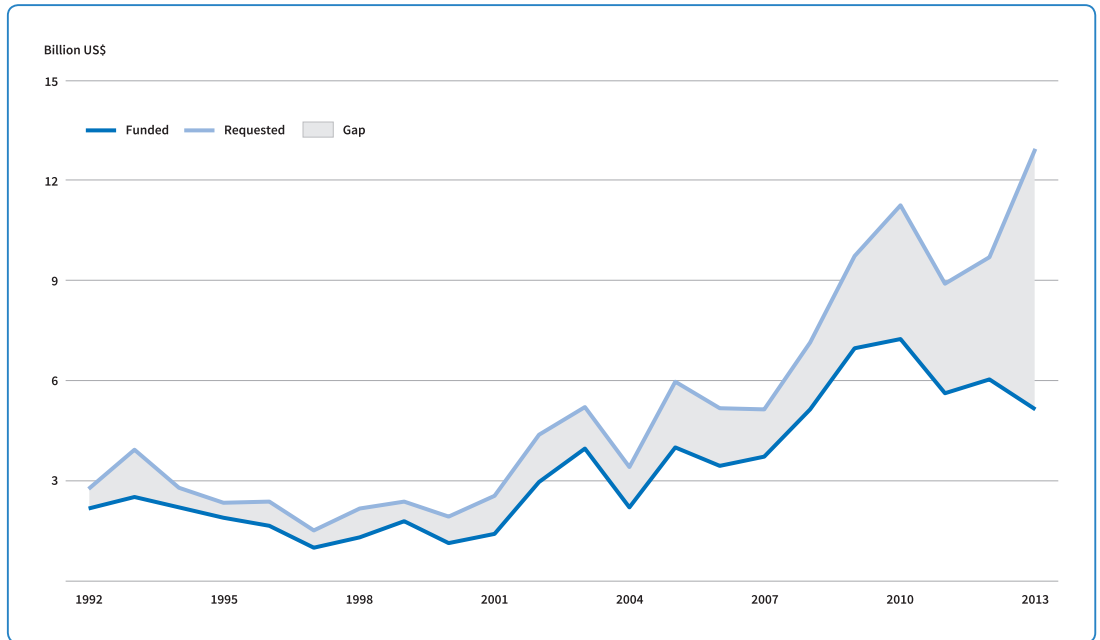
There is also a *humanitarian resource gap*, which can be expressed as the difference between estimated losses and the funding provided by the global humanitarian community. While it has been internationally recognized that response and relief are not sustainable as the main pillar of disaster risk management, recent figures are a stark reminder that this gap continues to grow (Figure 5.9). While humanitarian funding requests have more than quadrupled over the last 20 years, the gap between the funding requested and provided has grown by more than 800 per cent. In other words, global funding requirements are increasing, while the national and international capacity to meet them is not growing at the same rate. Rather than justifying the need for additional humanitarian assistance, this reinforces the case for investing in disaster risk reduction. Ultimately, the growing humanitarian resource gap is unsustainable, and an approach based principally on responding to disaster is increasingly bankrupt.

Globally, the resource gaps vary significantly for different risk layers (Figure 5.10). For example, covering the resource gaps caused by losses with

a return period of 10 to 50 years would require more than US\$2.5 billion per year globally (Hochrainer-Stigler et al., 2014). This is based on the assumption that there is a cap on the maximum payment a country can receive, as is usually the case with reinsurers' average claim payments.

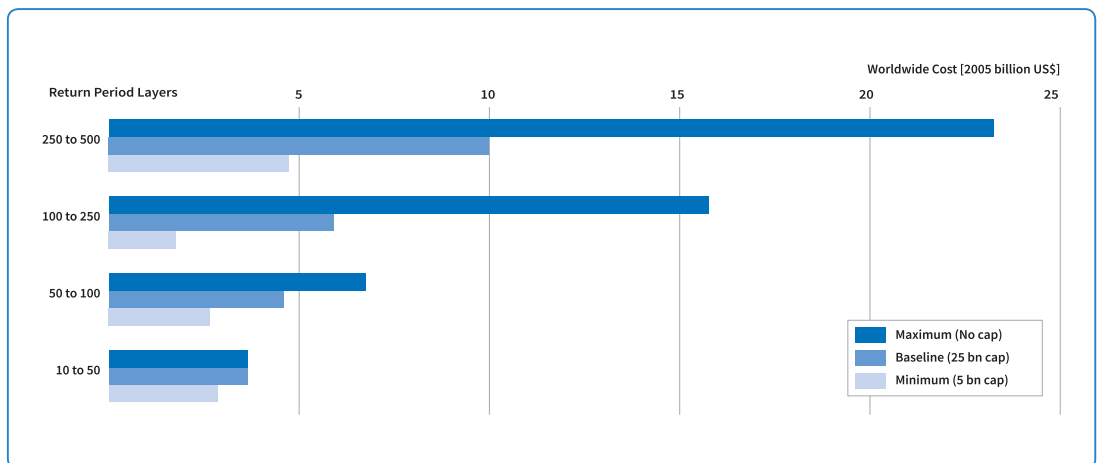
Assuming there is no cap on payments that can be made to countries, the funding requirements grow dramatically, ranging from US\$3.3 billion per year for a loss with a 10 to 50-year return period to more than US\$20 billion per year for a loss with a 250 to 500-year return period.

**Figure 5.9** Funding requested and received through United Nations appeals (CAP and flash appeals)



(Source: UNOCHA, 2014a.)

**Figure 5.10** Resource gaps for different risk layers at the global level



(Source: Hochrainer-Stigler et al., 2014.)

## Notes

---

1 <http://www.air-worldwide.com/Press-Releases/AIR-Estimates-Insured-Losses-from-Super-Typhoon-Haiyan-at-Between--USD-300-Million-and-USD-700-Million>.

2 Calculations are based on results of the UNISDR Global Risk Assessment for earthquakes, tropical cyclone wind and storm surge, and tsunamis. Estimates of losses from flood events were generated by fitting empirical loss observations to parametric loss curves. These results should not be used for in-depth national analysis. For further information on the methodology, see Williges et al., 2014, and Hochrainer-Stigler et al., 2014.

3 Information provided by the Japan International Cooperation Agency (JICA) in support of GAR15. The simulations were carried out with JICA's improved *DR2AD model*, an economic model that allows policymakers to assess the impacts of disasters and the benefits of disaster risk reduction investments at different points in time.

4 A similar calculation was performed for the 2009 Global Assessment Report; the findings from that time have been confirmed using 5 additional years of new data and the analysis has been updated.

5 <http://episcopaldigitalnetwork.com/ens/2013/06/25/natural-disasters-displacement-perpetuate-poverty-in-el-salvador/>.

6 <http://www.pnud.org.sv/2007>.





## **Part II**

# **Inside disaster risk management**

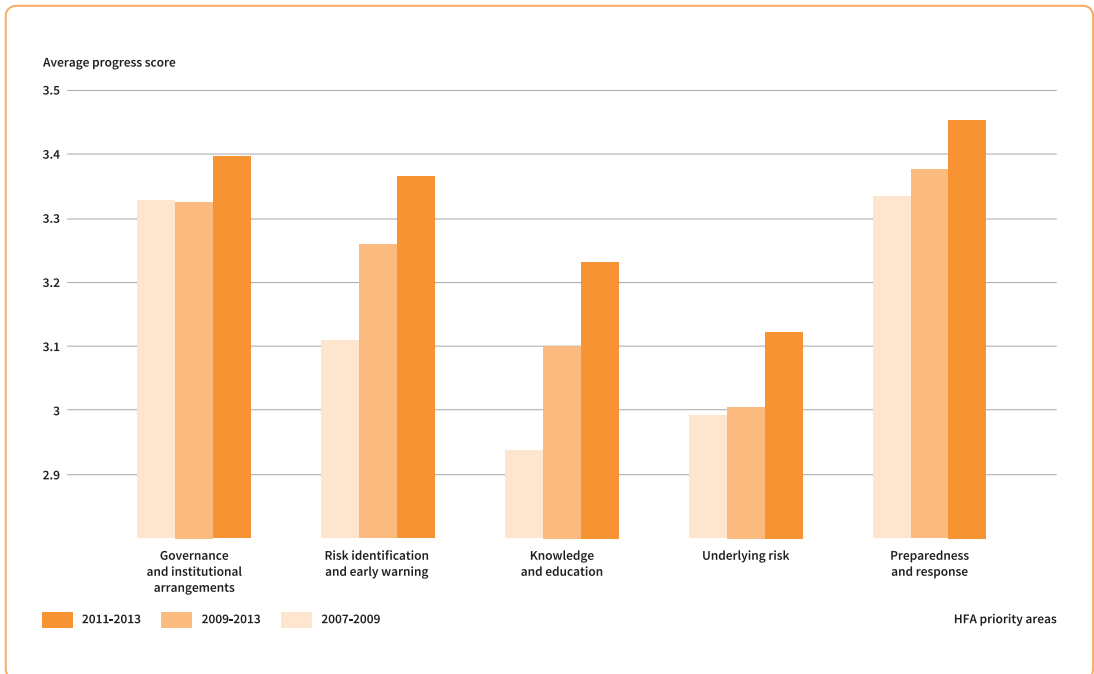
Since the declaration of the IDNDR in 1990 and in particular since the adoption of the HFA in 2005, the disaster risk management sector has grown exponentially in both size and salience.

It could be argued that the disaster risk management sector first became conscious of its own existence at the International Conference on Disaster Mitigation Program Implementation in Ocho Rios, Jamaica in 1984 (Virginia Polytechnic Institute, 1985). Yet only 51 international participants attended that conference, indicating the small size of the incipient sector at that time. In contrast, the Fourth Session of the Global Platform for Disaster Risk Reduction held in Geneva in May 2013 attracted over 3,500 participants, including 172 government delegations, 240 non-governmental organizations, 175 businesses, 30 parliamentarians from 26 countries as well as local government representatives, scientists and academics. Over thirty years, the size of the sector has increased by two orders of magnitude.

PreventionWeb, the United Nations-hosted global portal for disaster risk management information, now identifies 32,600 professionals involved in the disaster risk management sector, compared to 5,000 in 2006.<sup>1</sup> This represents only a small proportion of those who actually work in the sector at the national or local level. According to PreventionWeb, in 2013 there were 1,127 conferences, seminars, workshops and other events that connected and integrated the sector, again reflecting only a small proportion of the events occurring on the national and local stage.

As the sector has grown, government self-assessments prepared using the HFA Monitor (UNISDR, 2011b, 2013b, 2013c; UNISDR et al., 2009) provide evidence of an enormous investment by governments in new legislative and instrumental systems, policies, budgetary allocations, information systems, early warning mechanisms, disaster preparedness, and to a lesser extent in corrective disaster risk management.

**Figure II.1** Progress in implementing the HFA (2007-2013)



(Source: UNISDR, 2013a.)

HFA progress reports highlight that governments have not only committed to the policy objective of disaster risk reduction, they have also made considerable efforts to achieve that objective.



Since 2007, 146 governments have participated in at least one cycle of the HFA review using the online HFA Monitor. In 2011-2013, 136 countries submitted reports, and governments have reported growing levels of HFA implementation (Figure II.1) over time. The 2013-2015 assessment cycle is ongoing as part of the preparations for the successor framework to the HFA, and country reports will contribute to a complete picture of progress over the course of the HFA.

However, from the HFA Monitor alone it is difficult to gauge how much of the progress reported has really led to measurable outputs and outcomes in terms of reduced disaster risks. In other words, while there is no doubt that the HFA has been a resounding success in terms of catalysing activity, it is far less clear how effective all that activity has really been.

The HFA Monitor is constructed around 22 core indicators spread across five priorities for action. These core indicators are broad and generic, aggregating the far more specific guidance on key activities provided in the HFA itself and referring to multiple areas of public policy and actions by different stakeholders.



As such, it is often unclear from progress reports which (and whose) actions have made a real contribution to the progress reported under each core indicator. For many of the key activities, it is also unclear whether any progress has been made at all. As a result, where disaster risks have

been reduced it is often difficult to identify which policies, strategies or instrumental systems are responsible.

At the same time, the core indicators measure inputs into disaster risk reduction rather than outputs and outcomes. For example, the HFA Monitor provides information on the adoption of new national policies (input) but has no way of measuring the level of implementation (output) or whether it has led to a real reduction in risk (outcome). Therefore, while the momentum of the disaster risk management sector under the HFA is undeniable, its effectiveness is unclear. Increased inputs do not necessarily indicate achievement of the desired outcome.

Furthermore, while the HFA Monitor captures activities in the disaster risk management sector, it does not necessarily include actions under agendas such as the environment, poverty reduction, energy or climate change that may have contributed to disaster risk reduction or actions from other stakeholders, including the private sector and civil society.

The archive of accumulated national HFA progress reports now represents the most comprehensive body of information available on how countries have implemented the HFA. However, seen from a broader perspective, this information is largely self-referential. The HFA Monitor documents real achievements in developing the policies, legislation, information systems and institutional frameworks recommended by the HFA, but not the achievement of the policy goal of reducing disaster risk.

Where success in implementing parts of the HFA is conflated with success in reducing disaster risk, there is a real possibility of delusion in the disaster risk management sector. The rapid growth of the sector and its apparent success in implementing the HFA may have generated a self-reinforcing *hyper-reality* (Baudrillard, 1994; Eco,

The 22 core indicators of the HFA were divided into thirteen research areas, with four additional areas covering subjects that were not explicitly addressed in the core indicators, namely *interconnected and interdependent risk*, *private investment in disaster risk reduction*, *climate change adaptation and mitigation*, and *standards and normative mechanisms for disaster risk management*.

Assessments were coordinated by organizations of the United Nations, the World Bank, the Organisation for Economic Co-operation and Development and other institutions according to sector-specific expertise. Following an open call for papers, more than 200 input papers were received, and a peer-reviewed background paper was prepared for each research area.<sup>3</sup>

1986).<sup>2</sup> In this *hyper-reality*, perceptions of progress and achievement in disaster management contrast with the lack of progress in addressing the underlying risk drivers.

To provide a more complete picture of whether the inputs described by the HFA Monitor have led to outputs that contribute to the expected outcome, and to identify common success factors and challenges, peer-reviewed research was commissioned for GAR15 to complement the findings from the HFA Monitor (Box II.1).

The peer-reviewed assessment has filled many gaps in knowledge. However, there is still a general absence of systematic and comparable output indicators that could allow a more rigorous assessment of what has actually been achieved under each priority for action, such as the number of buildings built to disaster-resistant codes, the proportion of watersheds protected, the coverage of early warning systems, or the proportion of risk-sensitive public or private investment. As such, the assessment still relies heavily on anecdotal evidence, from which broader tendencies have to be induced.

This part of the report uses the evidence from the peer-reviewed assessment together with findings from the HFA Monitor to look inside the disaster risk management sector. Chapter 6 examines how and why the understanding and

practice of disaster risk management as disaster management has not been effective in preventing and avoiding risk generation and accumulation. Chapter 7 analyses the social production of risk information and questions the effectiveness of public awareness and information in generating a *culture of prevention*. Chapter 8 reviews the strengthening of disaster management, at the same time highlighting unmet challenges in post-disaster recovery.

## Notes

<sup>1</sup> [www.preventionweb.net](http://www.preventionweb.net).

<sup>2</sup> Baudrillard (1994) defined hyper-reality as “the generation by models of a real without origin or reality”. Eco (1986) likewise suggests that the action of hyper-reality is to desire reality and, in the attempt to achieve that desire, to fabricate a false reality that is to be consumed as real.

<sup>3</sup> For full list of research areas and related concept notes, see <http://www.preventionweb.net/english/professional/networks/private/hfa-thematic-review>.

## Chapter 6

# Disaster risk governance



**The model of disaster risk governance proposed by the HFA is one of the areas in which countries report greatest progress. And these efforts have involved not just a minority but a large majority of countries. Although it is still incomplete, the transition from emergency management to disaster risk management has picked up momentum.**

**In practice, however, most resources continue to be invested in strengthening capacities for disaster management, and there has been limited success in applying policies, norms, standards and regulations to manage and reduce risk across development sectors.**

## 6.1 The HFA as a catalyst

**Progress in some areas has been significant: over 100 countries now have dedicated national institutional arrangements for disaster risk management; more than 120 countries have undergone legal or policy reforms; over 190 have established focal points for disaster risk reduction; and 85 have created national multi-stakeholder platforms since 2007.**

Governance refers to the different ways in which governments, the private sector and in general all individuals and institutions in a society organize themselves to manage their common affairs (UNDP, 2010). The concept of governance includes formal and explicit mechanisms such as legislation, policies, mandatory standards and administrative procedures through which societies are organized as well as the wide range of informal and implicit arrangements that mediate social, economic and political relationships and the management of territory and resources.<sup>1</sup>

Governance arrangements evolve over time in the context of the broader political economy, reflecting how social, economic and political relationships emerge, mesh and interweave in space and time, and become infused with and justified by symbolic values relating to notions such as democracy, freedom, human rights or the nation-state (Ishiwatari, 2013).

Within this broader governance concept, disaster risk governance refers to the specific

arrangements that societies put in place to manage their disaster risk (UNISDR, 2011a; UNDP, 2013a Gall et al., 2014a) within a broader context of risk governance (Renn, 2008). This reflects how risk is valued against a backdrop of broader social and economic concerns (Holley et al., 2011). For example, the fact that a country adopts and enforces a seismic building code is as much a reflection of the importance of safe buildings for economic development and social well-being as it is a safeguard against earthquake risk.

The HFA placed considerable emphasis on different aspects of governance (Box 6.1), including the development of institutional and legislative frameworks, the allocation of resources and the mobilization of communities. The model of disaster risk governance proposed by the HFA was influenced by the approach adopted by Colombia in 1989 and subsequently by many other middle and low-income countries (with important variations). This model stressed a horizontally and vertically integrated systems approach with strong coordination across sectors and a delegation of responsibilities to the local level based on the principle of subsidiarity. It emphasized the adoption of regulation and other mechanisms to ensure compliance and provide incentives. The model also recommended specific budgetary allocations for disaster risk reduction, and it promoted the participation of volunteers and communities. At the same time, it stressed the importance of integrating disaster risk reduction into development policies, including poverty reduction, on the basis of *strong political determination*.

**National institutional and legislative frameworks:**

*(a) Support the creation and strengthening of national integrated disaster risk reduction mechanisms, such as multi sectoral national platforms, with designated responsibilities at the national through to the local levels to facilitate coordination across sectors. National platforms should also facilitate coordination across sectors, including by maintaining a broad based dialogue at national and regional levels for promoting awareness among the relevant sectors.*

*(b) Integrate risk reduction, as appropriate, into development policies and planning at all levels of government, including in poverty reduction strategies and sectors and multi sector policies and plans.*

*(c) Adopt, or modify where necessary, legislation to support disaster risk reduction, including regulations and mechanisms that encourage compliance and that promote incentives for undertaking risk reduction and mitigation activities.*

*(d) Recognize the importance and specificity of local risk patterns and trends, decentralize responsibilities and resources for disaster risk reduction to relevant sub-national or local authorities, as appropriate.*

**Resources**

*(e) Assess existing human resource capacities for disaster risk reduction at all levels and develop capacity-building plans and programmes for meeting ongoing and future requirements.*

*(f) Allocate resources for the development and the implementation of disaster risk management policies, programmes, laws and regulations on disaster risk reduction in all relevant sectors and authorities at all levels of administrative and budgets on the basis of clearly prioritized actions.*

*(g) Governments should demonstrate the strong political determination required to promote and integrate disaster risk reduction into development programming.*

**Community participation**

*(h) Promote community participation in disaster risk reduction through the adoption of specific policies, the promotion of networking, the strategic management of volunteer resources, the attribution of roles and responsibilities, and the delegation and provision of the necessary authority and resources.*

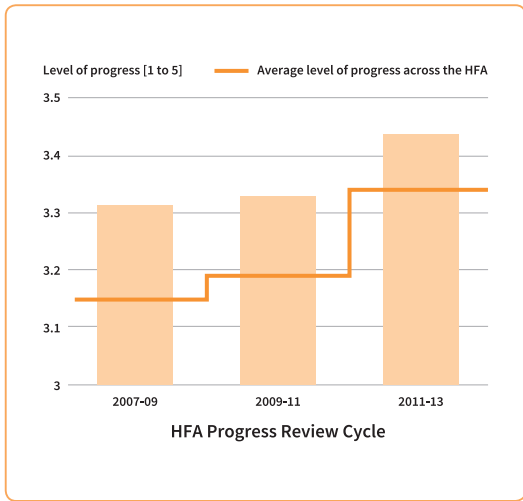
The 302 self-assessment reports prepared using the HFA Monitor<sup>2</sup> and the UN Global Assessment Reports on Disaster Risk Reduction published in 2009, 2011 and 2013, as well as the Mid-Term Review of the HFA (UNISDR, 2011b) and other published analyses from the HFA Monitor (UNISDR, 2011c, 2013b, 2013c; UNISDR et al., 2009), have provided detailed country-by-country evidence of how participating states have invested in most (but not all) of these key activities. The measures taken have included the formulation of legislation and national policies, the creation of institutional frameworks, the decentralization of

responsibilities to local governments and the creation of dedicated budgets.

When understood as an instrument of policy formulation and institutional organization, the model of disaster risk governance proposed by the HFA is one of the areas in which countries report making greatest progress (Figure 6.1). According to the HFA Monitor, over 100 countries now have dedicated national institutional arrangements for disaster risk management. As of 2014, more than 120 countries had undergone legal or policy reforms, over 190 had established focal points



**Figure 6.1** Progress against Priority for Action 1 of the HFA



(Source: UNISDR with data from the HFA Monitor.)

for disaster risk reduction and 85 had created national multi-stakeholder platforms since 2007 (UNDP, 2014a).

Over the last two years, at least eight countries have established new legal frameworks for disaster risk management. For example, Bhutan (Government of Bhutan, 2013) and Burkina Faso (Government of Burkina Faso, 2014) have applied a number of legal principles to reform their institutional arrangements, including a reform of the division of powers between all stakeholders and strengthened national mechanisms. Paraguay decided in December 2013 to reform its national policy on disaster risk reduction based on four pillars: to strengthen institutional capacities, to increase funding, to improve education, communication and citizen participation in disaster risk reduction, and to improve the acquisition and management of knowledge and technology (Government of Paraguay, 2013). This evidence is testimony to an extraordinary burst of progress in only a short period of time, and the efforts have involved not just a minority but a large majority of countries. It reflects how countries have been able to use the HFA to catalyse a range of activities and an increasing concern with and

commitment to disaster risk reduction. Although it is still incomplete, the transition from emergency management to disaster risk management which began under the IDNDR has picked up speed and momentum under the HFA (Gall et al., 2014a).

At the same time, and as highlighted in Chapter 1, the syncretic evolution of the sector from emergency management organizations means that disaster risk management has been principally understood and practised as disaster management. For a number of reasons, this approach has not been effective in achieving the policy goal of disaster risk reduction.

## 6.2 Prospective disaster risk management: the divorce between discourse and practice

**While a number of new policies, legislation and organizations have been developed and set up, there remains a disconnect between theory, formal arrangements and disaster risk management practice.**

In the 1990s, the work of disaster research networks such as LA RED in Latin America, Peri-Peri U in sub-Saharan Africa, Duryog Nivaran in South Asia<sup>3</sup> (Lavell, 2004; Gellert-de Pinto, 2012; Peri-Peri U, no date) and others influenced both the Yokohama Strategy and the HFA, highlighting how disasters are indicators of unresolved social and development problems and making the case that disaster risk reduction could not be achieved unless the underlying drivers of risk were addressed (Gall et al., 2014a).

Priority for Action 1 of the HFA called for the integration of disaster risk reduction into poverty reduction and other development strategies on the basis of strong political determination by governments. Reflecting these key activities under the HFA, the governance arrangements adopted

by many countries have increasingly incorporated language that stresses the importance of addressing the underlying risk drivers. In recent years, many national disaster management organizations have been relabelled as disaster risk management systems. Regional and national plans, strategies and policies have given increasing prominence to reducing risk rather than managing disaster, to prospective rather than merely corrective disaster risk management, and to protecting vulnerable households and communities instead of strategic economic assets and infrastructure alone (UNDP, 2014a).

Unfortunately, many of these commitments in law and policy have not been translated into real priorities and investments. A review of the qualitative information in HFA progress reports (UNISDR, 2014a) highlights a divorce between discourse and practice and a continued focus on disaster management and corrective risk management rather than on addressing the underlying drivers. Although they include language consistent with prospective risk management, most new laws continue to focus largely on disaster management. The priority assigned to prospective risk management is usually weak, as highlighted by the consistently low level of achievement of HFA Priority for Action 4 in HFA progress reports (UNISDR, 2009a, 2011a, 2013a).

In other words, disaster risk management has become synonymous with interventions to address specific and existing risks, for example by constructing flood defences, reinforcing or upgrading infrastructure, and retrofitting schools and hospitals, to name but a few examples (Lavell and Maskrey, 2014). In practice, however, most resources and efforts continue to be invested in strengthening capacities for disaster management (Gall et al., 2014a).

At the same time, the sector in general has developed only weak connections with and influence on development sectors, and it has often lacked

the political authority, governance arrangements and technical competencies to do so. Development policies, plans and investments that generate and accumulate risks continue to enjoy political support in many countries, for example if they are seen to boost economic growth (UNDP, 2014a). Prospective disaster risk management generally requires lower levels of financial investment but higher levels of political capital and support than corrective disaster risk management. Given that disaster risk management has been understood and put into practice as a set of instrumental and administrative mechanisms to protect development against exogenous threats, this political support has rarely been forthcoming. At the same time, development sectors also tend to understand disaster risk management as disaster management, again weakening the imperative for prospective risk management.

As a result, the disaster risk management sector has had little success in mainstreaming its priorities and ensuring that other ministries or departments adopt policies, norms, standards and regulations to manage and reduce risk. Similarly, there has been little systematic engagement with the private sector in most countries, except through the lens of corporate social responsibility.

In effect, the *strong political determination* required by the HFA *to promote and integrate disaster risk reduction into development programming* has rarely materialized. The practice of prospective disaster risk management continues to be more symbolic than real. As the HFA comes to a close, it is difficult to identify countries where the strengthening of disaster risk governance has seriously influenced the direction of development.

## 6.3 A transient political and economic imperative

While risk management generally gains momentum in the aftermath of disasters, the importance of investing in risk reduction is usually not part of daily political agendas.

The political importance of the disaster risk management sector in most countries is transient. When large-scale disasters threaten development, the sector enjoys strong political support and budgetary allocations. Before and after large disasters, the sector is often relegated to the political and economic margins of government as other priorities and crises come into the foreground.

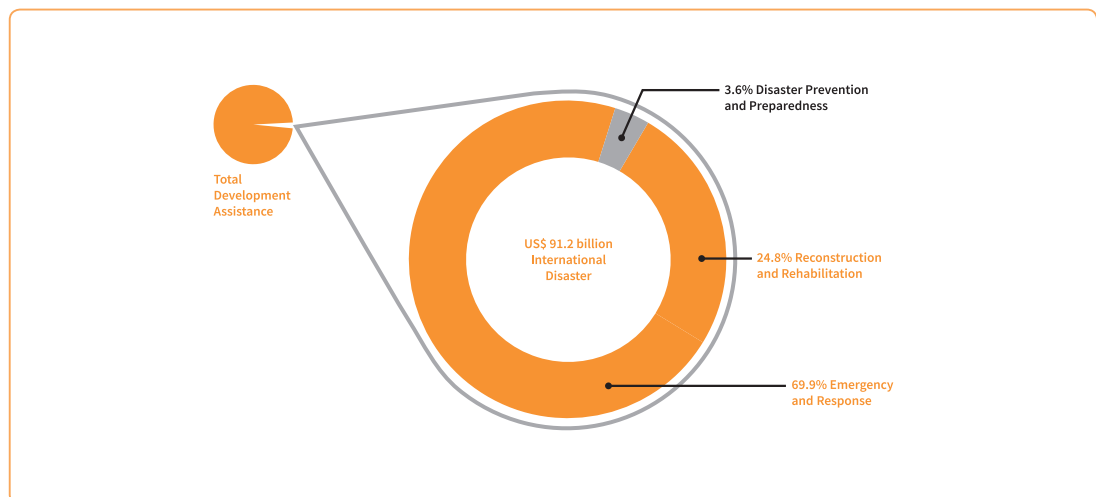
This transient political and economic support for the sector reflects its focus on protecting development from disasters as merely occasional events rather than on managing risks which are generated and accumulated on an ongoing basis. While extensive disasters occur regularly in most countries, they have only localized impacts and generally affect low-income households, small businesses and local infrastructure, so they

rarely translate into a national political and economic imperative for disaster risk management (UNISDR, 2011a).

This transient imperative is reflected in inadequate financing of the disaster risk management sector and insufficient investment in weak human and institutional capacities. Nationally, some countries have established designated budget mechanisms to ensure that the disaster risk reduction sector has some level of guaranteed resources. Examples include percentage allocations by law in the Philippines, budgetary policy in Japan, or specially earmarked funds in Mexico (IFRC and UNDP, 2014).

However, in many other countries the sector is dependent on resources from emergency and contingency funds, which are only replenished when large disasters occur. In the HFA Monitor, some countries report insufficient resources to maintain even basic response capacities. The dependence on emergency funding encourages a form of *humanitarian materialism* in which disasters themselves become commodities that can influence the consolidation of institutional resources and power.

Figure 6.2 Share of development aid allocated to disaster prevention and preparedness



(Source: GFDRR, 2012b.)

The transience of this political and economic imperative is reflected at all scales. Internationally, resources for disaster risk management represent only a small fraction of those dedicated to disaster response, which in turn represent only a small proportion of overall development assistance (Figure 6.2). On average, only around 1 per cent of the total international development aid budget is allocated to disaster risk management (Kellett and Sparks, 2012), and 75 per cent of that budget is allocated to only four countries (ibid.)

## 6.4 Uneven decentralization

**While there is agreement on the critical role of local governments in disaster risk management, efforts to strengthen their capacities remain restricted to a handful of countries.**

In those cases where a national political imperative for disaster risk reduction has been identified, implementation has often been challenged by weak capacities at the local level. For example, Peru's Ministry of Economy and Finance has been working since 2007 to integrate disaster risk management into public investment planning and evaluation. The implementation of this policy, however, has been undermined by weak capacities in many regional and local governments, where most public investment is planned and implemented.

A pervasive problem reported by many countries through the HFA Monitor is the general lack of implementation of laws and policies (UNISDR, 2009a, 2011a, 2013a). National policies and laws are often developed but fail to include real mechanisms of implementation. This is particularly critical at the local level.

In many countries, primary responsibility for disaster risk management has been devolved to the municipal level. Many larger cities with

well-resourced local governments have been able to take full advantage of this decentralization. One of the success stories of the HFA is the growing engagement of city governments in all income groups, from Istanbul to Medellin and from San Francisco to Manila, in managing their disaster risks. The growing number of cities signing up to the United Nations Making Cities Resilient campaign is testimony to this achievement.<sup>4</sup> Some of these local governments have shown greater effectiveness than their national counterparts and are becoming role models and leaders in disaster risk reduction.

In contrast, many smaller local governments, particularly in rural areas, lack the necessary capacities to implement disaster risk management or even basic emergency management (UNISDR, 2011a). For example, while disaster risk management has been legally integrated into municipal-level development planning in South Africa since 2002, local government capacity remains limited (Scott and Tarazona, 2011; Botha and van Niekerk, 2013; Johnson, 2011). Similarly, a large proportion of municipalities in Colombia have mandated local committees for disaster risk reduction, but only a fraction of these have developed contingency plans (Scott and Tarazona, 2011). While it is widely recognized that local governments should play a critical role in disaster risk management, there is little evidence to suggest that there has been any concerted effort to strengthen their capacities outside of a handful of countries which have dedicated training institutions (Box 6.2).



In many countries, the decentralization of disaster risk reduction to local governments can therefore become a weakness rather than a strength and represents another manifestation of a *hyper-reality* in which disaster risk management capacities exist on paper but not on the ground.

In India, the National Institute of Disaster Management (NIDM), constituted under the Disaster Management Act of 2005, bears national responsibility for human resource development, capacity building, training, and policy advocacy in the field of disaster risk management. Under this mandate, the Institute delivers a basic online course on comprehensive disaster risk management as well as specialized courses on community-based disaster risk reduction (CBDRR), climate change and disaster risk, earthquake risk management, safer cities, and gender aspects of disaster recovery and reconstruction (NIDM, 2013). The NIDM has also published numerous online training manuals, including a step-by-step guide to the development of village disaster management plans (NIDM, 2012a), train-the-trainer modules on flood risk mitigation and management (NIDM, 2012b) and on urban risk mitigation (NIDM, 2014), and a manual on psychosocial care in disasters (Satapathy and Subhasis, 2009).



In some countries, local structures for disaster risk reduction have been set up in parallel to local government, further undermining the effectiveness of both. And while the arrangements for disaster risk governance in many countries echo the HFA by explicitly calling for community involvement, most of the progress in community-based or local-level disaster risk reduction has been restricted to specific short-term projects or programmes, often supported by non-governmental organizations. Community and local-level disaster risk management has perhaps become another *hyper-reality*: it appears to have become mainstream and ubiquitous at all levels, while in reality community empowerment has been more symbolic than real (Maskrey, 2011).

## 6.5 Weak regulatory capacity

**Effective regulation and dedicated investments in corrective disaster risk management have enabled many high-income countries to reduce their disaster risk. However, many low and middle-income countries lack the necessary regulatory quality for norms and standards to be applied effectively.**

The HFA Monitor also points to continued progress in the adoption of norms, standards and codes in areas such as land-use planning, building and environment.

In higher-income countries, laws, norms, standards and regulation can be (and have been) effective mechanisms for disaster risk management because of factors such as strong institutional frameworks, mechanisms for accountability and redress, free flows of information and a general culture of compliance (IFRC and UNDP, 2014). The successful application of voluntary standards in particular requires a trusted certification process (UNECE, 2014).

The combination of effective regulation and major investments in corrective disaster risk management has enabled many high-income countries to successfully reduce their more

extensive risk layers. In Japan, for example, continued investment in flood protection—together with regulation—has resulted in a dramatic reduction in the areas flooded and in mortality (Figure 6.3).

In contrast, many low and middle-income countries lack the necessary regulatory quality for norms and standards to be applied effectively. In many such countries, weak accountability of local to central government, of government to citizens, and across government sectors has undermined the effectiveness of norms, standards, laws and policies (Coskun, 2013). For example, while most disaster risk reduction laws provide some kind of mandate for the involvement of women and vulnerable groups, these often consist of general aspirational statements without specific mechanisms for implementation (IFRC and UNDP, 2014).

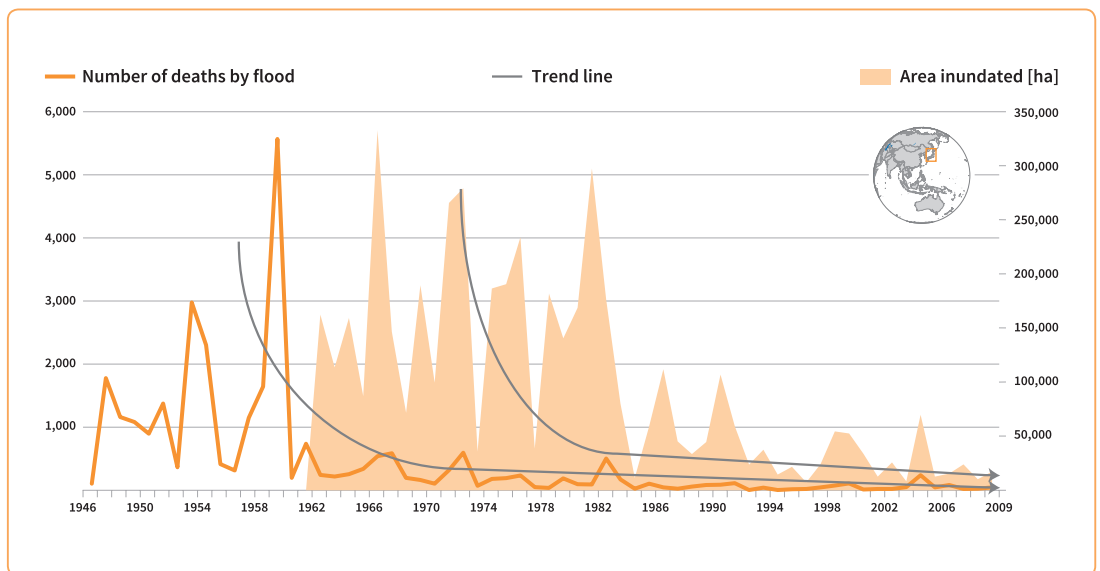
As a consequence, the adoption of improved building codes or environmental regulations in lower-income countries may lay a veneer of disaster risk management over the surface of relentless risk accumulation (Wamsler, 2006). In

particular, where a significant proportion of economic and urban development takes place informally (either in an informal sector *per se* or due to corruption and lack of compliance in the formal sector), instruments such as building codes and zoning plans are only effective in strictly limited areas and sectors, typically in higher-income enclaves and strategic economic sectors. Most building outside of these enclaves and sectors is non-engineered, most urbanization is unplanned and local governments have weak capacities to promote or enforce standards.

In addition, the adoption of inappropriately strict codes and standards may have the opposite effect of driving more development into the informal sector, as low-income households and small businesses are unable to afford the costs of building to code in areas zoned for residential or commercial use.

Finally, the responsibility of those taking the decisions with regard to urban development, the application of building codes or land-use planning is not always clear-cut, as seen in the legal

**Figure 6.3** Successful flood reduction in Japan



(Source: UNISDR with data from Takyea Kimio, JICA.)



### Box 6.3 Legal repercussions after Xynthia<sup>5</sup>

At 2 a.m. on 28 February 2010, a strong *tempête* (storm) hit the French Atlantic coast. *Xynthia* combined a storm surge with a high tide, and the large waves caused flood defences to fail all along the coast from the Gironde near Bordeaux to the Loire Estuary. Over 50,000 hectares of land were flooded and 47 people died. Some 10,000 people were forced to evacuate their homes on the Atlantic coast.



The town of La Faute-sur-Mer in Vendée saw 29 deaths, 28 of which were in a 3-hectare area labelled the “bowl of death” by the media as well as political authorities.

Four years after Xynthia, the French state prosecutor identified *excessive urbanization* as a reason for the high losses and attributed responsibility to the mayor and deputy mayor of La Faute-sur-Mer. Flood risk in the area was known to be high, but risk information had been hidden deliberately by the authorities to allow the construction of more than 200 new dwellings in flood-prone areas of La Faute-sur-Mer.

As a consequence, the town’s mayor has been sentenced to four years in jail. Other officials are on trial for up to 5 years of imprisonment along with fines of up to EUR 75,000.

aftermath of the storm Xynthia in France in 2010 (Box 6.3).

## 6.6 Corruption: an inconvenient truth

**Corrupt practices in hazard-prone areas contribute directly to increasing the vulnerability and exposure of assets and people. Those countries that have high levels of corruption and weak regulatory frameworks will be challenged to reduce their disaster risk.**

Although the HFA provides detailed guidance on institutional and legislative arrangements, budgetary allocations and local capacities, it does not mention accountability or transparency as a requirement for effective disaster risk governance. Nor does it make reference to the challenge posed by corruption. And yet, these terms and the social and institutional realities that they signify are critical to the effectiveness of disaster risk management (Wisner et al., 2003; UNISDR, 2009a; Kelman, 1998). The absent or limited voice of citizens and accountability of decision-makers to the people they represent have been

identified as underlying drivers of disaster risk (UNISDR, 2009a). It is also a common characteristic of countries in conflict situations. Perhaps unsurprisingly, many countries that are ranked high on indices of disaster risk and vulnerability are in conflict or post-conflict situations (Maplecroft, 2014; UNU, 2013).

Corruption mediates both the generation of disaster risk and the impact of disasters. At the global scale, corruption has reached dimensions that dwarf development efforts (Lewis and Kelman, 2012): global proceeds from criminal activities, corruption and tax evasion that flow freely across international borders are estimated at US\$1 trillion to US\$1.6 trillion per annum (United Nations and World Bank, 2007). Illicit financial flows from low and middle-income countries from 2003 to 2012 were US\$6.6 trillion, equivalent to almost 10 times the flow of overseas development assistance (GFI, 2014).

Corrupt practices during and following disasters have been well studied (Ambraseys and Bilham, 2011; Lewis, 2011; IFRC, 2011; Lewis and Kelman, 2012). For example, a study conducted on corruption and disaster occurrence in the United States

between 1990 and 2002 found that high rates of corruption-related crimes in Mississippi, Florida and South Dakota were correlated to large numbers of disaster events and related losses in the same three states and throughout America (Leeson and Sobel, 2008). There was some causality to this correlation in that opportunity for corruption in those states was bred by the inflow of large sums of relief funding and lucrative post-disaster construction contracts (ibid.).

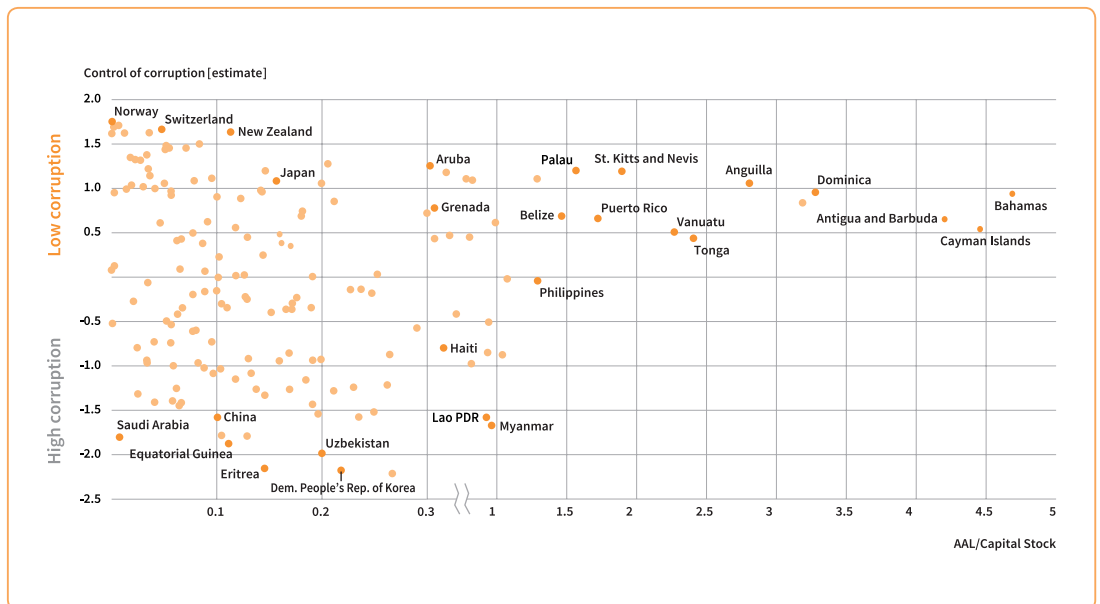
In contrast, the different ways in which corrupt practices shape patterns of vulnerability and exposure and determine levels of risk are not as well understood. In sectors and localities, corrupt practices can increase disaster risk by corroding a culture of compliance that is key to the effectiveness of codes, standards and similar regulatory mechanisms. The construction industry is one of the sectors most critical to disaster risk management and also one of the most prone to corruption (Transparency International, 2005). An estimated US\$4 trillion per year is spent on government procurement for construction worldwide, and a

significant part of this expenditure is lost to corruption, accounting for an estimated 10-30 per cent of every project's value (ibid.).

Corrupt practices in hazard-prone areas contribute directly to increasing the vulnerability and exposure of assets and people (Lewis, 2011). For example, following the Sichuan earthquake in China in 2008, the depletion of funds for school buildings reportedly led to compromised design standards and regulatory codes (Pei, 2007; Lewis, 2011). While many older buildings survived the earthquake relatively unscathed, over 7,000 more recently built classrooms collapsed, resulting in high mortality; one local school reported the death of 900 children in the earthquake (Lewis, 2011).

Given that disaster risk is configured by hazard and exposure as well as vulnerability, there is no direct correlation between disaster risk and levels of corruption (Figure 6.4). For example, Japan and Eritrea or Grenada and Haiti are pairs of countries with similar relative levels of disaster risk (AAL as a proportion of exposed assets).

Figure 6.4 Control of corruption and disaster risk



(Source: UNISDR based on data from Global Risk Assessment and the World Bank.)

However, Haiti and Eritrea have far higher levels of corruption than Japan and Grenada, and the former are likely to be more challenged to manage their risks effectively.

## 6.7 The times they are a-changing

**The governance arrangements adopted by many countries, relying heavily on specialized emergency management organizations, are not always appropriate to address disaster risk. The governance approach based on the disaster management cycle and represented by a specialized disaster risk management sector may have reached its limit, while at the same time a new governance paradigm has yet to emerge.**

Emergency management is a specialized technical domain that is relevant not only to disasters but also to technological, marine and aeronautical accidents, civil disturbances and other events. However, the governance arrangements required to manage emergencies effectively are not necessarily appropriate to address development challenges related to urban development and environmental management. Put simply, while the fire services at the local level may be completely capable of rescuing flood victims from their roofs or earthquake victims from collapsed structures, these capabilities and the underlying institutional and legislative arrangements have little connection with those required to address issues of land use or water management.

While emergency management was able to evolve as a stand-alone sector addressing the challenges of responding to accidents, technological disasters and the impacts of conflict, the governance arrangements required to manage disaster risks need—by definition—to interweave with and flow through the broader governance arrangements used by countries to manage economic and social development (UNDP, 2014a). As

additional responsibilities have been assigned to specialized emergency management organizations in their syncretic evolution into disaster risk management systems, the governance arrangements adopted by many countries have become *unfit for purpose*. In other words, while specialized and self-contained arrangements for disaster risk governance may be appropriate for emergency and disaster management, other aspects of disaster risk management are heavily dependent on the overall quality of governance to achieve its objectives (UNDP, 2014a; Lavell and Maskrey, 2014).

As such, while strengthening disaster risk governance may have catalysed progress in disaster management and contributed to a significant reduction in mortality in some countries, it has not guaranteed effectiveness and success in those areas of the HFA related to prospective risk management. Today's governance failures may ripple through time and affect future generations; this is the case with the 2008 financial crisis, which resulted from decades of failure to effectively govern increasingly interdependent financial markets and mechanisms (Turnbull and Pirson, 2011).

When the multiple mirrors that make up the *hyper-reality* of the disaster risk management sector begin to shatter in real disasters, it becomes clear that—in the same way that disaster risk is endogenous to the social and economic processes that configure it over time—managing risks cannot be separated from the broader governance of social and economic development. Capacities for disaster risk management cannot be strengthened autonomously without reference to broader governance constraints such as low levels of voice and accountability, under-resourced local governments, dysfunctional judicial systems, social conflict and economic crisis.

As this *hyper-reality* is revealed through the experience of risk and disaster, new forms of

managing disaster risk, new stakeholders and new forms of governance are beginning to emerge. The *traditional* disaster risk management sector now shares an increasingly crowded space with the climate change sector, finance and planning ministries, the private sector and city governments, amongst other stakeholders and players.

The creation of the UNFCCC in 1994 as an international mechanism to address global climate change soon spawned a specialized climate change sector. Climate change is an underlying driver of disaster risk, and many plans for climate change adaptation have a strong disaster risk management component (IPCC, 2012; SEI, 2014; UNDP, 2014a). However, this sector, which is usually anchored in environment ministries, is only weakly integrated with the disaster risk management sector in most countries (SEI, 2014); exceptions include the small island states in the Pacific (UNDESA, 2014a). The climate change sector, however, has been more successful in attracting resources and political support and now challenges the disaster risk reduction sector for salience. Climate change adaptation has therefore become another forum for disaster risk governance. At the same time, it remains a major challenge to reconcile the policy arenas of disaster risk reduction and climate change adaptation as well as climate change mitigation, economic growth and sustainable development (SEI, 2014).

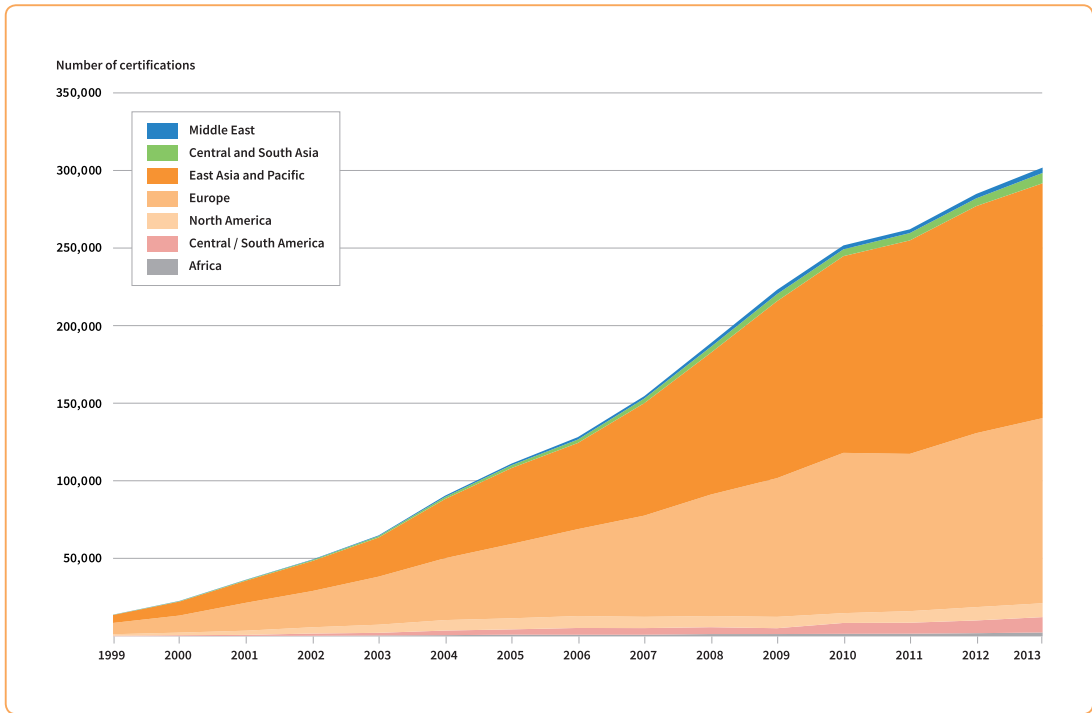
Recent years have also seen a growing interest in risk financing from both the disaster risk reduction and climate change sectors. Finance ministries, insurance regulators, international finance institutions as well as insurance, reinsurance and catastrophe modelling companies (Arnold, 2008; Cummins and Mahul, 2009; Muir-Wood, 2011; GFDRR, 2014b) have also increased their involvement in developing and extending risk financing mechanisms such as insurance, contingency financing and catastrophe bonds, including in regional arrangements such as CCRIF and

PCRAFI.<sup>6</sup> These mechanisms have the explicit objective of protecting social and economic development against external shocks and can be interpreted as a modernization of the logic of the disaster management cycle. At the same time, finance and planning ministries have also been involved in promoting new approaches to disaster risk governance based on public investment planning and evaluation (Lavell, 2014; GFDRR, no date; UNISDR, 2009a and 2011a) and have responded to concerns regarding sustainable public investment and the quality of public spending.

Since the major disasters in Japan and Thailand in 2011 exposed risks to global supply chains, interest in disaster risk reduction has increased among businesses and, more recently, in the financial sector (Ingirige et al., 2014; UNISDR, 2013a). This has led to a large number of initiatives that seek to develop new forms of risk governance involving both business and government, investors and financial regulators, such as the innovative *RISE* or *1-in-100* initiatives, both of which seek to make investments more risk-sensitive.<sup>7</sup> In addition, large cities are now providing spaces where the public and private sectors, disaster risk management and climate change adaptation are starting to converge.

Government statutory regulation has also been complemented by a range of voluntary standards relevant to disaster risk reduction, not just in sector-specific areas such as private housing, transport networks and hubs, schools, hospitals' electro-technical equipment and other critical infrastructure, but also in cross-cutting areas such as environmental management (Figure 6.5), corporate social responsibility and business continuity (UNECE, 2014). Both public and private organizations have begun to apply standards that combine risk management with environmental and social codes of conduct and principles in areas as diverse as housing, protected areas management, industry and investment portfolio management. Codes governing social

Figure 6.5 Uptake of environmental management system standards



(Source: ISO, 2014.)

and environmental responsibility are increasingly being adopted by businesses to enhance their value proposition (UNECE, 2014).

The way in which disaster risk management has been approached is now being challenged by these innovative efforts, most of which are currently in a phase of exploration rather than consolidation. As the HFA comes to a close, therefore, disaster risk management finds itself at something of a crossroads. Disasters such as Typhoon Haiyan in the Philippines in 2013 are blowing away the veils of *hyper-reality* to show that even countries with apparently mature and comprehensive disaster risk governance arrangements in place are challenged by continued risk accumulation. The governance approach based on the disaster management cycle and represented by a specialized disaster risk management sector may have reached its limit, while at the same time a new governance paradigm has yet to emerge.

## Notes

- 1 <http://iog.ca/defining-governance>.
- 2 For more information on local, national and regional HFA reports, see <http://www.preventionweb.net/english/hyogo/progress/?pid:73&pil:1>.
- 3 [www.duryoginivaran.org](http://www.duryoginivaran.org).
- 4 <http://www.unisdr.org/campaign/resilientcities>.
- 5 Various sources:  
<http://www.nat-hazards-earth-syst-sci.net/11/2321/2011/nhess-11-2321-2011.pdf>;  
<http://www.bbc.com/news/world-europe-30453552>;  
[http://www.lemonde.fr/planete/article/2014/12/12/xynthia-l-ancien-maire-de-la-faute-sur-mer-condamne-a-quatre-ans-de-prison-ferme\\_4539436\\_3244.html](http://www.lemonde.fr/planete/article/2014/12/12/xynthia-l-ancien-maire-de-la-faute-sur-mer-condamne-a-quatre-ans-de-prison-ferme_4539436_3244.html) (accessed 11 January 2015).
- 6 For more information on the Caribbean Catastrophe Risk Insurance Facility, see <http://www.ccrif.org/content/about-us> and the Pacific Catastrophe Risk Assessment and Financing Initiative: <http://pcrafi.sopac.org/> (accessed 28 August 2014).
- 7 For more information on these initiatives, see [www.theriseinitiative.org](http://www.theriseinitiative.org) and <http://www.un.org/climatechange/summit/action-areas>.

## Chapter 7

# A culture of prevention and resilience?



**Investment in public awareness, education and risk assessment has increased. However, these efforts have rarely taken into account the social and economic constraints on disaster risk reduction or the opportunities sacrificed by not addressing that risk. As a result, the increasing volume of risk information available has not generally been translated into risk knowledge.**

## **7.1 From Ratnapura to the Chao Phraya River**

**Where risk awareness is limited, those exposed to hazards have limited motivation to invest in reducing their risk levels.**

It is highly improbable that any resident of the District of Ratnapura, Sri Lanka, is unaware of disaster risk. Since 1990, Ratnapura has reported a staggering 2,601 extensive disaster events, an average of over 100 per year, which have damaged or destroyed 23,000 homes, affected over a million people and eroded essential local infrastructure.<sup>1</sup> Ratnapura is a highly disaster-prone district which is particularly affected by floods and landslides (OXFAM, 2006). Thirteen per cent of its low-lying areas are generally affected by floods during heavy rains (UN-Habitat, 2009). Moreover, increases in annual rainfall and temperature variations have led to increased annual landslide occurrence over the last decade (Rathnaweera, et al., 2012).

Ratnapura is only one of thousands of municipalities around the world that experience recurrent extensive disasters. In general, the residents of these localities are fully aware of the risks they face. But their choice as to where to live and work is often constrained by social and economic factors, including a lack of access to safer land, the need to be close to employment opportunities, insufficient investment in risk-reducing infrastructure by local and national authorities, and sometimes discrimination. With constrained opportunities, people faced with recurrent extensive risk often have no choice but to live with that risk and periodically recover from disaster loss and damage.

In contrast to Ratnapura, it is probable that very few of the companies that built factories on the floodplains of the Chao Phraya River in Thailand before the massive flooding in November 2011 were fully aware of the risk they faced. Flood risk in the basin had never been modelled, and the scale of the disaster took global businesses, the government and the insurance industry by surprise. Rippling through global supply chains, the disaster affected production around the world and resulted in massive losses. The total loss of operating profit to Toyota and Honda alone was estimated at US\$1.25 billion and US\$1.4 billion, respectively (UNISDR, 2013a).

Despite the scale of these losses, very few companies have decided to relocate to less hazardous areas of Thailand or to other countries. A survey conducted among Japanese businesses in Bangkok in 2012 showed that almost 80 per cent had decided to stay in the same locations, compared to 16 per cent that had already moved or were planning on moving to other locations in Thailand and 6 per cent that planned to move overseas (Government of Japan, 2012). All of the businesses in the area are now fully aware of the flood risks. While it may not always be a matter of choice, particularly due to financial constraints (*ibid.*), for most businesses the value creation opportunities provided by the location outweigh any contingent liabilities posed by future floods.

Awareness, identification, understanding and estimation of disaster risks are all clearly fundamental underpinnings of disaster risk management. If those exposed to hazards are unaware of the risks they face, it is difficult to see how or why households, businesses or governments would invest in reducing their risk levels.

However, the examples of Ratnapura and the Chao Phraya River illustrate that disaster risk is not an objective and tangible externality to be reduced. Similarly, risk awareness does not automatically lead to investments in disaster risk management. Risk can only be understood in terms of the dynamic relationship between exposed and vulnerable households, businesses or governments and the probability of hazard events of different intensity and extent. While risk awareness may be a precondition, the importance people attach to managing their risks can only be understood in the context of the full range of social, economic, territorial and environmental constraints and opportunities they face.

## 7.2 The information challenge

**While much more disaster risk information is generated today than ever before, it is not necessarily accessible to households, businesses and investors.**

Under Priority for Action 3, the HFA attached considerable importance to improving risk awareness and information in order to contribute to the adoption of a *culture of disaster prevention and resilience* (Box 7.1).

### Box 7.1 Risk awareness and information

#### Information management and exchange

*(a) Provide easily understandable information on disaster risks and protection options, especially to citizens in high-risk areas, to encourage and enable people to take action to reduce risks and build resilience. The information should incorporate relevant traditional and indigenous knowledge and culture heritage and be tailored to different target audiences, taking into account cultural and social factors.*

*(b) Strengthen networks among disaster experts, managers and planners across sectors and between regions, and create or strengthen procedures for using available expertise when agencies and other important actors develop local risk reduction plans.*

*(c) Promote and improve dialogue and cooperation among scientific communities and practitioners working on disaster risk reduction, and encourage partnerships among stakeholders, including those working on the socio-economic dimensions of disaster risk reduction.*

*(d) Promote the use, application and affordability of recent information, communication and space-based technologies and related services, as well as earth observations, to support disaster risk reduction, particularly for training and for the sharing and dissemination of information among different categories of users.*

*(e) In the medium term, develop local, national, regional and international user-friendly directories, inventories and national information-sharing systems and services for the exchange of information on good practices, cost-effective and easy-to-use disaster risk reduction technologies, and lessons learned on policies, plans and measures for disaster risk reduction.*

*(f) Institutions dealing with urban development should provide information to the public on disaster reduction options prior to constructions, land purchase or land sale.*

*(g) Update and widely disseminate international standard terminology related to disaster risk reduction, at least in all official United Nations languages, for use in programme and institutional development, operations, research, training curricula and public information programmes.*

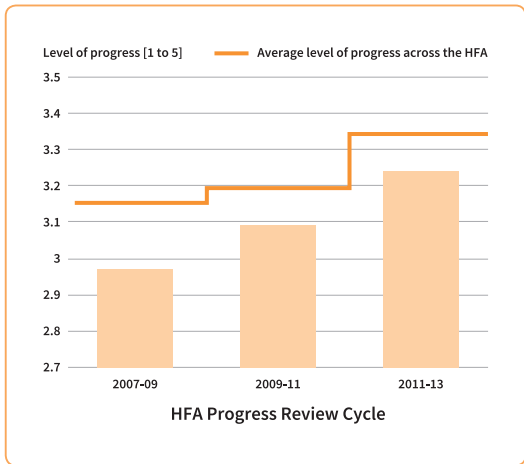
#### Public awareness

*(p) Promote the engagement of the media in order to stimulate a culture of disaster resilience and strong community involvement in sustained public education campaigns and public consultations at all levels of society.*



HFA progress reports show that countries have made significant progress in this area. However, progress in general is lower than the average across the various priorities for action (Figure 7.1). With notable exceptions, citizens, businesses and other stakeholders in most countries rarely have access to risk information before they make investment decisions or undertake property transactions. As discussed below, there has been explosive growth in the production of risk information and in collaboration between scientific and technical institutions, but too little of this information ends up in the hands of users in a format that can inform decisions (CDKN, 2014).

Figure 7.1 Progress in risk awareness



(Source: UNISDR with data from the HFA Monitor.)

## 7.3 Experiencing disaster risk

**Gaining risk awareness is a dynamic process which is highly dependent on disaster experience. It therefore differs across time and space.**

Risk awareness and understanding would seem to be fundamentally experiential. For example, Japan has the highest level of hazard exposure in the world and has been dealing with repeated

disasters for millennia. Shaped by that experience, risk awareness is high amongst citizens and government authorities alike, research into risk identification and estimation is a priority, and risk knowledge permeates disaster risk management strategies and policies at all levels. Sustainability depends on sound disaster risk management.

In contrast, the disaster risk awareness of households, businesses and governments in countries with low levels of hazard exposure and infrequent disasters is likely to lack that essential experiential quality. Irrespective of public information on hazards, a strong political and economic imperative for disaster risk management is far less likely to emerge in those countries (Neumayer et al., 2012).

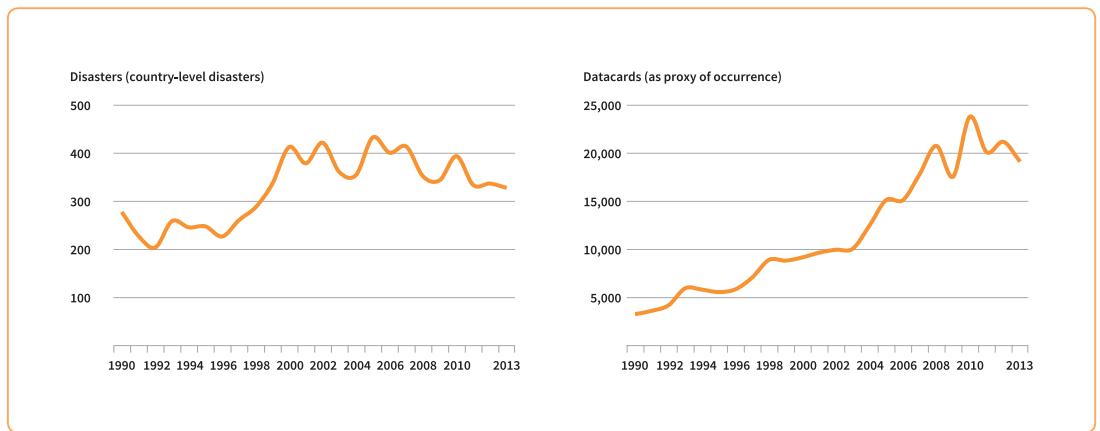


At the global level, disaster risk awareness is not systematically assessed, and it is difficult to measure how it has evolved since the adoption of the HFA or the declaration of the IDNDR. However, the number of nationally and internationally reported disasters has shown a strong upward trend since 1990 (Figure 7.2), which could indicate that more people have experienced manifestations of risk first-hand.

Large intensive disasters with major social and economic impacts certainly generate risk awareness, at least in the short term, and may catalyse change. As noted in Chapter 1, the impetus to reform risk governance arrangements often surfaces in the wake of large disasters. This change is not limited to governments. For example, the impact of the 2011 disasters in Japan and Thailand on global supply chains (UNISDR, 2013a) certainly led to raised awareness of and concern with disaster risk in the private sector.

This awareness (Box 7.2) continues to grow, and disaster and climate-related risks now figure

**Figure 7.2** Disaster records in global (left) and national databases (right)



(Source: UNISDR with data from EM-DAT and national disaster loss databases.)

highly on the radar screens of senior executives in global corporations.

Whether risk awareness is maintained over the medium and long term would seem to depend on disaster frequency. When intensive disasters are very infrequent, as in the case of Indian Ocean tsunamis, inter-generational awareness of disaster risks may fade. To cite an extreme example, it is highly doubtful whether earthquake risk awareness is still strong in the south-east of England as a result of the Canterbury earthquake on

21 May 1382. As a result of migration, populations that may have lived in an area for decades are unaware of the risks manifested in historical disasters hundreds of years ago. In addition, increasing geographical mobility now means that people frequently live, work and travel far from the areas and disaster risks they are familiar with.

As highlighted by the case of Ratnapura, extensive disasters clearly shape risk awareness in a far more tangible way in the localities where they

## Supply chains



### Box 7.2 Increasing awareness of disaster and climate risks

Around 70 per cent of companies responding to a recent survey by the Carbon Disclosure Project identified clear business continuity risks to their supply chains and thus risks to their revenue streams due to climate change and the resulting extreme weather events (CDP, 2013). Most importantly, more than half of these risks have either already impacted these companies or are expected to do so within the next five years (ibid.).

Local surveys of a similar nature reflect these global results and show that awareness of climate risk in particular is rising across the globe. For example, of more than 300 businesses responding to an annual survey on climate change in Hong Kong, 82 per cent identified disruptions due to extreme weather as critical risks, compared to “only” 44 per cent in 2010 (BEC CCBF, 2014).

However, smaller companies may be less aware of the potential scale of climate risks (Ceres, 2013). Among 184 companies surveyed in the insurance sector, only 23 large companies had a “specific, comprehensive strategy to cope with climate change” (ibid., p. 7). The approaches of others range from viewing climate change as a risk inherently captured in their enterprise risk management strategies to an environmental issue immaterial to their business.



occur. And given their frequency, this awareness is unlikely to fade. However, as they affect mainly low-income households and communities, small businesses and local infrastructure rather than strategic political and economic interests, they are less likely to catalyse an increased imperative for disaster risk management at the national level (UNISDR, 2011a). At the same time, opportunities to manage risks are often severely constrained at the local level.

## 7.4 In search of the scoop

**Media interest in disasters is transient, and reporting on disaster causes and impacts can reinforce the perception of disasters as exogenous to development.**

The world is changing rapidly as connectivity increases and global television, the Internet and social media become all-pervasive. Images of disasters occurring anywhere in the world are now transmitted and disseminated globally in real time. Similarly, disaster impacts themselves ripple through global supply and value chains. A more global awareness of risk would seem to be emerging that is not necessarily grounded in the

experience of disasters in particular places. This global risk awareness has been strengthened by the threat of catastrophic climate change to the extent that disaster risk has been increasingly portrayed as synonymous with climate change.

However, the global media focuses on major disaster events rather than the underlying processes and drivers that generate and accumulate disaster risks. Like resources for the disaster risk management sector, media coverage of and interest in disasters is transient: it spikes when major events occur, for example following the Indian Ocean tsunamis in 2004 and the East Japanese earthquake in 2011, but it falls silent between events (Box 7.3).

Against this backdrop, while the global media can increase risk awareness, it may tend to reinforce the perception of disasters as exogenous events, thus dissimulating and veiling the drivers through which the development paradigm generates and accumulates risk. In addition, while these drivers do become visible through extensive disasters, the resulting risk awareness is largely limited to the local level.



### Box 7.3 Disaster mortality and the media

The space dedicated to mortality in the media is not proportional to the number of deaths that actually occur (Bomlitz and Brezis, 2008). Mortality associated with illicit drugs, motor accidents, toxic agents and homicide are overrepresented (Frost et al., 1997), as are hazards such as SARS and bioterrorism. In contrast, more prevalent mortality factors such as AIDS, physical inactivity and smoking are under-represented (Bomlitz and Brezis, 2008).

In general, the media tends to overlook creeping changes (Glantz, 1999) even though the threats posed by environmental change such as biodiversity loss, climate change, desertification, stratospheric ozone depletion, tropical deforestation, mangrove and coral destruction, soil erosion, soil and water pollution, overfishing, invasive species (Meadows et al., 1972; Turner, 2008; Randers, 2008 and Rockström et al., 2009) and other global drivers may increase disaster risk to catastrophic levels. These incremental changes go unnoticed until they pass a threshold and quickly lead to changes in the environment or are revealed by a disaster (Maskrey, 1999). Only then does the media pay attention.

## 7.5 Information but not communication

**Risk information is being generated and disseminated on a large scale, but how far it reaches and whether it changes risk perceptions and awareness levels is not well understood.**

Since the declaration of the IDNDR, there has been explosive growth in the production and dissemination of information on disaster risks and disaster risk reduction (UNISDR, 2014c). However, it is unclear to what extent this has contributed to increasing awareness of disaster risk.

As the disaster risk management sector has grown and become structured around different communities of practice, such as emergency management, community-based disaster risk management, insurance and risk financing,<sup>2</sup> the volume of information produced and exchanged has increased exponentially, facilitated by the expansion of the Internet since the early 1990s. PreventionWeb now records 6,587 organizations that have promoted disaster risk reduction through their websites, including 1,093 media and news organizations, mediated regionally and thematically by dedicated information portals and online documentation centres such as CRID in Latin America, PreventionWeb itself, Pacific Disaster Net and others (UNISDR, 2014c).

A large number of formal and informal networks now provide channels for information sharing and dissemination inside the sector. In addition, whereas there were only a handful of specialized training programmes on disaster risk reduction in 1990, there are now over 100 dedicated master's programmes servicing the sector across all regions (Holloway, 2014).

Therefore, there is evidence of exponential growth in the production and exchange of information on disaster risk management. What is unclear, however, is how much of that information

actually seeps and spills out of the sector into other social, economic and political domains. And it is even less clear how much of this information has truly generated changes and transformation in development practices. As mentioned in Chapter 1, some of the key activities proposed in the HFA regarding risk information, for example, "*Institutions dealing with urban development should provide information to the public on disaster reduction options prior to constructions, land purchase or land sale*", were incisive and could have directly influenced and transformed the operation of land markets and valuations of disaster risk. However, there is little evidence that this key activity was ever acted on.

In contrast, far more progress has been made in disseminating information through public awareness programmes. According to the HFA Monitor, the number of countries with national disaster information systems and mechanisms for proactive information dissemination has increased over the last two reporting cycles (2009-2013), with important regional differences. In Africa, lack of capacity, funding and Internet connectivity are all cited as barriers, and many countries face issues of sustainability. In Asia, some low-income countries would appear to have more advanced systems than high-income countries.

However, in most countries (UNISDR, 2014c; SCI, 2014) the existence of a web site is often taken as evidence for the existence of a disaster information system. Increases in the number of websites offering risk information or the number of experts attending regional and international conferences certainly gives the impression of expanding risk awareness, but as indicated in the introduction to this part of the report, this may simply strengthen the *hyper-reality* of the sector. Little information is available on the extent to which households, businesses and government institutions from outside the sector visit these web sites or whether the information available is actionable.



Many countries have also used media campaigns (print media, radio, television) to raise public awareness. However, the dissemination of information is generally unidirectional and reflects the agenda and vision of the sector rather than the information needs of those at risk. Top-down media campaigns by definition tend to be simple and generic. They generally focus on awareness of hazards and on disasters as exogenous events rather than on socially constructed processes of risk generation and accumulation. The constraints and opportunities for risk management, the rights of those at risk, or the responsibility of local and national governments are rarely featured, and the specific needs of women, the elderly, people with disabilities, and children have only occasionally been brought into focus. At the same time, a number of governments still consider risk and even disaster loss information sensitive from a national security standpoint, meaning that it is not disseminated or made available to citizens.

This is insufficient to build a *culture of prevention and resilience* given that it does not empower risk-prone households and businesses to manage their risks in the face of wider social and economic opportunities and constraints. In many sectors, opportunities for short-term economic gain often still outweigh longer-term risks. A *culture of prevention and resilience* will only emerge if the information allows a transparent and comprehensive assessment of the costs and benefits of disaster risk management and if a system of accountability is put in place that offers incentives and encourages compliance (OECD, 2014b).



## 7.6 Education as a vehicle to effective risk management

**Education, and in particular formal school education, is a strong foundation enabling individuals to understand disaster risk. Adapted curricula can support a significant improvement in risk awareness.**

In Nepal, villages with higher mean years of schooling had fewer families affected by floods and landslides (KC, 2013), and in Thailand, better-educated communities suffered lower welfare impacts, particularly in terms of lost income (Garbero and Muttarak, 2013). The policy implications from these findings are clear: investments in education, and particularly in female education, have been shown to reduce vulnerability and should therefore be presented as a core strategic investment in disaster risk reduction (Muttarak and Lutz, 2014).

While general formal education lays the foundations for synoptic brain structure and the accompanying problem-solving and cognitive skills, it also creates the required literacy and numerical skills and abstract thinking that enables individuals to better understand risk information such as early warning messages and evacuation plans (ibid.). More directly, education facilitates knowledge acquisition on a broad range of issues directly related to individual and community vulnerability, including health and nutrition practices as well as direct knowledge of hazards. In addition, education may enhance the socio-economic status of individuals and families and thus contribute to improved disaster risk management through increased income, better access to information and stronger social networks (ibid.).

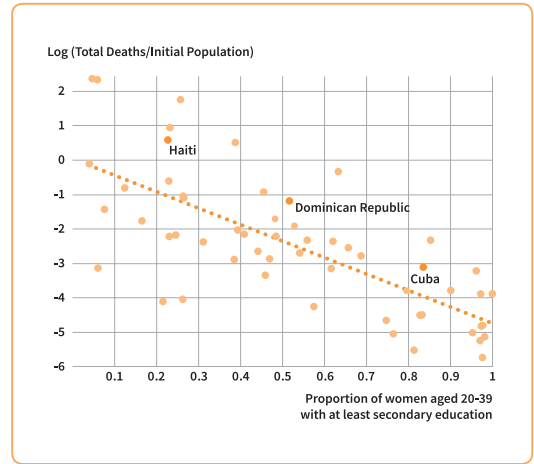
Recent studies comparing national education levels with mortality risk show that countries with higher education levels, particularly amongst women and girls, exhibit lower

mortality from disasters (KC, 2013; Striessnig et al., 2013). For example, education levels and mortality rates were shown to be highly correlated in the case of weather-related disaster risk in 56 countries with an average of one or more disasters per annum (Figure 7.3).

While education in itself is critical to disaster risk reduction, the HFA proposed a number of key activities under Priority for Action 3 which relate specifically to the inclusion of disaster risk reduction in education and training (Box 7.4).

Since 2005, an abundance of educational materials in the form of guidelines, teacher’s guides and curriculum reform guides have been produced in various languages.<sup>3</sup> However, the content and quality of educational materials on disaster risk reduction has not been seriously reviewed, and the uptake of the available materials by educational institutions is not monitored. As a result, it is difficult to assess what progress has been made, to what extent efforts in reforming curricula to include risk considerations have been successful, or where and why they may have failed.

**Figure 7.3** Weather-related disaster mortality and female education in Cuba, the Dominican Republic and Haiti



Note: The graph shows deaths per 1,000 based on 1980 population levels (y-axis) proportional to secondary and higher education among women aged 20-39 (x-axis) for 56 countries with one or more disasters on average per annum.

(Source: Pichler and Striessnig, 2014.)

The nature of curriculum development in itself makes it difficult for a framework like the HFA to exert strong influence on the decision-making process. On the one hand, curricula are reviewed and adapted in 5 to 10-year cycles, which may not

**Box 7.4** Key activities related to education and training in the HFA

- (h) Promote the inclusion of disaster risk reduction knowledge in relevant sections of school curricula at all levels and the use of other formal and informal channels to reach youth and children with information; promote the integration of disaster risk reduction as an intrinsic element of the United Nations Decade of Education for Sustainable Development (2005–2015).*
- (i) Promote the implementation of local risk assessment and disaster preparedness programmes in schools and institutions of higher education.*
- (j) Promote the implementation of programmes and activities in schools for learning how to minimize the effects of hazards.*
- (k) Develop training and learning programmes in disaster risk reduction targeted at specific sectors (development planners, emergency managers, local government officials, etc.).*
- (l) Promote community-based training initiatives, considering the role of volunteers, as appropriate, to enhance local capacities to mitigate and cope with disasters.*
- (m) Ensure equal access to appropriate training and educational opportunities for women and vulnerable constituencies; promote gender and cultural sensitivity training as integral components of education and training for disaster risk reduction.*


**Box 7.5** The role of children in strengthening preparedness

The United States and Australia have developed educational materials that foster leadership among school children in disaster preparedness and teach them how to share this information with others. Looking at children as *active agents* of change instead of objects that need to be protected can broaden the scope of education and its future impact. Several programmes have been developed in order to develop children's awareness of and capacities for DRR, such as Save the Children's school safety programmes or the Children's Charter for Disaster Risk Reduction (Children in a Changing Climate Coalition, 2011).

In France, The Memo'Risks initiative has been operating in the Loire River catchment area since 2004 and brings together local governments and schools to survey local disaster risk awareness (UNISDR et al., 2010). Students are rallied by local mayors to investigate and map risks and to survey the preparedness and risk knowledge of the local population. The survey results then become a valuable data resource on perceptions of risk and levels of risk knowledge in the local population. The process of collecting, presenting and publicizing the results is used by local government to raise disaster awareness through the media, to increase community participation in disaster risk reduction, and to form the basis of targeted disaster risk information campaigns (ibid.).<sup>4</sup>

correspond to the short cycles of projects aimed at raising risk awareness in schools. On the other hand, the generic and global guidance in the HFA is often difficult to align to the sub-national contexts where curricula are often developed.

However, about 72 per cent of countries reporting through the HFA Monitor indicate that disaster risk reduction is included in some way in the national educational curriculum, with coverage in primary school curricula slightly higher than in secondary and university or professional programmes. Only about a third were able to report on the inclusion of disaster risk reduction in curricula at all education levels as well as in professional education programmes (UNICEF and UNESCO, 2014).

While there is little systematic research on changing perceptions, anecdotal evidence shows that preparedness drills and simulation activities in schools (Box 7.5) may make an important contribution to risk awareness, particularly amongst children and youths.

Children's engagement in school disaster management, including risk assessment and active problem-solving, lays the foundation for critical thinking and promotes an increasing willingness to take on other challenges. Engaging students and families in planning for educational continuity may also be a factor in reducing school drop-out rates when disasters occur (UNICEF and UNESCO, 2014).

Rather than promoting disaster risk reduction as a stand-alone curricular subject, there are obvious synergies in combining it with related subjects, such as climate change. For example, Cambodia is promoting a combined disaster risk reduction and climate change adaptation curriculum that reduces the pressure on what is seen as an already overcrowded school curriculum. There are other examples where disaster risk reduction has been linked with topics like conflict and peace-building, sustainable development, other common localized risks, and with the underlying social, economic and political drivers of risk. Unfortunately the silo-like nature of the disaster risk management sector and institutional rivalries with other sectors such as climate change may be obstacles to this sort of integration.



## 7.7 Living in a modelled world

The volume of risk information produced has increased significantly over time and is accompanied by associated communities of practice, increasing data availability and scientific and technical capacities to transform that data into risk information.

In parallel with the growth of the disaster risk management sector as a whole, there has been equally exponential growth in the number of people and institutions involved in risk assessment. At all levels, the volume of risk information produced has increased significantly, and this development has been accompanied by a commensurate increase in the size of the associated community of practice, in the data available and in the scientific and technical capacities to transform that data into risk information. The series of *Understanding Risk* meetings organized by the World Bank since 2010<sup>5</sup> highlights the emergence of an increasingly large and dedicated community of practice in this area. It would appear that disaster risk management is increasingly taking place in a modelled world.

Until the early 1990s, much of the insurance industry based its business decisions on actuarial approaches using historical data. The use of catastrophe risk models in this industry grew dramatically after Hurricane Andrew, which struck

Florida in 1992 and gave rise to insured losses far greater than those expected on the basis of historical experience (GFDRR, 2014a). Shortly after the hurricane made landfall, the risk-modelling company AIR modelled and estimated the insured losses; these were far larger than any experienced in the past and closer to the actual insured losses from the hurricane.

The arrival of powerful personal computers in the early 1990s ushered in the era of mathematical modelling of disaster risks using probabilistic approaches. Following Hurricane Andrew, the insurance industry began to invest heavily in risk modelling in order to set premiums appropriately and to protect itself against insolvency.

With a few notable exceptions,<sup>6</sup> probabilistic risk modelling was largely confined to the insurance industry and to specialized risk modelling companies until the advent of the HFA. While many national and local governments, international organizations and non-governmental organizations carried out risk assessments, these were generally qualitative in character (e.g. highlighting areas of low, medium or high risk) or deterministic (calculating risk quantitatively for one particular hazard scenario) and limited by the availability of historical data.

The HFA gave detailed guidance on key activities in risk assessment under Priorities for Action 2 and 3 (Box 7.6).

**Box 7.6** Key activities related to risk assessment in the HFA

### National and local risk assessments

*(a) Develop, update periodically and widely disseminate risk maps and related information to decision-makers, the general public and communities at risk in an appropriate format.*

*(b) Develop systems of indicators of disaster risk and vulnerability at national and sub-national scales that will enable decision-makers to assess the impact of disasters on social, economic and environmental conditions and disseminate the results to decision makers, the public and populations at risk.*

*(c) Record, analyse, summarize and disseminate statistical information on disaster occurrence, impacts and losses on a regular basis through international, regional, national and local mechanisms.*



## Capacity

*(i) Support the development and sustainability of the infrastructure and scientific, technological, technical and institutional capacities needed to research, observe, analyse, map and where possible forecast natural and related hazards, vulnerabilities and disaster impacts.*

*(j) Support the development and improvement of relevant databases and the promotion of full and open exchange and dissemination of data for assessment, monitoring and early warning purposes, as appropriate, at international, regional, national and local levels.*

*(k) Support the improvement of scientific and technical methods and capacities for risk assessment, monitoring and early warning, through research, partnerships, training and technical capacity- building. Promote the application of in situ and space-based earth observations, space technologies, remote sensing, geographic information systems, hazard modelling and prediction, weather and climate modelling and forecasting, communication tools and studies of the costs and benefits of risk assessment and early warning.*

*(l) Establish and strengthen the capacity to record, analyze, summarize, disseminate, and exchange statistical information and data on hazards mapping, disaster risks, impacts, and losses; support the development of common methodologies for risk assessment and monitoring.*

## Regional and transboundary risks

*(m) Compile and standardize, as appropriate, statistical information and data on regional disaster risks, impacts and losses.*

*(n) Cooperate regionally and internationally, as appropriate, to assess and monitor regional and trans-boundary hazards, and exchange information and provide early warnings through appropriate arrangements, such as, inter alia, those relating to the management of river basins.*

## Research

*(n) Develop improved methods for predictive multi-risk assessments and socioeconomic cost-benefit analysis of risk reduction actions at all levels; incorporate these methods into decision-making processes at regional, national and local levels.*

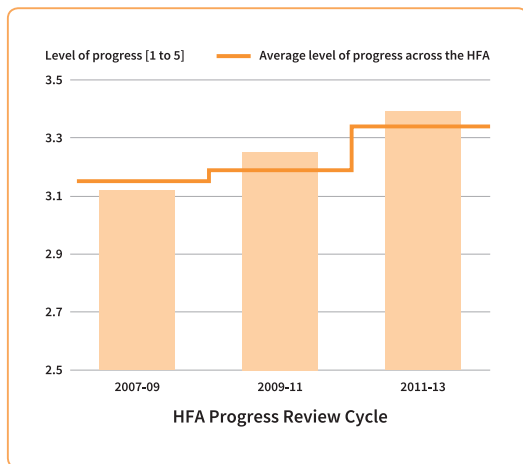
*(o) Strengthen the technical and scientific capacity to develop and apply methodologies, studies and models to assess vulnerabilities to and the impact of geological, weather, water and climate-related hazards, including the improvement of regional monitoring capacities and assessments*

Since the adoption of the HFA, there has been explosive growth in the production of risk information by public-sector scientific and technical institutions, universities and international organizations at all scales (GFDRR, 2014a). This growth has been facilitated by the increasing availability of remotely sensed information, open source software and platforms, social media, crowdsourcing and mobile phones, and by exponential increases in computing power. At the same time, there has been growing convergence between risk assessment efforts in the insurance and catastrophe modelling industries and those in the public and academic sectors. As a result,

significant progress has been made in each critical element of the risk assessment process (Figure 7.4).

There has been substantial progress towards creating and providing open access to many global and national data sets critical to understanding hazard. The greater availability of global data sets on population, building types, satellite imagery, and so on is opening up significant opportunities to model global exposure at higher and higher resolutions. At the national and sub-national levels, data and information from government ministries (such as statistics authorities,

**Figure 7.4** Progress in risk identification and assessment



HFA Priority for Action 2: Identify, assess and monitor disaster risks and enhance early warning.

(Source: UNISDR with data from the HFA Monitor.)

transportation and infrastructure departments, and education and health departments) are increasingly being liberated<sup>7</sup> and merged in order to understand community, city and national exposure. At the city and community levels, the growing popularity of crowdsourcing has also enabled the collection of exposure data as well as the survey and mapping of disaster impacts in real time, for example after the 2010 Haiti earthquake and Pakistan floods (Degrossi et al., 2014; Chohan et al., 2011). Applications such as *OpenStreetMap* (Box 7.7) are helping to make this information increasingly pervasive.

At the same time, tools and models for identifying, analysing, and managing risk have grown in

number and utility; and risk data and tools are increasingly being made freely available to users as part of a larger global trend towards open data. More than 80 freely available software packages, many of which are open source, are now available for flood, tsunami, cyclone (wind and storm surge) and earthquake risk assessment, with at least 30 of them in widespread use (GFDRR, 2014a). Significant progress has also been made in improving open source geospatial tools such as QGIS, GeoNode and PREVIEW, which are lowering the financial barriers to risk information at the national and sub-national levels.

Since the publication of an initial global multi-hazard risk analysis by UNDP in 2004 (UNDP, 2004), models designed to provide insight into global and regional trends in disaster risk have also become more sophisticated and, as highlighted in Chapter 3 of this report, have now adopted probabilistic approaches.

Disaster loss data has also significantly improved. As mentioned in Chapter 4, over 85 nationally owned databases of disaster loss and damage now exist, compared to only 12 in 2005. Similarly, efforts have been undertaken to improve the interoperability of disaster loss data from national and global databases through the development of common data standards<sup>8</sup> and unique identifiers such as GLIDE.<sup>9</sup> In a number of countries the compilation of national disaster loss data has opened the doors to a broader approach

**Box 7.7** OpenStreetMap



OpenStreetMap is an online geospatial database and a global community of over 1.5 million contributors engaged in building a free and open map of the world. The principle that anyone can contribute to the database and that it can be used in any tool or analysis is the reason why it is also known as the “the Wikipedia of maps”. Established in the United Kingdom in 2004 in reaction to restrictions around the use and/or availability of geospatial data across the world, OpenStreetMap is a confederation of organizations and technologies that seek to improve public understanding of natural hazard risks and climate change impacts.

(Source: Simpson, 2014. For more information, see <http://www.openstreetmap.org/>.)

**Box 7.8** A policy-maker's view of understanding risk

A recent initiative towards “Building capacities for increased public investment in integrated climate change adaptation and disaster risk reduction” that will span around 40 countries by the end of 2015 helps countries understand and manage disaster risk in a uniquely comprehensive manner.<sup>10</sup> The UNISDR-led and European Commission-supported initiative, in partnership with several international agencies and academic institutions, supports countries through a *full package* approach for disaster loss accounting, probabilistic risk assessment, economic analysis and policy development.

For example, in Mauritius, a total of 1,105 data cards on disaster loss in 1980-2013 were registered, with total economic losses estimated at US\$59 million. Of these losses, 82 per cent were found to be from cyclones alone. The following probabilistic risk assessment therefore calculated the average annual loss and probable maximum loss for tropical cyclonic wind, which were estimated at US\$87 million (AAL) and US\$1.7 billion (PML) for a 100-year return period.

While these numbers highlighted the need to reduce tropical cyclone risk, in themselves they did not provide any policy guidance. Therefore, a thorough policy review and economic analysis were implemented, and it was found that the country would face difficulties in managing losses from cyclones and earthquakes with return periods of only 62 to 87 years. This pointed to the need for Mauritius to invest in both disaster risk reduction as well as risk financing mechanisms, including insurance.

Probabilistic cost-benefit analyses were then conducted to support concrete and specific decision-making, for example on retrofitting of housing, and a further review of the public finance systems was undertaken. As a result, the government found that there were significant gaps in terms of a coherent risk-sensitive investment policy across all relevant sectors, in particular for critical infrastructure, and that contingency financing mechanisms were underdeveloped. Examining the disaster loss and risk information from the perspective of policy-makers, especially financial planners, in Mauritius, highlighted the importance of a linked approach to disaster risk reduction and resulted in concrete recommendations from the Ministry of Finance.

(Source: UNISDR. For more details, see Annex 3.)

to disaster risk management including probabilistic risk assessment and dialogue with finance and planning ministries (Box 7.8).

## 7.8 On rigour in science

**The extent to which the risk information produced since the adoption of the HFA is really informing development is not well known. Even within the disaster risk management community, new scientific information is not applied consistently.**

*“... In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time,*

*those Unconscionable Maps no longer satisfied, and the Cartographers Guilds produced a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast map was Useless, and not without some Piteousness was it, that they delivered it up to the Inclemencies of Sun and Winters. In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars; in all the Land there is no other Relic of the Disciplines of Geography.”<sup>11</sup>*

In principle, risk information should provide a critical foundation for raising risk awareness and for informing disaster risk management policies, practices, investments and measures from the local to the global level, including financial

applications to transfer risk and contingency plans to deal with possible disasters.

Globally, risk information should inform international agreements and policies on development priorities. In the insurance sector, the quantification of disaster risk is essential given that the solvency of most non-life insurance companies is strongly influenced by their exposure to catastrophe risk. Through their finance or planning ministries, governments should be using risk information to inform public investment and to assess their fiscal resilience to large disasters (UNISDR, 2011a). In the construction sector, quantifying the potential hazard expected in the lifetime of a building, bridge, or critical facility should be driving the creation and modification of building codes. In the land-use and urban planning sectors, an analysis of flood risk, for example, should be driving investment in flood protection, informing zoning changes and possibly leading to changes in insurance pricing (GFDRR, 2014a). In hazard-exposed communities, risk information should be underpinning local-level disaster risk management initiatives. Finally, in the private and financial sectors, it should be informing not only business continuity planning but also corporate planning, investment and risk management (UNISDR, 2013a).

In practice, however, and as the short story by Jorge Luis Borges cautions, the burgeoning risk assessment community would appear to be making greater investments in increasing the accuracy and rigour of risk models and assessments than in developing understandable and actionable information that responds to the needs of users.

It is unclear how much of the risk information that has been produced since the adoption of the HFA is really seeping and spilling out of that community of practice into sector and territorial development or even into the mainstream disaster risk management sector (CDKN, 2014). In fact,

the exponential growth of risk information has the effect of creating an elaborate play of reflections in a room full of mirrors. Inside the community of practice, there would seem to be growing opportunities to produce more and better risk information. Seen from outside the room, however, disaster risk information is still perceived as an exotic commodity. Outside of the insurance industry, cases where risk information has become fully integrated into decision-making are still the exception rather than the rule (Box 7.9).

There appear to be a number of instrumental reasons for this disconnect. Risk information produced by the insurance and catastrophe modelling industry is still largely retained as intellectual property within each company and is rarely accessible to governments, businesses or households. The information is based on proprietary models, and even if the results were made available, it might be unclear how the data was transformed and what assumptions were made to generate risk estimates.

The predominant academic culture of publication in scientific journals is likewise an obstacle to accessing risk information. For many university-based risk modellers and researchers, publication becomes an end in itself rather than a means of opening the results for application and dissemination. Given that scientific journals are usually only read by other scientists, this creates a closed circuit. The fact that so much published scientific literature is in English further removes it from application in non-English speaking countries.

Insufficient emphasis has been placed on making fundamental data sets generated through the risk assessment process more open and accessible for reuse and repurposing, meaning that resources are wasted through the repetitive creation of the same data sets (GFDRR, 2014a).

Hazard and risk assessments tend to be driven by well-intentioned science and engineering experts

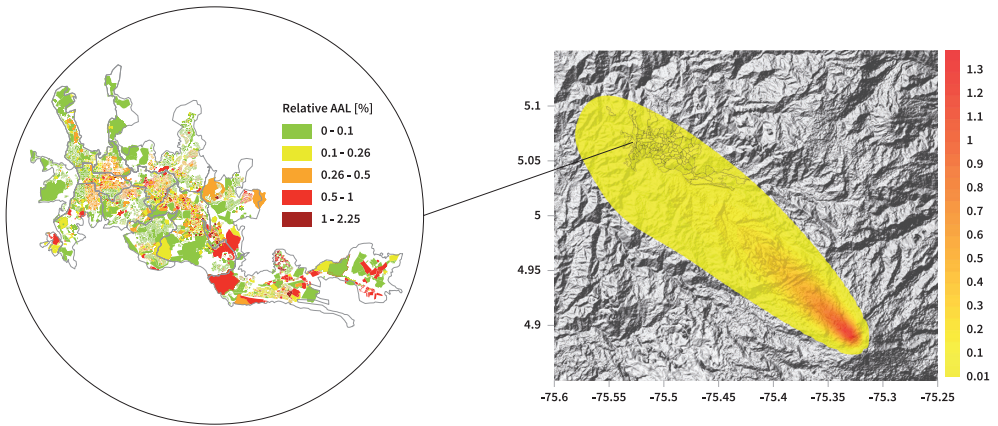
In Manizales, Colombia, a full set of probabilistic risk assessments were carried out to develop a comprehensive disaster risk management strategy. This included retrofitting existing structures, updating a municipal earthquake insurance scheme and performing a cost-benefit analysis of structural risk reduction measures and land-use planning. Probabilistic seismic hazard assessment was used to calibrate the national earthquake building code to local seismic micro-zones for both building stock and the water and sewage network.



Flood hazard for the Chinchiná basin was assessed using 30 years of rainfall data. Landslide risk analysis based on detailed information about land use, topography and geological information was used to support urban planning applications.

In addition, probabilistic volcanic ash hazard was analysed for the Ruiz Volcano located 30 km south-east of Manizales.

Ultimately, the Manizales voluntary municipal insurance scheme was based on this multi-hazard risk assessment. In this innovative scheme, middle and high-income groups underwrite policies, while low-income homeowners are subsidized by other homeowners and the local government, which acts as an intermediary.



Relative AAL loss distribution for the building stock of Manizales

Volcanic ash thickness hazard map (m)

(Source: Salgado et al., 2014a and 2014b.)

rather than by the end-users and decision-makers who need access to targeted information in different formats. All too often, risk information is driven by supply rather than demand, meaning that even when decision-makers are aware that they require risk information, it is often not available in a usable form.

Finance ministers, for example, might be interested in metrics such as annual average loss

(AAL) or probable maximum loss (PML) in order to estimate the potential fiscal impact of disasters or the costs and benefits of investing in disaster risk reduction. They need numbers, not maps. In contrast, planners preparing local land-use or zoning plans will require hazard and risk maps rather than numbers (GFDRR, 2014a). Global risk indices or assessments are useful for comparing risk levels across countries but are too coarse-grained to inform national and local planning. In

any case, decision-makers may not understand the uncertainties inherent in modelling. A risk model can produce very precise results. It may show, for example, that a 1-in-100-year flood will affect 388,123 people. In reality, however, the accuracy of the model and input data may provide only an estimate of the order of magnitude.

At the same time, given the continued focus on managing disasters rather than disaster risk, demand for risk information from governments may be weak. Many risk assessments are one-off projects, particularly in the context of post-disaster recovery operations, and even the maintenance of national disaster loss databases faces sustainability issues (Wirtz et al., 2014; Gall et al., 2014).

While international organizations have supported risk assessments in many high-risk, low-income contexts (GFDRR, 2014a), these assessments are rarely appropriated by national institutions and seldom contribute to risk awareness in the country, simply because the underlying research infrastructure to sustain such efforts does not exist (Gall et al., 2014b). The capacity to produce and use risk information varies enormously from country to country. Unsurprisingly, the HFA Monitor highlights that high-income countries with strong scientific and technical communities have been able to make significant progress in monitoring and forecasting hazards and developing national and local risk assessments, whereas many low-income countries simply do not have the capacities to do so. As such, the coverage of risk information is patchy from a geographical perspective, responding more to project opportunities than to real needs. And even when risk information is available in national institutions, mechanisms to ensure that the information is available and usable at the local level are often missing, especially given the weak capacity of most local governments outside of major cities (CDKN, 2014).

Linked open data, social media and crowdsourcing could potentially bridge this gap. But there

remain tensions between data as a power source, as an income generator and as a social good. Legal obstacles often remain regarding the extent to which proprietary data needs to be transformed to become free and open (GFDRR, 2014a).

Another problem identified by the HFA Monitor is the absence of agreed standards or normalized approaches. This means that large volumes of studies and research carried out by universities, research institutions and others at the national level do not provide standardized results. In Padang, Indonesia, for example, no less than twelve different tsunami risk assessments were carried out, each producing different results (Løvholt et al., 2014). In many other tsunami-prone locations, not a single detailed assessment has been carried out.

Shared language, terminology and translation are other barriers to sharing and using risk information. While international efforts under UNISDR and the Intergovernmental Panel on Climate Change (IPCC) have developed standard terminologies, words such as vulnerability, resilience and mitigation are used in widely differing ways in different communities. When such words are translated into other languages, this divergence multiplies even further. In practice, national meteorological and geological institutions are rarely integrated and frequently use different concepts and methods to assess risk.

This makes multi-hazard assessment particularly challenging. Multiple or concatenated risks from cascading and technological hazards are increasingly common, meaning that a single-hazard risk assessment is often not relevant to the decision-makers responsible for broader risk management. Moreover, failing to consider the full risk spectrum can actually increase risk. For example, heavy concrete structures with a ground-level soft story for parking can protect against cyclone wind, but can be deadly in an earthquake (GFDRR, 2014a).



Given these challenges, there are relatively few contexts (Box 7.10) where decision-makers have successfully incorporated risk information into day-to-day planning, regulation and decision-making. Risk knowledge implies an appropriation of risk information by society in a way that facilitates risk management. From that perspective, the increased production of risk information during the HFA has not necessarily led to greater risk knowledge nor to improved risk management (Gall et al., 2014b). The growing supply of increasingly sophisticated and accurate risk information remains an exotic commodity which is still largely divorced from mainstream social, economic and territorial concerns. Like the cartographers described by Jorge Luis Borges, modern-day risk modellers are still too often disconnected from the needs of their potential users.

## 7.9 The social production of risk information

**The role of social and economic constraints and opportunities facing households, businesses or governments has to become more central to the understanding of risk and to choices of disaster risk management strategies.**

Experience has shown that a purely technical assessment of risk, however sophisticated and cutting-edge, is by itself unlikely to trigger actions that reduce risk. Successful risk assessments produce information that is *targeted*, *authoritative*, *understandable*, and *usable*.

For example, the Build Back Better campaign led by the government of Indonesia in the aftermath

### Box 7.10 Turning risk data into applicable risk knowledge

In Peru, all hazard information from the national seismic hazard model is being integrated into the National Public Investment System (Sistema Nacional de Inversión Pública) database, which facilitates the sharing of findings with the scientific community, government authorities and the general public. The findings of a seismic probabilistic risk assessment carried out for 1,540 schools and 42 hospitals in Lima and Callao are being used by the Ministry of Education to complement the countrywide infrastructure census and to design the National School Infrastructure Plan (GFDRR, 2014a; AIFDR, 2013).

The earthquake, tsunami, and volcanic hazard modelling activities of the Australia-Indonesia Facility for Disaster Reduction have increased government capacity to understand the country's hazard risk profile, and these gains have in turn informed significant policy directives at the national level, such as the 2012 Indonesian Presidential Master Plan for Tsunami Disaster Risk Reduction (GFDRR, 2014a).

As early as 1987, France adopted a law that grants every citizen the right to information on their exposure to major risks (Government of France, 2004), on foreseeable damage, on possible preventive measures to reduce vulnerability, and on protection and relief support available from the government in the case of an emergency. Since 1990, local authorities have been obliged to provide the information online (Government of France, 1990).

Since 2009, the international NGO ACTED has been working closely with the Government of Uganda to manage the Karamoja Drought Early Warning System (DEWS). By collecting and monitoring data on key indicators, this system allows drought prediction across Karamoja, a region prone to cyclical droughts. Monthly drought bulletins alert communities, districts and development partners of the risk of drought and suggest preparedness measures to be initiated (ACTED, 2012).

In Colombia, the provision of risk information is now a legal obligation under which the authorities are accountable for keeping all citizens and residents fully informed about levels of disaster risk, disaster management, rehabilitation and construction efforts, as well as all related funding received, managed and delivered (Government of Colombia, 2012).

of the Padang earthquake in 2009 demonstrated conclusively that well-targeted education and the communication of risk information can increase awareness of hazards and their potential impacts (GFDRR, 2014a). However, the campaign’s key assumption—that increased awareness would lead the West Sumatra population to invest in safer building—turned out to be false. In fact, those living in the worst-affected areas demonstrated higher resistance to change than those in less-affected areas, reflecting their higher exposure to other risks and hence greater constraints on change. The influence of the earthquake on safe building practices seemed to be limited to those who had gone through a traumatic first-hand experience during the earthquake, such as being trapped or injured by falling debris.



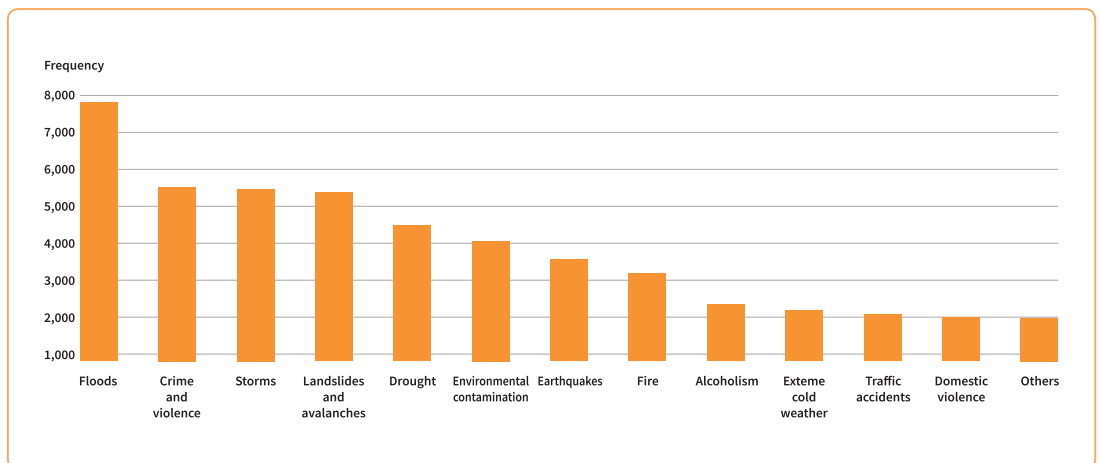
While risk can be objectivized through metrics such as annual average loss (AAL) or probable maximum loss (PML) or through maps, these metrics only become useful if they are socially appropriated. Given that risk is socially constructed, this is a prerequisite for a transformation in how the social and economic constraints and

opportunities facing households, businesses or governments are valued. What is considered acceptable or unacceptable risk, or what is an optimum strategy for risk management can only be understood in the relationship between the stakeholders and these opportunities and constraints.

Local assessments of everyday and disaster risks, for example, show how the prevalence of non-physical hazards and of small-scale recurrent events is part of an undifferentiated multi-threat environment (Figures 7.5 and 7.6). They also show how households of different income levels have very different perceptions of risk.

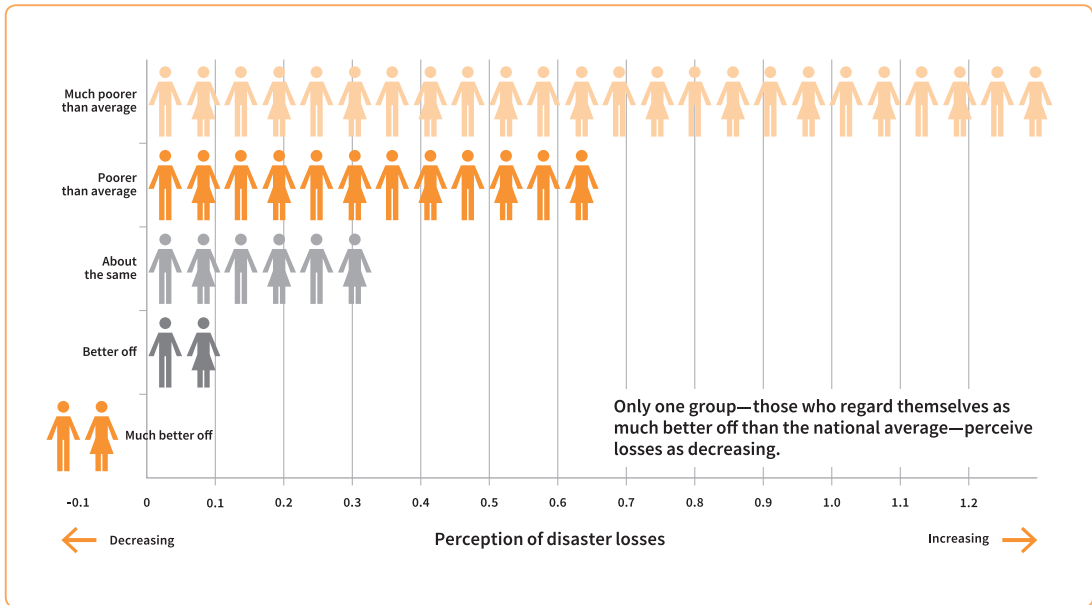
Not only risk but also the production of risk information is socially constructed. Beyond the instrumental barriers to its use (described in detail in Section 7.8), risk information so often fails to trigger changes in how risk is managed precisely because disaster risk is presented as an objective externality that can be measured and reduced rather than only one of a number of variables in a complex social, economic, political and cultural web of constraints and opportunities (UNISDR, 2011a). Risk then becomes technical, neutral and objective, delinked from its underlying drivers.

**Figure 7.5** High-priority threats as reported by communities in ten countries in Latin America<sup>12</sup>



(Source: Gibson, 2014.)

**Figure 7.6** Perceived losses according to self-reported income level



(Source: GNDP, 2013.)

As a consequence, risk assessments, particularly in the private sector, have tended to focus more on hazards, exposure and physical vulnerability than social and economic vulnerability and resilience, on extreme intensive risks rather than recurrent extensive risks, and on applications to protect development against external threats rather than applications to transform development. For example, these assessments are meant to identify optimum levels of protection for strategic and critical infrastructure which is essential to a country’s economy, to identify options for risk transfer and financial protection, or to inform preparedness and early warning for intensive disasters (GFDRR, 2014a).

As noted in Chapter 4 of this report, far less attention has been devoted to assessing extensive risks. Despite the magnitude of associated losses and impacts, these risks remain unaccounted for and largely invisible because the disasters rarely challenge strategic economic and political interests (Box 7.11).

Therefore, while improved interoperability, open data, sustainability and capacities may make risk information more usable and actionable, a different approach to the production of risk information is required.

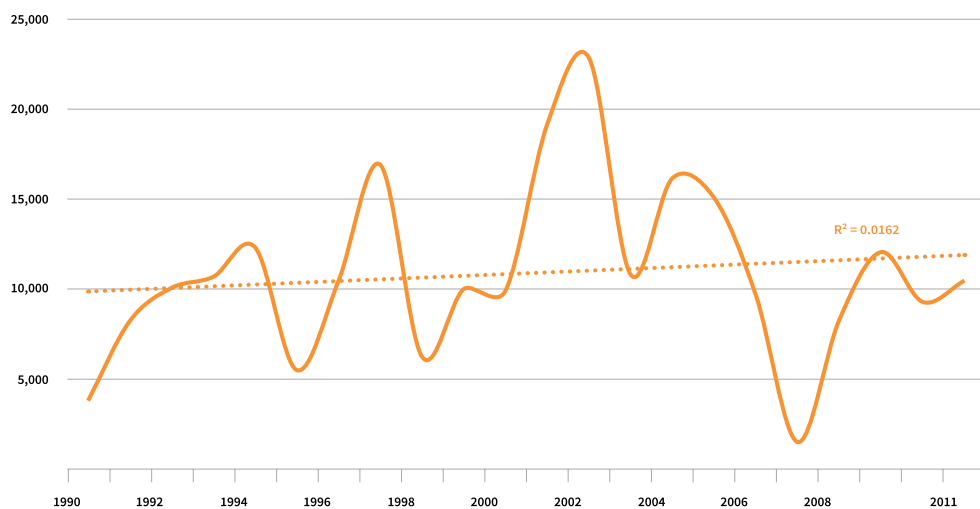
Risk always implies both opportunities and costs for different stakeholders. A factory built in a hazard-exposed location but in an area with low labour costs and good access to markets may represent an opportunity for business owners and investors. However, damage from a disaster will not only affect the business, but also the workers, who may lose their employment temporarily or permanently, as well as the local economy and the government, which may lose tax receipts, among others. Risk information should clarify who takes the risks, who benefits, who pays and thus who owns the risks. It should also clarify the benefits and costs of investing in disaster risk management. In other words, in order for risk information to become risk knowledge, the basic parameters of accountability have to be clarified in a way that

**Box 7.11** Something's burning

Catastrophic urban fires devastated Rome in 64 CE, London in 1666, Chicago in 1871, and Boston in 1872; the 1906 San Francisco fire destroyed nearly 95 per cent of the city, and the Tokyo fire of 1923 killed over 40,000 people. The implementation of modern building codes, land-use planning, the establishment and expansion of emergency services, greater citizen responsibility, and insurance regulations have largely consigned the catastrophic urban fire to history. From the perspective of intensive risk, the problem has been solved (GFDRR, 2014a).

National disaster loss data, however, reveals a very different story. The occurrence of fires in urban informal settlements and rural villages is trending up, and housing damage has been increasing since 1990. In Odisha and Tamil Nadu, India, for example, fires have caused 13 per cent of all housing damage since 1990 and are on the rise (Figure 7.7).

**Figure 7.7** Number of houses damaged and destroyed in Tamil Nadu and Odisha, 1990-2013



(Source: UNISDR with national loss data.)

provides clear incentives to manage risks and to ensure compliance.

The current understanding of the different groups with vested interests in the outcomes of risk management is far too broad. For example, private investment and the private sector encompass small and medium enterprises, farmers, informal traders and labourers, households and individuals, national businesses and large international corporations, investment banks and asset managers, insurers and a vast range of service providers to all of these groups.

For risk information to play such a role, it needs to be located *inside* development and *within* the social and economic constraints and opportunities that frame risk management. The room full of mirrors needs to open its doors; only then can a real culture of prevention and resilience emerge.



## Notes

---

- 1 All data from national loss databases. See [www.desinventar.net](http://www.desinventar.net) for an overview and links to national websites and data sets.
- 2 PreventionWeb lists 95 disaster risk reduction communities of practice; see [www.preventionweb.net](http://www.preventionweb.net).
- 3 For more information, see <http://www.preventionweb.net/english/themes/education>.
- 4 For more information, see <http://www.memorisks.org/index.htm>.
- 5 Three *Understanding Risk* forums have taken place so far (2010, 2012 and 2014). For more information, see <https://www.understandrisk.org/node/4889>.
- 6 The Federal Emergency Management Agency (FEMA) released Hazus97, the first version of Hazards US (Hazus), a geographic information system (GIS) based natural hazard loss estimation software package, in 1997.
- 7 Liberated data refers to data that was at one time inaccessible due to format, policies, systems, etc., but is now being made available for use, either as discoverable and useable data sets or (in many cases) as technically open data sets.
- 8 <http://www.irdrinternational.org/projects/data>.
- 9 <http://glidenumbers.net/glide/public/search/search.jsp>.
- 10 For more information on the initiative, see Annex 3.
- 11 Suarez Miranda, 1658; cited in Borges, J.L., 1998: p. 325.
- 12 Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela.

## Chapter 8

# Managing disasters



## 8.1 From early warning to early warning systems

The development and implementation of early warning systems is one of the areas where the most progress has been made within the HFA. Improvements in risk monitoring and forecasting, satellite data quality and increasing computer power and connectivity have resulted in a transformation of early warning across the globe.

Despite much progress, gaps remain: integration of comprehensive risk information into hazard warning information is still weak, and it is still rare for alerts to provide information on the level of risk and possible actions beyond evacuation alerts.

The first International Conference on Early Warning Systems for Natural Disaster Reduction was held in Potsdam, Germany in 1998 and set out the conceptual and programmatic foundations for the development of early warning systems.

A study produced for that conference (Maskrey, 1997) introduced the notion that an early warning system should be far more than a mechanism to issue warnings of impending hazard events. For an early warning to become a system, four integrated sub-systems are required: *a warning sub-system* in which hazards are monitored and forecasts and warnings issued; *a risk information sub-system* in which risk scenarios can be generated for the areas and population likely to be affected; *a preparedness sub-system* that indicates the actions that should be taken to reduce loss and damage, and *a communication sub-system* which allows the timely communication of information on pending hazard events, risks and appropriate preparedness strategies to those at risk.

From that perspective, the effectiveness of an early warning system should be judged less on whether warnings are issued *per se* but rather on the basis of whether the warnings facilitate appropriate and timely decision-making by those most at risk (Maskrey, 1997).

### Box 8.1 Key activities related to early warning systems in HFA Priority for Action 2

*d) Develop early warning systems that are people centered, in particular systems whose warnings are timely and understandable to those at risk, which take into account the demographic, gender, cultural and livelihood characteristics of the target audiences, including guidance on how to act upon warnings, and that support effective operations by disaster managers and other decision makers.*

*(e) Establish, periodically review, and maintain information systems as part of early warning systems with a view to ensuring that rapid and coordinated action is taken in cases of alert/emergency.*

*(f) Establish institutional capacities to ensure that early warning systems are well integrated into governmental policy and decision-making processes and emergency management systems at both the national and the local levels, and are subject to regular system testing and performance assessments.*

*(g) Implement the outcome of the Second International Conference on Early Warning held in Bonn, Germany, in 2003, including through the strengthening of coordination and cooperation among all relevant sectors and actors in the early warning chain in order to achieve fully effective early warning systems.*

*(h) Implement the outcome of the Mauritius Strategy for the further implementation of the Barbados Programme of Action for the sustainable development of small island developing States, including by establishing and strengthening effective early warning systems as well as other mitigation and response measures.*

By the time of the Second International Conference on Early Warning, which was held in Germany in 2003, this systems approach to early warning had become orthodox and influenced national legislation such as the National Integrated Drought Information System (NIDIS) Act of 2006 (Public Law 109-430) in the United States of America.<sup>1</sup>

Further momentum for the development of early warning systems was generated by the Indian Ocean tsunamis in 2004, which highlighted how many lives could have been saved if a regional tsunami early warning system had existed. As a consequence, early warning featured heavily on the agenda of the Second World Conference on Disaster Reduction in 2005 and was given heavy emphasis in the HFA, which reprises the emerging early warning systems concept in key activities within Priority for Action 2 (Box 8.1).

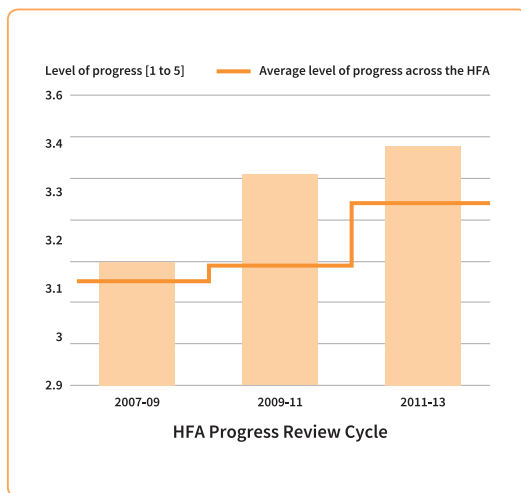
Government self-assessment reports prepared using the HFA Monitor show significant progress against the third core indicator under Priority for Action 2: *Early warning systems are in place for all major hazards, with outreach to communities*

(Figure 8.1). Each biennial reporting period since 2007 has shown growing achievement, although the indicator is too generic to capture how much progress has actually been made against each of the key activities listed above.

The development and implementation of early warning systems has been repeatedly cited as one of the areas where the most progress has been made within the HFA (WMO, 2011, 2014a; UNISDR, 2013b, 2011b). Success stories from Bangladesh, Chile, India, the Philippines and other countries show that timely and effective warning and communication coupled with risk information and a prepared population significantly reduces mortality. The Third International Conference on Early Warning, which was held in Germany in 2006 took advantage of the momentum generated by the HFA and, under the slogan *From concept to action*, documented over one hundred initiatives to develop early warning systems at different levels (UNISDR and Government of Germany, 2006).



**Figure 8.1** Progress in early warning



HFA Core Indicator 2.3: *Multi-hazard early warning system with community outreach.*

(Source: UNISDR with data from the HFA Monitor.<sup>2</sup>)

In particular, HFA progress reports highlight success in developing early warning systems that correspond more closely to local needs. For example, Australia reports that every state and territory now has the ability to tailor core messages to fit local conditions and evacuation plans. In Sri Lanka, a people-centred early warning system was established that includes teams of volunteers using local communication methods. In Thailand, volunteers have been trained at the village level to monitor hazards and transmit early warnings in a timely manner.

Technical, institutional and social challenges in developing and maintaining these systems are often reported in conjunction with the remoteness of villages and difficulties of terrain, making outreach to *the last mile* difficult. Many countries also note financial constraints and limited

human capacity and are still dependent on international assistance to finance and maintain their systems, in particular when it comes to upgrading the equipment to monitor hazards and transmit warnings (WMO, 2014a).

### Early warning reframed

Since the Third International Conference on Early Warning Systems, rapid changes in information and communications technology have shaken many of the assumptions that had framed the development of early warning systems up to that point.

The growing sophistication of hydro-meteorological monitoring and forecasting has greatly increased the probability of being able to provide accurate forewarnings of tropical cyclones, storms, floods, droughts, tsunamis and other hazards. The growing availability of high-resolution satellite data, coupled with an exponential increase in computing power and the development of predictive models, has transformed hazard-warning capabilities since the adoption of the HFA. These technological advances have been supported by enhanced international cooperation (Box 8.2). At the same time, meteorological information in particular has become increasingly pervasive through global media and the Internet. There is less and less dependence on official channels for hazard forecasts, although this has created new issues around the accuracy of warning information, particularly when conflicting information is available from apparently credible sources.

A second and even more disruptive change is associated with exponentially increasing global connectivity through access to the Internet, social media and particularly through mobile phones. Globally, mobile telephone penetration rates have reached 96 per cent. There is now almost one mobile phone per person on the planet, with subscription rates of almost 90 per cent even in low-income countries (ITU, 2013). In sub-Saharan Africa, for example, the penetration rate of mobile phones was around 10 per cent at the beginning of the HFA. It now stands at almost 80 per cent (Deloitte, 2012).

This dramatically increases the potential to disseminate timely warnings directly to those at risk and also opens the door to peer-to-peer warning, even across national boundaries (Gow and Waidyanatha, 2011). To the extent that mobile phone warnings facilitate timely preparedness by households and businesses, they contribute to reducing risks and avoiding loss of life. For example, earthquake early warnings are now also issued via mobile networks in Mexico (Box 8.3) and in Japan.

In Sri Lanka, the Sri Lankan Disaster Management Centre launched the Disaster and Emergency Warning Network (DEWN; Purasinghe, 2014). After a successful trial period, the system became operational in January 2009. Messages are sent to emergency personnel, who then verify the information and disseminate public alerts. Mass

**Box 8.2** The Global Data-Processing and Forecasting System (GDPFS)



The Global Data-Processing and Forecasting System (GDPFS) produces and disseminates weather and climate analyses and predictions to enable National Meteorological and Hydrological Services (NMHS) to provide high-quality meteorological forecasts, warnings and other information services related to weather, environmental quality and climate on a 24/7 basis. Its three-level system—World Meteorological Centres (WMCs), Regional Specialized Meteorological Centres (RSMCs; including Regional Climate Centres [RCCs]), and National Meteorological Centres (NMCs)—support NMHSs and their early warning capacities. The improved accuracy and lead time of predictions of high-impact weather events have made a major contribution to early warning.

### Box 8.3 Earthquake early warning in Mexico

In 1985, the Michoacán earthquake hit Mexico City, leaving an estimated 10,000 dead and 30,000 people injured. The disaster raised awareness of earthquake risk and generated interest in the feasibility of earthquake early warning. The primary seismic source for earthquakes that affect Mexico City is the Guerrero Fault along the Pacific Coast of Mexico. Given the time it takes seismic waves to reach Mexico City from the coast, it is possible to provide early warnings that allow people a minute or more to move to a safer area in a building or in some cases to evacuate.



Operated by CIRES, the Seismic Alert System of Mexico City was established in 1991, and a similar system (SASO) was set up in Oaxaca in 2003. These two systems are now part of the Mexican Federal Government's Seismic Early Warning System (SASMEX). Seventy-six seismic monitoring stations are now located along the Guerrero Fault, and warnings are provided to a number of important cities.

SASMEX issues two types of warning: "public" or emergency warnings for the risk of high-intensity movements and "preventive" or alert messages for moderate intensity-movements. Since its creation, SASMEX has issued 34 emergency warnings and 72 alert messages. For example, in 1995, a 7.3 magnitude earthquake occurred 300 km away from Mexico City. An emergency warning was issued 72 seconds before the seismic waves shook the city, facilitating the partial evacuation of public buildings, schools, residential buildings and public transport systems. An estimated 2 million people were reached by the warning and acted upon it.

(Sources: Cuéllar et al., 2010; Singh and Pérez-Campos, no date.<sup>3</sup>)

alerts are dispatched through cell broadcasting, which is immune to network congestion, while messages to certain groups are sent via SMS. The alerts are sent in three local languages and can be received by both smartphones and basic handsets, or by an alarm device with a lamp and siren for public spaces (GSMA, 2013; Purasinghe, 2014).



Mobile phones are increasingly being used to disseminate weather and climate forecasts to farmers, to provide information on market prices, to access markets and even to take out insurance.<sup>4</sup> These changes are radical given that the communication of early warning information to remote, rural hazard-exposed communities was described as a major challenge as recently as 2006.<sup>5</sup>

These technological leaps have transformed and will continue to transform the landscape of early warning systems. New technologies and

enhanced trans-boundary cooperation for hazard monitoring, forecasting and early warning are continuing to emerge (WMO, 2014a). Moreover, successful technologies in one context have sometimes been brought to market for broader applications, for example in flood early warning systems (Box 8.4). The telemetric monitoring system at the Enguri Dam in Georgia served as a prototype to develop an early warning system for dam failure (Chelidze, 2013). In Italy, flood monitoring in Umbria formed the basis for the development of an integrated early warning system for floods and landslides (Molinari et al., 2013).

Crowdsourcing platforms and initiatives such as OpenStreetMap and Ushahidi facilitated the engagement of thousands of volunteers and experts during the 2010 Chile and Haiti earthquakes and the floods in Pakistan; these innovations are also challenging conventional assumptions about early warning systems (Keim and Noji, 2011). When the concept was first proposed in 1997, early warning systems were conceived as vertically integrated chains where

**Box 8.4** Advances in flood early warning in Europe and Africa

Belgium's early warning system, which has been operating for a decade, is based on advanced real-time monitoring and forecasting technology which provides high-resolution flood risk maps, while simulation models are used for impact assessment. Warnings are sent out by SMS and e-mail and published on a web portal, which is frequently visited by the public during floods. The 24/7 early warning system operators collaborate closely with the civil protection crisis management team, which in turn is linked to a multi-sector and multi-scale response mechanism. However, dynamic maps of flooded areas are still lacking, and as the system is largely top-down, many local authorities and civil protection committees are still unfamiliar with the information generated by the system. Preparedness in general remains limited.

Egypt's early warning system is based on historical analyses of storm and flash flood events, while local knowledge of exposed areas is used as a qualitative data source. The system has been successful in issuing alerts for flash floods on the basis of rainfall forecasts. Warnings are communicated to the disaster management authorities, and as a result timely actions such as setting up roadblocks or releasing overflow water from dams have been taken on the basis of agreed decision-making protocols. However, the system faces operational and technical challenges, for example due to power cuts and weak cooperation with local communities.

Mali's early warning system is largely based on a good understanding of the underlying drivers of flood risk and the impact of flooding on local economies and on biodiversity; this information is presented in a flood risk atlas for local use. Flood maps and forecasts are developed using satellite images of flooded areas, and warnings are issued with a long lead time by telephone, radio and the web.<sup>6</sup> Although the early warning system is still being tested, resolution and accuracy need to be improved, and scenarios on food security and disease outbreaks are yet to be included, the system heavily involves local communities. Early warning information based on and packaged for end-user needs includes local knowledge and supports the traditional practice of decision-making based on local pastoral calendars and practices, thus blending modern science with traditional risk management know-how.

(Source: Cools and Innocenti, 2014.)

failure in one link in the chain limits its effectiveness and can even lead to failure across the entire system (UNISDR, 2011a; WMO, 2014a). Coupled with continuously improving mobile connectivity and the increasing pervasiveness of hazard monitoring and forecasting information, crowdsourcing has now disrupted that concept and opened the door to more horizontally integrated and organically evolving systems.

**Early warning of vulnerability and risk?**

At the same time, however, many of the challenges to effective early warning described in the past still persist (UNISDR, 2009a). While major advances have been made in hazard monitoring and forecasting and in the issuing of warnings (EEA, 2013), progress in integrating the appropriate risk information and risk management strategies

into early warning and preparedness has lagged behind (WMO, 2014a; Molinari et al., 2013).

There are still major gaps in hazard monitoring, particularly in low-income countries, which are often challenged to maintain the necessary technical and institutional infrastructure. Similarly, there may be inadequate links and coordination between geological and hydro-meteorological services and disaster risk management organizations. Some low-income countries lack the institutional and technical capacities to develop a multi-hazard, multi-sector and multi-level approach to early warning (WMO, 2014a; Molinari et al., 2014).

Warnings are still not standardized within and across countries, meaning that they may be

incomplete or ineffective. Moreover, the proliferation of warning information with different messages may dilute their strength and authority. As discussed in Chapter 6, the capacities of local governments may be weak, local preparedness plans may only exist on paper, and there may be a lack of clarity with respect to roles and responsibilities at all levels. The transmission of warning information across national borders is likewise a political challenge in some regions. Civil or military conflicts undermine not only the effectiveness of early warning, but also that of disaster risk reduction in general (WMO, 2014a).

In particular, progress has been uneven in two key early warning sub-systems. Firstly, the integration of risk information (where available) into hazard warning information is still weak. Despite exceptions such as the Famine Early Warning System,<sup>7</sup> early warning continues to prioritize monitoring and forecasting hazards and may omit or underestimate the key importance of exposure and vulnerability in explaining risk levels (Box 8.5). Ultimately, vulnerability early warning is as important

as hazard early warning if the translation of disaster losses into impacts is to be avoided. As recurrent disasters in the Horn of Africa show, early warning is not effective when chronic livelihood crises reach a tipping point, putting extreme pressure on food prices, livestock survival, and water and food availability. At least 13 million people across southern Ethiopia, south-central Somalia and northern Kenya were affected by drought in 2011-2012. Armed conflict across the region compounded chronic ecological and economic vulnerability, which escalated the crisis and limited people's survival and recovery choices (Slim, 2012).

A second issue is that in order to be effective, early warnings not only have to forecast a hazard but need to include *value-added* information with respect to the risks that can be expected and the actions that can be taken. Even while warnings can now be issued directly via SMS, which overcomes the communication barriers at the *last mile*, it is still rare for alerts to provide information on the level of risk. Both depend on detailed and intimate knowledge of the local contexts where impacts are

**Box 8.5** Absence of development in the Bolivian Chaco

The people of the Chaco region in south-eastern Bolivia know what an absence of development looks like. In the municipalities of Huacareta (Chuquisaca), Caraparí and Entre Ríos (Tarija), for example, 82 per cent, 51 per cent, and 43 per cent of the population (respectively) live in extreme poverty, with infant mortality rates fluctuating between 64 and 72 for every 1,000 live births.



In the course of the 2009/10 El Niño Southern Oscillation (ENSO) event in the region, reductions in rainfall began to generate problems with food availability and access, compromising livelihoods and food security. Access to water and basic sanitation was limited, leading to a greater incidence of health problems, especially for those living in more remote areas.

Following alerts of rainfall deficit and low temperatures in late 2009, an assessment by external experts focused on the variation in rainfall averages. In reality, the assessment should have focused on the underlying drivers of risk: adverse soil conditions, biophysical and environmental degradation, and social and economic deprivation, factors that ultimately resulted in an officially reported “humanitarian gap” of more than a third of the rural population of the Chaco towards the end of September 2010.

Where disaster is understood as a disruption to *normal* life and development, everyday and extensive risk are not recognized as indicators precisely because they are part of that *normality* in places such as the Chaco region. In the Chaco, this meant that warnings of a looming crisis did not come early, but late.

(Source: adapted from Reyes and Lavell, 2012.)



expected and of local disaster risk management strategies. As described in Chapter 1, the fact that evacuation plans for New Orleans assumed car ownership negated the effectiveness of the early warning about Hurricane Katrina for part of the population at risk. In order to be effective, early warning systems need to embrace an understanding of how hazard-exposed households and communities manage risks as well as their vulnerabilities and resilience. This in turn depends on local governments or local disaster management agencies having both the skills and the willingness to engage with what are often low-income households and communities.

Lack of progress in these two of the original four early warning sub-systems means that timely and accurate early warnings that reach those at risk may fail to trigger effective action, particularly in the context of slow-onset hazards and where poverty is infused with everyday and extensive risk. Early warning information empowers only to the extent that households and communities are able to act on that information.

## 8.2 Preparedness for response

**Priority for Action 5 has been the area of the HFA where most progress appears to have been made. Many successes of the HFA are associated with improvements in preparedness, often combined with more effective early warning. There have been real improvements in disaster preparedness and major investments in the necessary capacities.**

**While effective preparedness can be achieved with the governance arrangements that evolved from emergency management, local capacity and resource constraints still hamper progress in a number of countries. Preparedness for slow-onset and extensive risks, in particular, remains a challenge.**

### The main focus of the disaster risk management sector

Preparedness has been defined as “*the capacities and knowledge developed by governments, professional response organizations, communities and individuals to anticipate and respond effectively to the impact of likely, imminent or current hazards or conditions*” (UNISDR, 2009b).

Preparedness activities are a critical part of corrective disaster risk management in that certain risks, particularly those associated with mortality and morbidity, can be reduced through anticipation and response. Put simply, if a prepared population is able to evacuate an area before a major flood, lives will be saved and mortality and morbidity risk will therefore be lower. At the same time, preparedness is part of compensatory risk management and helps strengthen resilience. Well-organized emergency assistance based on contingency plans can help households and communities to buffer disaster losses, recover more quickly and avoid the translation of loss into broader impacts, such as increased poverty or deteriorating health, nutrition or education.

By the 1980s it had been recognized that preparedness was a core principle of effective emergency management. At the international level, UN General Assembly resolution 46/182 of 1991 reflected the need to prepare for response and created mechanisms such as the Emergency Relief Coordinator (ERC), the Inter-Agency Standing Committee (IASC), and the Consolidated Appeals Process (CAP) as coordination mechanisms to support the ERC. This period also saw the creation of the UN Disaster Management Training Programme (UNDMTP)<sup>8</sup> in 1990, the International Search and Rescue Advisory Group (INSARAG) in 1991, and the UN Disaster Assessment and Coordination (UNDAC) mechanism in 1993 (IASC-WFP, 2014).

Similarly, preparedness has been central to all the international frameworks for disaster risk

**Box 8.6** Key activities related to disaster preparedness in the HFA

*(a) Strengthen policy, technical and institutional capacities in regional, national and local disaster management, including those related to technology, training, and human and material resources.*

*(b) Promote and support dialogue, exchange of information and coordination among early warning, disaster risk reduction, disaster response, development and other relevant agencies and institutions at all levels, with the aim of fostering a holistic approach towards disaster risk reduction.*

*(c) Strengthen and when necessary develop coordinated regional approaches, and create or upgrade regional policies, operational mechanisms, plans and communication systems to prepare for and ensure rapid and effective disaster response in situations that exceed national coping capacities.*

*(d) Prepare or review and periodically update disaster preparedness and contingency plans and policies at all levels, with a particular focus on the most vulnerable areas and groups. Promote regular disaster preparedness exercises, including evacuation drills, with a view to ensuring rapid and effective disaster response and access to essential food and non-food relief supplies, as appropriate, to local needs.*

*(e) Promote the establishment of emergency funds, where and as appropriate, to support response, recovery and preparedness measures.*

*(f) Develop specific mechanisms to engage the active participation and ownership of relevant stakeholders, including communities, in disaster risk reduction, in particular building on the spirit of volunteerism.*

reduction since the IDNDR and was included in Priority for Action 5 of the HFA (Box 8.6).

HFA Priority for Action 5 is the area of the HFA where most progress appears to have been made (Figure 8.2).

HFA progress reports highlight that preparedness for response has been the main focus of the disaster risk management sector in many countries. Many success stories during the HFA are associated with improvements in preparedness, often combined with more effective early warning. These include the dramatic reductions in disaster mortality in countries like Bangladesh, Mozambique, India and Cuba described in Chapter 2. But in a large majority of countries, there have been real improvements in disaster preparedness and major investments in the necessary capacities.

As Chapter 6 highlighted, disaster risk management has generally been understood and practised as disaster management, including in

international organizations. For example, UNICEF's disaster risk management programmes focus heavily on school safety, emergency drills, an understanding of preparedness and life skills.<sup>9</sup> Regional organizations have also played a key role in supporting the preparedness agenda of their member countries and in setting up regional support mechanisms. For example, the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) supports member states in strengthening sub-regional emergency response capabilities, including the development of Regional Standby Arrangements and Coordination of joint disaster relief and emergency response operations (IASC-WFP, 2014).

Disaster preparedness has been strengthened through emergency preparedness drills, which are now carried out on a regular basis in schools and in other contexts (UNISDR, 2013b). For example, the municipality of Quito in Ecuador carries out drills and simulations at the institutional level as well as in communities and schools; in Bhubaneswar, India, drills are held at the city, ward,



and community levels, and at schools and colleges (SCI, 2014).

Community-based disaster risk management (CBDRM) programmes have also provided a critical vehicle for strengthening preparedness. Most CBDRM programmes usually have a strong component of raising local awareness of risks (Shaw, 2013). Given the severe social and economic constraints often faced by local communities (Maskrey, 1989 and 2011), CBDRM may do little

to address the underlying risk drivers (SCI, 2014). However, while many programmes are short-lived, there are numerous examples of CBDRM programmes successfully leading to enhanced preparedness and early warning (Box 8.7).

### The preparedness imperative

A number of factors may explain the progress made in disaster preparedness. Unlike other investments in disaster risk reduction, effective response is politically visible and therefore enjoys

**Figure 8.2** Progress reported against core indicators in HFA Priority for Action 5



(Source: UNISDR with data from the HFA Monitor.)

**Box 8.7** Community-based early warning and preparedness

Every year, Viet Nam experiences storms, floods and other hazards which give rise to annual economic losses equivalent to 1-1.5 per cent of GDP (GFDRR, 2013b; Nguyen, 2011). In 2009, the government introduced a 12-year project to strengthen community-based disaster risk management (GFDRR, 2013b; Nguyen, 2011; AMDI, 2013).

In the project, international agencies have worked in partnership with the Vietnamese government, enabling local communities to prepare for disasters and reduce risks more effectively. Training in local communities and including disaster reduction in the school curriculum have allowed vulnerable populations to develop preparedness strategies, while infrastructure such as rural roads and irrigation systems has improved their resilience (ADPC, 2008; AMDI, 2013).

A new CBDRM project is underway in Myanmar, where the population is exposed to cyclones, earthquakes, tsunamis and storm surges. The Myanmar Action Plan on Disaster Risk Reduction was introduced by the Government of Myanmar and is being implemented between 2013 and 2015 in partnership with a number of international and UN agencies (UNDP, 2013b).

One of the main aims of the programme is to train 60,000 households in CBDRM by 2015. This will include increasing awareness of natural hazards within communities, first aid and early warning training, search and rescue training, and improving construction methods and standards in vulnerable rural areas (Government of Myanmar, 2012; UNDP, 2013b).

a strong political imperative. As noted in GAR11, *electorally critical, hazard-prone states are twice as likely to have disasters officially declared than non-critical states, and for each disaster declaration, a US President can expect a one-point increase in votes in a statewide contest* (Reeves, 2010). Conversely, the disastrous response to Hurricane Katrina generated negative political fallout for the city, state and federal administrations at the time.

At the same time, preparedness represents a relatively natural and organic evolution from emergency response. With its focus on contingency plans and evacuation drills, logistics and stockpiles, trained and positioned search and rescue teams, hard-hats and uniforms, it is an extension of emergency response into the pre-disaster phase of the disaster management cycle. Preparedness is both manageable and feasible with the kind of governance arrangements that evolved from emergency management.

Unlike corrective disaster risk management, preparedness does not require major investments.

The resources required to prepare contingency plans, to train staff and students and to organize evacuation drills in the case of earthquake-exposed schools, for example, are infinitely smaller than what would be required to structurally retrofit the school to make it safe. Similarly, preparedness does not require the same investment of political capital as prospective disaster risk management, which would include ensuring safe, well-located land to build future schools.

At the same time, and as noted above, preparedness was not only integrated into the HFA and its predecessor frameworks for disaster risk reduction, it was also supported by another set of international mechanisms created through UN General Assembly resolution 46/182. In general, these mechanisms have enjoyed stronger and more stable funding and support from donor governments than the more prospective aspects of the HFA.

Importantly, the priority given to disaster preparedness builds on periodic and well-publicized



successes, for example the major reduction in mortality following Cyclone Phailin in Odisha, India in 2013 compared to the super-cyclone of 1999. While much of this success should be attributed to improving development indicators, it is disaster preparedness that has been able to capitalize on the political gains.

### No bed of roses

At the same time, disaster preparedness is no bed of roses. HFA progress reports highlight that some low-income countries remain challenged to create and sustain the necessary capacities. For example, Indonesia reports that a major challenge in enhancing preparedness measures is the lack of resources, including human resources, expertise, budgets, equipment and facilities, at the local level coupled with continued dependency on the national level for preparedness planning (UNISDR, 2014a).

In effect, in some countries mortality risk remains high, as was tragically highlighted in Myanmar in 2008. The capacity gap is often even greater in countries experiencing military or civil conflict. In addition, as the example of Hurricane Katrina demonstrated, capacities may not be as strong as they seem, even in the world's richest countries.

The foundation for effective disaster preparedness and response is laid at the local level. Well-prepared localities can often significantly reduce their disaster losses, even if national level emergency management structures collapse or fail to respond. In contrast, even the best-organized disaster management at the national-level may be ineffective if local preparedness capacities are weak or non-existent. As discussed in Chapter 6, local capacities tend to be uneven, as they are stronger in larger urban centres with strong city governments and weaker in remote and rural areas.

More fundamentally, an extensive body of literature (Quarantelli, 1986; Yodmani, 2001; Pandey

and Okazaki, 2005) has demonstrated how vertically integrated contingency plans and response mechanisms often seem to respond more to the *command and control* culture of emergency management and to preconceptions regarding response than to expressed needs and requirements on the ground. Preparedness plans and response may reflect ingrained prejudices and stereotypes regarding the affected population (Tierney, 2008) or fail to account for the specificities and complexity of local risk scenarios or local strategies for managing risk (IASC-WFP, 2014). As a result, disaster response may have unintended or negative consequences at the local level.

Often disasters themselves become *simulacra*, events configured and magnified by the media and by pre-existing stereotypes and conceptions rather than by what is happening in reality. For example, in the case of Hurricane Mitch in Honduras in 1998, while the international media portrayed the total destruction of the entire country, in reality most damage was concentrated in only a few municipalities (UNISDR, 2011a). In the case of the mudslides in Vargas State, Venezuela in 1999, it was found that a reported death toll of over 30,000 in reality did not exceed 700 (UNISDR, 2009a). Disaster response (Box 8.8) often fails to understand or respond to local requirements and needs precisely because it responds to a *simulacrum* of disaster rather than to real local conditions (Maskrey, 1996).

Preparedness plans may often exist to deal with infrequent intensive risks while ignoring recurrent local extensive risks. The fact that the volume of response and support to disaster-affected localities tends to be proportional to the number of fatalities rather than the number of survivors is one visible reflection of this mismatch. Preparedness plans supported by NGOs using mechanisms such as VCAs (vulnerability and capacity assessments) are often more sensitive to local needs and strategies. However, they are often developed in the context of


**Box 8.8** Disasters and simulacra: the experience of the Indian Ocean tsunami

That national plans don't often match local realities is nothing new. However, in disaster response as in broader disaster risk management, the local diversity of conditions and needs are regularly overlooked as national visions can be skewed towards achieving humanitarian targets, including the distribution of assets such as boats (TEC, 2007). After the 2004 Indian Ocean tsunami, highly politicized or socially contentious issues such as land rights, tax laws and gender relations were poorly understood by relief agencies. These agencies often had no effective mechanisms in place to ensure local ownership and frequently treated affected countries as "failed states", undermining local and national capacities by offering unsolicited and often badly designed support programmes (TEC, 2006).

In contrast, international action was most effective in cases where local actors led response efforts and received appropriate support (TEC, 2007). Unfortunately, the allocation of funds and staff was more often than not "driven by politics and funds, not by assessment and need" (ibid.). These politics were not only international; the international response to the tsunami was also severely hampered by indecisive and protective national and regional leadership (TEC, 2006).

short-term projects or programmes which may not be sustainable.

As currently defined, preparedness also seems challenged to address the increasingly complex multi-hazard and concatenated risks that now characterize large urban areas and regions (IASC-WFP, 2014). The reality of risk in many contexts is now one of multi-dimensionality, which cannot be addressed through single-hazard contingency plans.

Finally, as highlighted in Chapter 6, with notable exceptions such as Mexico's National Disaster Prevention Fund and dedicated budget lines in countries such as the Philippines and Indonesia, most disaster management agencies rely heavily on emergency funding. As such, they are usually under-resourced for preparedness activities.

## 8.3 Business as usual or building back better?

**Even though recovery and reconstruction after disasters are an integral part of the disaster management cycle and of disaster risk reduction, the HFA does not provide detailed guidance to countries in this area. In comparison to other aspects of the HFA, global progress has been limited.**

**Improvements can be observed in integrating disaster risk reduction into post-disaster needs assessments and recovery frameworks. But in many situations, the willingness to *build back better* is quickly replaced by *business as usual*.**

### Post-disaster recovery: a continuing challenge

Most of the citizens of Guiuan were still asleep when a heavy storm hit the small city in the Eastern Samar province of the Philippines at 4.40 a.m. on 8 November 2013. Typhoon Haiyan was the strongest tropical cyclone in recorded history to make landfall in the Philippines; and landfall it made, a total of five times across the islands of Samar, Leyte, Cebu and Iloilo (Figure 8.3).<sup>10</sup>

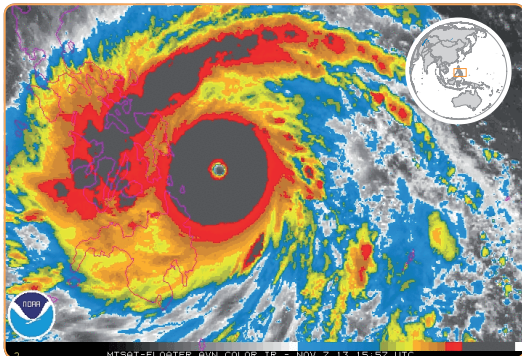


A Category 5 super-typhoon, it impacted the Eastern Visayas region and the city of Tacloban before moving to the South China Sea and affecting China, Taiwan (Province of China) and Viet Nam. To date, the death toll stands at 7,986,<sup>11</sup> with more than 1,000 people still missing (NDRRMC, 2014) and 4.1 million people displaced (IFRC, 2014). Total economic losses have been estimated at US\$10 billion, over ten times the losses associated with Typhoon Bopha of 2012, known locally in the Philippines as Typhoon Pablo (EM-DAT, 2014; UNISDR, 2014b).

Of the 4.1 million people displaced, little more than 100,000—or around 1 per cent—were able to move to shelters (DSWD et al., 2014). The remaining 4 million found lodging with host families or in other private, temporary accommodation (ibid.).

### Typhoon Haiyan

**Figure 8.3** Typhoon Haiyan making landfall and the resulting destruction



(Source: NOAA, 2014.)



(Source: Russell Watkins/ Department for International Development.)

However, six months after the disaster, more than 2 million people were still living in temporary accommodation (ibid.). Apart from housing issues, access to education, health facilities, transport, markets and income as well as unclear tenure and property arrangements impeded the return of displaced people (ibid.).

It has long been recognized that new vulnerabilities can be generated in the gap between initial displacement and longer-term recovery and reconstruction (Berke et al., 1993; Ingram et al., 2006; Brookings, 2008; IASC, 2009). In the case of Haiyan, of the US\$776 million requested for recovery, only 61 per cent of funding had been received by August 2014 (UNOCHA, 2014b). While recovery receives more attention and funding than other disaster risk management strategies (Kellett and Caravani, 2013; UNISDR, 2011a), it remains under-resourced, and this gap may even widen as the human and economic cost of disasters continues to increase (IDMC, 2014; Swiss Re, 2014a).

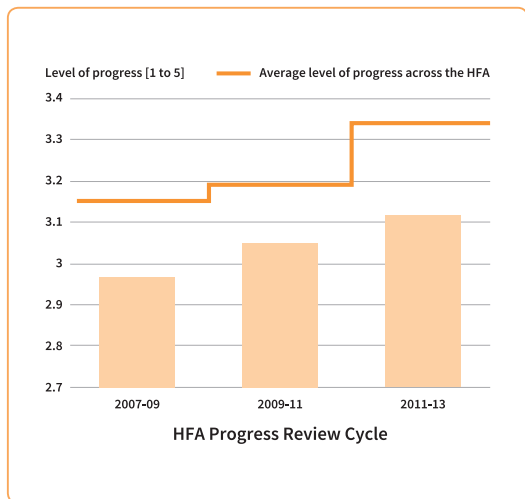
Despite the fact that recovery and reconstruction have always been described as an integral part of the disaster management cycle and of disaster risk reduction, the HFA does not emphasize this area heavily. Under Priority for Action 4 of the HFA, only one key activity specifically refers to recovery, namely:

*(h) Incorporate disaster risk reduction measures into post-disaster recovery and rehabilitation processes and use opportunities during the recovery phase to develop capacities that reduce disaster risk in the long term, including through the sharing of expertise, knowledge and lessons learned.*

In comparison to other areas of activity, global progress in this area has been limited (Figure 8.4).

As in the case of preparedness, while recovery was included in the HFA, its development has been influenced as much or more by other policy frameworks.

**Figure 8.4** Progress in integration of DRR in recovery and rehabilitation



HFA Core Indicator 4.5: DRR measures integrated into post-disaster recovery and rehabilitation.

(Source: UNISDR with data from the HFA Monitor.)

For example, the International Recovery Platform (IRP) was announced at the Second World Conference for Disaster Reduction in Kobe, Japan as a mechanism to *identify gaps and constraints experienced in post disaster recovery and to serve as a catalyst for the development of tools, resources, and capacity for resilient recovery. IRP aims to be an international source of knowledge on good recovery practice.*<sup>12</sup>

Soon afterwards, the Inter-Agency Standing Committee (IASC) created a Cluster Working Group on Early Recovery (CWGER) as part of a new approach to improve coordination within the UN system and between the UN and other stakeholders after major disasters. At the same time, support for national recovery planning and programming was an important component of the Global Facility for Disaster Reduction and Recovery (GFDRR), of the former UNDP Bureau for Crisis Prevention and Recovery (BCPR) as well as similar units in other regional and international organizations. At the same time, UNDP, the World Bank and the European Union joined forces to develop a common approach to assessing

recovery needs: the Post-Disaster Needs Assessment and Recovery Framework (PDNA/RF).

### In search of space

When disaster occurs, an enormous quantity of accumulated risk is liberated. On the one hand, this vast energy is destructive. But on the other hand, it creates a space where new possibilities can emerge. How this space can be used is the fundamental challenge facing post-disaster recovery. The experience of recovery and reconstruction highlights just how difficult it is to take advantage of the window of opportunity that opens in the space or gap after a disaster and to ensure that new development prevents and avoids risks rather than reconstructing them.

A first set of problems refers precisely to the length of the gap or space between the destruction of the disaster and new development. This has variously been described as the *gap between relief and recovery* or the *relief to development continuum* (Buchanan-Smith and Maxwell, 1994; Longhurst, 1994). Fundamentally, the longer the gap, the greater the probability that losses to assets in disasters, including homes, possessions and livestock, as well as death or injury in the case of households; equipment, stocks and premises in the case of businesses; or infrastructure and facilities in the case of local governments will translate into longer-term impacts. GAR09 presented evidence indicating that unless losses are buffered by prompt recovery actions, the depth and breadth of poverty increase, education, health and nutrition suffer, and social indicators deteriorate. GAR11 highlighted the financing gap that can arise for governments if they are unable to buffer disaster losses, while GAR13 showed how many small businesses never recover from those losses (UNISDR, 2009a, 2011a, 2013a).

Recovery, therefore, raises key issues in compensatory risk management, in particular whether mechanisms are in place which can allow households, businesses and governments to

compensate for losses quickly and resume their activities before these losses translate into negative and longer-term impacts on development. This issue is complicated because ultimately the recovery of households, businesses and government is interdependent. Restarting a business, for example, depends on restoring power, water, telecommunications and transport, which may be the responsibility of local governments or utility providers. The recovery of households is contingent on the recovery of the businesses that provide employment and income.

A second set of issues refers to prospective risk management: whether it is possible in the space or gap after a disaster to develop in a way that prevents the reconstruction of risks. By revealing risks, disasters uncover their underlying drivers and can provide an imperative for change. As highlighted in Chapter 1, there are numerous historical cases of changes in building practice or urban design, for example, in which risk-reducing measures have been introduced. However, for every case of positive change there seem to be many more cases where risk is rebuilt, sometimes literally brick by brick. Low-income households and small businesses in particular often face severe constraints in changing the way they manage their risks and may be averse to *taking the risks* to experiment. In the case of governments and businesses, it is not straightforward to change the administrative and planning structures and processes that existed before a disaster. Therefore, the default option is often business as usual.

Using the recovery space to transform development in a way that reduces future risks is complicated because it requires consensus amongst a large group of stakeholders, including government, international and regional organizations providing finance and technical advice, affected households and businesses, utility providers and others in order to move development onto a different track. International organizations,

bilateral and multilateral donors and non-governmental organizations also have their own agendas as well as client relations at the national level. In addition, there is a tension between the need for speed in order to close the gap between relief and recovery as quickly as possible and the need for careful planning in order to avoid the reconstruction of risk. The window of opportunity for innovative change starts to close quite rapidly after the initial impact of a hazard, and *normal* politics often takes its place. As such, in many instances the momentum to capitalize on *disaster as an opportunity* for wider transformation is lost (GFDRR, 2014c; GFDRR et al., 2013; GFDRR et al., 2014).

### Income and governance

Recovery processes in any country are heavily conditioned by factors such as income and governance. Following the earthquakes in 2010, the very different paths taken by the recovery processes in Chile and Haiti (Box 8.9) show that the way in which countries address the issues of both compensatory and prospective risk management in recovery processes depends far more on the strength of their economies and the quality of governance in normal times than on the volume of external assistance they receive.

Many of the continuing challenges in disaster recovery and reconstruction are related less to technical issues such as finance or the quality of data for assessments than to the pre-existing political and economic cultures in countries, which may include competing and opaque institutional mandates and the power relations between different social and economic groups. Coupled with nebulous and even conflicting objectives of administrative units and agencies, diverging national and sectorial interests can stand in the way of effective reconstruction and recovery (GFDRR, 2014c).

This implies that countries that already have compensatory mechanisms such as effective

insurance<sup>16</sup> in place and that can rapidly buffer losses will recover far more quickly than those that do not. Such mechanisms may include insurance and reinsurance, catastrophe funds, contingency financing arrangements with multilateral finance institutions and market-based solutions such as catastrophe bonds (UNISDR, 2011a and 2013a). However, as the HFA draws to close, and as highlighted in Chapter 5, a financing gap remains in many low and middle-income countries, even when faced with less intensive disasters.

### Financing recovery

Lack of finance is often cited as an obstacle to *building back better* (UNISDR, 2013b; GFDRR, 2014c). Roughly a third of self-assessment reports submitted using the HFA Monitor list financing as the primary limitation to the integration of disaster reduction into recovery and reconstruction. However, as highlighted in GAR11, *building back better* normally has a very attractive benefit-cost ratio. It not only reduces future risk levels,

but also contributes to reducing the financing gap that countries would face to buffer future losses (Williges et al., 2014). In other words, it can increase a country's economic and fiscal resilience and enable it to absorb losses from events with longer return periods. For example, Ecuador could shift the return period for a loss event in which it would experience a resource gap by more than 50 years (Figure 8.5). Similarly, by moving to a *building back better* approach, Pakistan would be able to shift a resource gap of more than US\$3 billion for a 1-in-100 year loss event (see Figure 5.2 in Chapter 5) to a 1 in 143-157 year event..

At the same time, risk financing mechanisms are normally designed to protect public finances from intensive events. Often no protection is in place in the case of the multiple extensive disasters responsible for the vast majority of damage to housing, agriculture and local infrastructure. Therefore, while governments and large business can use insurance to protect themselves,

#### Box 8.9 Recovery in Chile and Haiti

In early 2010, two earthquakes of exceptionally high magnitude hit Haiti and Chile within two months of each other. The 7.0 magnitude earthquake in Haiti left the capital Port-au-Prince in ruins. Some 222,570 people were killed and the economy devastated. The 8.8 magnitude earthquake in Chile also caused major damage, although only 562 people were killed.

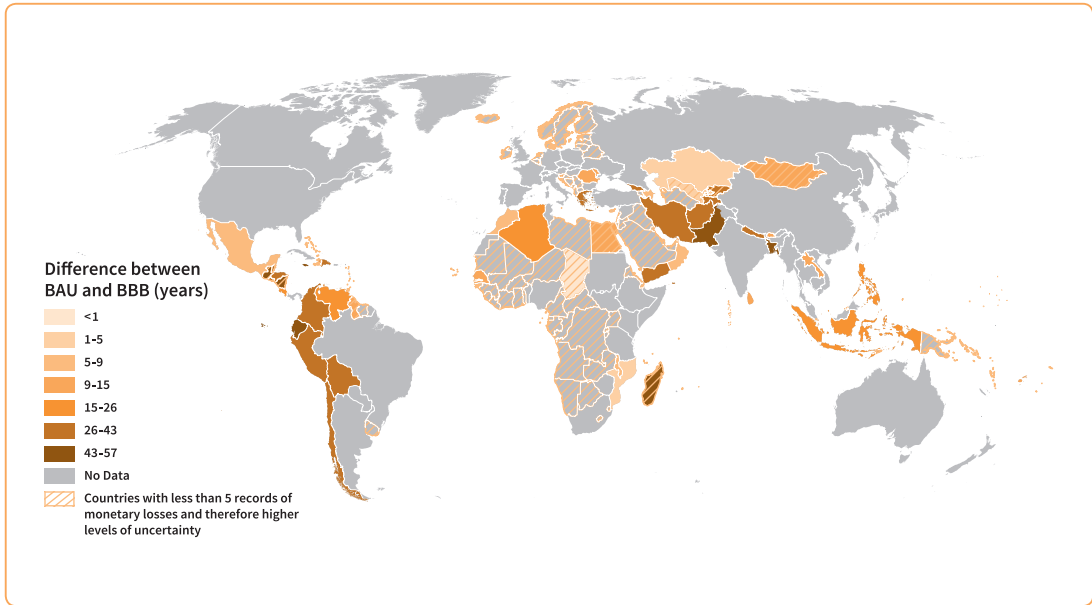


The narrative of each disaster, however, was completely different. Low mortality in Chile reflected a long history of enforced seismic building codes. In contrast, the last major earthquake in Haiti was in 1842, and disaster risk reduction efforts were focused on recurrent hurricanes rather than earthquakes. At US\$30 billion, direct economic losses in Chile were around four times greater than those in Haiti, estimated at US\$7.8 million, contrasting the value of exposed assets in one of the highest-income countries<sup>13</sup> and in the lowest-income country in the Americas. However, whereas in Chile these losses represented only 15 per cent of the country's GDP (CEPAL, 2010), the much lower losses in Haiti equalled 120 per cent of the country's GDP from 2009.<sup>14</sup>

With most of its economy unaffected, high quality of governance<sup>15</sup> and experience in managing earthquake disasters, Chile recovered relatively quickly. In contrast, five years after the disaster, with its economy devastated, weak governance and no recent experience in managing earthquake events, Haiti has been challenged to recover at all. Efforts to *build back better* quickly fell apart (GFDRR, 2014c). These two narratives highlight how the potential for recovering quickly and in a way that prevents the generation of new risks is influenced by the level of economic development and quality of governance in a country.



**Figure 8.5** Difference in financing gap with respect to return period from a “business as usual” (BAU) to a “building back better” (BBB) scenario



(Source: Williges et al., 2014.)

low-income households and small businesses continue to absorb the persistent losses from extensive risk. Similarly, international assistance is only forthcoming for recovery from larger disasters.

In general, countries that already have effective policy and regulatory frameworks as well as strategies and financial mechanisms in place to prevent new disaster risks can take full advantage of the gap to transform development, whereas the window of opportunity opens and closes rapidly for those which have made little progress in putting disaster risk management measures in place before disaster happens.



For example, in 2007 the principle of ensuring that risk-reducing measures are included in the recovery and reconstruction of essential public assets was introduced into Australia’s Natural Disaster

Relief and Recovery Arrangements (NDRRA) with the goal of reducing future disaster losses and reconstruction costs (Government of Australia, no date). Following Cyclone Oswald in 2013, the Queensland and Australian Governments launched the Queensland Betterment Fund, a joint, targeted fund of AU\$80 million to finance upgraded standards in the reconstruction of assets (Box 8.10).

**Data for assessment and recovery planning**

It is clear that post-disaster needs assessments and recovery frameworks are key instruments to reach consensus on how to kick-start recovery in the shortest possible time frame as well as how to incorporate risk-reducing measures. While good assessments do not guarantee successful recovery, weak or wrong assessments will almost surely result in badly conceived response and recovery (GFDRR, 2014a).

Understandably, the reliability, relevance and timeliness of data is crucial, as is effective

The Queensland Betterment Fund aims to cover the difference in cost between restoring or replacing an essential public asset to its pre-disaster standard and restoring or replacing the asset to a more disaster-resistant standard. Key projects financed by the AU\$80 million fund include design enhancements to a variety of projects involving water supply (The Gayndah Water Supply Intake), bridges (George Bell Crossing) and roads (Gayndah-Mundubbera Road, Round Hill Road, Upper Mount Bentley Road). These projects reduce risk by securing roads to communities that have been isolated in past disasters and by protecting vital telecommunications infrastructure, to name but two examples.



(Source: GFDRR et al., 2014.)

coordination between the national and local governments, international organizations and non-governmental actors, and in particular with affected households, businesses and communities (IRP, 2014). As in the case of early warning, there has been a major technological transformation in how data is collected since the adoption of the HFA. Social media now allows vast amounts of data to be sourced and broadcast and information to be collected by and shared across global communities (Gundecha and Liu, 2012). Surveys conducted in Japan in 2011 showed that large parts of the population relied on social media for disaster-related information (Peary et al., 2012). Earthquake intensity information in Japan is created in near real time by crowdsourcing information online (IRP, 2014).

A number of countries have recognized the potential of such accelerated information-sharing mechanisms and have developed relevant legal and regulatory frameworks and policies (IRP, 2014). For example, following the Christchurch earthquake in 2011, the Government of New Zealand developed the Open Access and Licensing Framework to address the barriers experienced by utilities providers due to issues of confidentiality in relation to property information (Ferreira et al., 2013). In Brazil, efforts to enable information sharing between civil defence authorities, municipal governments and local actors have been reflected in the new National Civil

Protection and Defense Policy and by a dedicated complementary state law passed in 2013 (Otoni de Araujo et al., 2013).

#### **Building back better or business as usual?**

Real progress has been made in ensuring that disaster risk reduction is factored into needs assessments and recovery frameworks. An assessment of twenty needs assessments conducted in sixteen countries between 2004 and 2011 found that roughly half recommended and promoted the integration of risk reduction into recovery. These principles included addressing both structural and non-structural measures, enhancing preparedness and integrating risk management into all sectors and levels of governance. Almost all recent needs assessments provide recommendations for the integration of disaster risk reduction into sector-specific recovery strategies (Box 8.11), in particular ensuring that damaged social and physical infrastructure such as schools, health facilities, houses and transportation networks are rebuilt to improved and reinforced standards (GFDRR, 2014c).

However, the incorporation of slogans such as *build back better* into needs assessments and recovery is rarely actionable unless fully factored into operational recovery plans and budgets and ultimately into a more comprehensive approach to disaster risk management. One common approach following major disasters is to




**Box 8.11** Recovery-led disaster risk reduction and institutionalization in Mozambique

Following the impetus and momentum provided by the recovery after the massive floods of 2007 in Mozambique, the Government incorporated community resilience and vulnerability reduction as key components in its Master Plan for Disaster Prevention and Mitigation. Recovery, resilience and development also came together in introducing farmers to drought-resistant crops, the construction of small-scale rainwater catchment systems using local materials, and reforestation along riverbanks. Despite heavy rains, the number of people who were negatively affected diminished considerably until the major floods of 2012/13 showed that still more effort was needed to reduce vulnerabilities.



Subsequently, the National Institute for Disaster Management (INGC) was assigned to coordinate the resettlement of displaced people from the banks of the Zambezi River in the absence of a housing ministry. An estimated 8,000 families benefited from government and international support in the construction of houses, schools and clinics on higher ground using more resilient materials, although the government had to recognize the continued importance of structures closer to the river for the continuation of existing livelihoods. Furthermore, 776 community-level committees have since been trained and equipped to use the flood alert system for evacuating vulnerable populations.

Institutionally, disaster risk management practices have become well established under the leadership of INGC, and responsibility for disaster recovery increasingly blends into development plans under other government institutions (GFDRR, 2014c).

centralize responsibility for recovery and reconstruction in an ad-hoc agency. While this may speed up recovery and ensure that improved standards are observed, it may actually weaken the role of the administrative structures responsible for ongoing efforts in development and disaster risk reduction. Often, once recovery is judged complete and the ad-hoc agency is dismantled, the country does not necessarily continue to *build back better*, but rather reverts to *business as usual*.

For example, the Earthquake Reconstruction and Rehabilitation Authority (ERRA) in Pakistan was able to substantially incorporate disaster risk reduction into recovery after the 2005 earthquake: over 85 per cent of the reconstructed houses were compliant with new seismic standards. However, this approach was not carried over into the National Disaster Management Agency (NDMA) created in 2007, which made it difficult to address disaster risk reduction in recovery following the 2010 floods (GFDRR, 2014c).

In contrast, the recovery in Indonesia following the 2004 tsunamis did lead to a broader inclusion of disaster risk reduction in recovery, and this approach was subsequently applied following the 2006 Yogyakarta and Central Java earthquake, the 2009 West Sumatra earthquake, and the 2010 Merapi volcanic eruption. Similarly, Mozambique's efforts to institutionalize disaster risk reduction and to ensure that it is factored into recovery have been mutually supportive (GFDRR, 2014c).

Even when implemented, the *build back better* concept may be limited to structural improvements in buildings or to specific elements of infrastructure, while no real attention is given to addressing the underlying drivers that constructed the risk in the first place. In the aftermath of the Kashmir earthquake in 2005, hopes that the commonly felt impact would bridge the political divide between Pakistan and India remained unfulfilled (ODI, 2013). In contrast, the Aceh region managed to capitalize on the opportunity

to reconstruct not only its infrastructure but also the foundations of Acehnese society after the Indian Ocean tsunami in 2004 (ibid.).

Ultimately, the integration of disaster risk reduction into post-disaster recovery and reconstruction has been hampered by the same conception of disaster through which the HFA has been interpreted and which explains why so little progress has been made in prospective disaster risk management. If disasters are viewed as exogenous shocks, recovery and reconstruction are seen first and foremost as a process of returning to normality rather than a process of transforming development and the underlying drivers of risk.



## Notes

---

- 1 <http://www.gpo.gov/fdsys/pkg/PLAW-109publ430/pdf/PLAW-109publ430.pdf>.
- 2 <http://www.preventionweb.net/applications/hfa/qbnhfa/home>.
- 3 For additional information, see [http://www.cires.org.mx/sasmex\\_es.php](http://www.cires.org.mx/sasmex_es.php) (accessed 11 December 2014).
- 4 <http://www.howwemadeitinafrica.com/how-mobile-phones-are-transforming-african-agriculture/8704> (accessed 11 January 2015).
- 5 This challenge was discussed at the Third International Conference on Early Warning (EWC III) held in Bonn, Germany, 27-29 March 2006.
- 6 [www.opidin.org](http://www.opidin.org).
- 7 <http://www.fews.net/>.
- 8 The UNDMTP was launched in the 1990s as a joint initiative by UNDHA and UNDP on behalf of the Inter-Agency Task Force. Following the launch of the HFA in 2005, the UNDMTP was relaunched as the Capacity for Disaster Reduction Initiative (CADRI).
- 9 [http://www.unicef.org/education/bege\\_61691.html](http://www.unicef.org/education/bege_61691.html).
- 10 <http://www.metoffice.gov.uk/weather/tropicalcyclone/2013/haiyan> (accessed 10 October 2014).
- 11 [www.em-dat.be](http://www.em-dat.be).
- 12 [http://www.recoveryplatform.org/about\\_irp](http://www.recoveryplatform.org/about_irp).
- 13 Chile became a high-income country in 2013 (<http://data.worldbank.org/news/new-country-classifications>).
- 14 <http://www.unodc.org/lpo-brazil/es/frontpage/2010/03/18-cepal-sismo-en-haiti-retrocedio-lucha-contra-la-pobreza-en-una-decada.html> (accessed 11 January 2015).
- 15 <http://info.worldbank.org/governance/wgi/index.aspx#home>.
- 16 Recovery following the Christchurch earthquakes was partly paralysed due to difficulties in settling insurance claims.





## **Part III**

# **Enter the void**

On 26 July 2005, Mumbai was brought to a halt by severe flooding. Water supply, drainage and sewerage, all forms of public transport, power and telecommunications collapsed across wide areas (Revi, 2005). Some 1,150 people died (Carpenter, 2006), trains were derailed and parts of the city were submerged under the heaviest rainfall recorded in Mumbai's history (Hallegatte et al., 2010; Ranger et al., 2011; Dossal, 2005).

Mumbai's 150-year-old municipal government was unprepared and unable to organize an effective response. Many administrative and political institutions were paralysed, seemingly in a state of shock (ibid.). And yet city life continued, no riots broke out, and Mumbaikars soon organized themselves for a speedy response and recovery.<sup>1</sup> The event and its immediate aftermath highlighted not only limitations but also the existence of a civic culture.

The 2005 floods affected a city of around 13 million people.<sup>2</sup> Mumbai has now grown to more than 20 million (UNDESA, 2014b), and this rapid growth continues to be characterized by high levels of inequality. Informal settlements and markets with weak public infrastructure exist side by side with a dynamic economy and a strong middle

class. By 2020, the city is projected to have the highest population density in the world (ibid.).

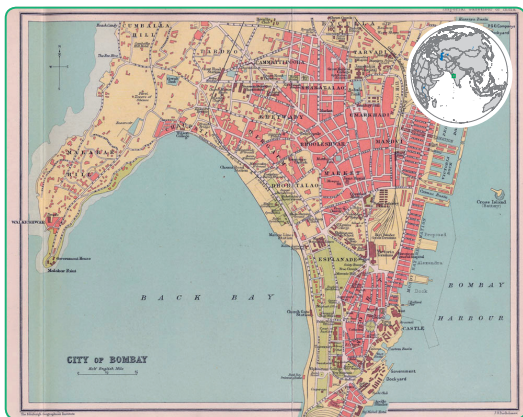
Mumbai is no stranger to risk management challenges. At the end of the nineteenth century, failures in urban planning, regulation and public investment resulted in a devastating outbreak of the bubonic plague (Gandy, 2008; Christakos et al., 2007). The risks exposed by the 2005 floods were constructed in a very similar manner.

In 1908, Arthur Crawford, Municipal Commissioner from 1865 to 1871, published plans for urban renewal that provided for adequate housing, water supply, drainage and waste management systems (Crawford, 1908). He had already suggested similar plans during his time in office, but they had been opposed by wealthy landowners and officials with vested interests. As a result, the bubonic plague that raged in the city for almost a decade until 1906 led to a heavy death toll and severely impacted the city's economy, social cohesion and self-image (Dossal, 2005).

Mumbai continued to grow rapidly in the twentieth century at the same time as being exposed to a multitude of physical and technological hazards, including earthquake, cyclone, storm surge, landslide, rainstorm and local flooding, sea level rise, drought, and nuclear and industrial accidents. With the 2005 floods, the strategic and competitive advantages provided by location, history, and the resulting concentration of capital, human resources and technology seemed to have been overtaken by a dramatic accumulation of both systemic and idiosyncratic risks (Revi, 2005).

Today, more than half of the population lives in informal settlements (Bertaud, 2011). Public investments in infrastructure have been playing catch-up. Basic services and utilities such as uninterrupted energy and water supply, wastewater management and garbage collection are non-existent or sub-standard in many parts of the

**Figure III.1** Mumbai in the early twentieth century



(Source: Bartholomew, 1908.)

city, particularly in informal settlements (Agarwal, 2011; Subbaraman et al., 2012). The municipal government is regulating and investing in a landscape of fluid and erratic changes in demographics, exigencies and prospects (Bertaud, 2011). In addition, it is forced to grapple with corruption in a society (Gandy, 2012). The next disaster is already in the making.

The case of Mumbai provides just a small glimpse of the limitations of the current approach to disaster risk reduction as well as what the “*new normal*” of accelerating disaster risk is starting to look like.

Part II of this report highlights the success of the HFA in catalysing major investments by countries as well as regional and international organizations in disaster management. The different priorities for action identified in the HFA have different degrees of complexity and therefore manageability. And the disaster risk management sector has made significant progress in those areas where its governance arrangements are appropriate (UNDP, 2014a).

As suggested in Chapters 1 and 6, while the HFA created space for addressing underlying risk, particularly in Strategic Goal 1 and Priority for Action 4, this space has been only partially explored by governments, regional and international organizations. HFA progress reports have consistently highlighted a low level of achievement of Priority for Action 4. The syncretic evolution, consolidation and expansion of a disaster risk management sector from its origins in emergency management has led to its understanding and practice as disaster management (Enia, 2013; Hewitt, 2013; UNISDR, 2013a; 2011a). If disasters are understood as exogenous threats, then priority is given to policies, plans, strategies and other instruments designed to protect people and their assets from such threats rather than addressing the generation and accumulation of risk *inside* development.

As a result, it would appear that HFA Strategic Goal 1, the *integration of disaster reduction into sustainable development policies and planning*, has not been realized sufficiently. The generation and accumulation of new disaster risks, particularly extensive ones, seem to be outstripping the increasing efforts to protect development against those risks. As underlined in Part I of this report, as the HFA draws to a close, disaster risk remains a growing challenge, particularly in low and middle-income countries. And the extensive risks of today can become the intensive risks of tomorrow.

However, this apparent shortfall masks a more complex reality. Innovation and progress in other agendas, including those related to climate change, environment, water, urban design and management and sustainability, are leading to the adoption of policies and practices that have direct or indirect co-benefits for disaster risk reduction, even if they are not labelled as such. Given the focus of the disaster risk management sector on preparing for emergencies and managing disasters, these practices are all too rarely documented through the HFA Monitor. Although the tide of risk generation and accumulation would still seem to be flowing in, there is now growing momentum in some sectors to transform development in a way that addresses some of the underlying risk drivers.

### Unease and uncertainty

Unfortunately, there is mounting evidence that notwithstanding this momentum, the world is going to see rapidly accelerating disaster risk over the coming decades.

Despite the introduction of alternative metrics to measure progress in development, such as the Human Development Index (UNDP, 2014b), the Genuine Progress Indicator (Talberth et al., 2007), the World Happiness Report (Helliwell et al., 2013) or the Social Progress Index (Porter et al., 2014), the decisions of governments and investors alike



are still largely determined by GDP per capita, the rate of GDP growth, credit ratings and short-term return on capital rather than measures of sustainability and equity. The development paradigm continues to be based fundamentally on economic growth and is characterized by contradictions and unsustainable qualities, including the overconsumption of natural capital and the production of inequality.

Over the last quarter of a century, the global economy has doubled in size, an estimated 60 per cent of the world's ecosystems have been degraded and the benefits of growth have been distributed unevenly: the bottom half of the world's population now shares just 1 per cent of global wealth. Even in high-income countries, huge gaps in wealth and well-being persist between rich and poor. As these trends evolve, the political and social consensus on the benefits of development is being replaced by growing uncertainty and unease, including concerns about increasing disaster risk.

### Increasing exposure of economic assets

Global GDP per capita increased by 122 per cent between 1990 and 2010.<sup>3</sup> As the economy becomes more global, investment tends to flow to locations offering comparative advantages for capital accumulation, including low labour costs, access to export markets, infrastructure, stability and other factors. As highlighted in GAR13 (UNISDR, 2013a), investment decisions rarely take into account the level of hazard in these locations or else discount the risk excessively due to the short-term profits that can be made. This has led to large flows of capital into hazard-prone areas and a vast increase in the exposure of economic assets to earthquakes, tsunamis, storm surges, floods and other hazards. At the same time, the resulting risk becomes globalized as both the causes and impacts of disaster ripple through global supply chains and impacts in increasingly integrated sectors spill over into others.

### Growing risk inequality

The concentration of capital generates social and territorial inequalities. The richest 2 per cent of the world's adult population now own over 50 per cent of global wealth (Davies et al., 2012), whereas the bottom 50 per cent own less than 1 per cent of global wealth (Credit Suisse, 2013). This ratio translates into a Gini coefficient of 0.893, where 0 is perfect equality and 1 is perfect inequality. In other words, the world is nearing what can be considered absolute levels of inequality (Davies et al., 2012). Sectors and territories without comparative advantages for capital accumulation are left behind. In those areas, disaster risk is associated with an absence of development characterized by low levels of investment in risk-reducing infrastructure, an absence of social and environmental protection, and rural and urban poverty. The geography of risk inequality occurs at all scales, between geographical regions and countries, within countries and even within cities and localities.

### Segregated urban development

Urbanization mirrors economic growth. Urban growth *per se* can concentrate risk when it occurs in hazard-exposed locations. However, in most low and middle-income countries it is also usually characterized by unequal access to urban space, infrastructure, services and security, as speculative urban capital is invested in modern enclaves while the low-income majority has access only to informal or sub-standard urbanization. Globally, about one in seven people live in overcrowded, low-quality housing conditions with inadequate access to services (Mitlin and Satterthwaite, 2013). This generates new patterns of both extensive and intensive disaster risk, as low-income households are forced to occupy hazard-exposed areas with low land values, deficient or non-existent infrastructure and social protection, and high levels of environmental degradation.

### Climate change

Economic growth requires increasing energy

consumption, which is still largely dependent on fossil fuels and manifests as increased greenhouse gas emissions. While greenhouse gas emissions by Annex I<sup>4</sup> countries to the Kyoto Protocol decreased by 9.3 per cent between 1990 and 2011,<sup>5</sup> global emission levels rose over the same time period and well into 2013 (WMO, 2014b), resulting in atmospheric concentrations of greenhouse gases exceeding pre-industrial levels by around 40 per cent (IPCC, 2013). The emissions of almost 50 per cent of all countries exceed the currently established global thresholds (UNDP, 2014b). As a result, through changing temperatures, precipitation and sea levels, among other factors, global climate change feeds back into modifications in hazards and magnifies disaster risks. Climate change transfers risk as many of the territories most affected are those which have contributed least to greenhouse gas emissions. But at the same time, climate change is a meta-risk driver, as both its causes and consequences are global.

### Overconsumption

Economic growth also relies on the increasing consumption of environmental resources, including freshwater, forest and marine resources. Of the 140 countries for which data is available, 59 per cent show an ecological footprint that is above global biocapacity, and 49 out of 172 countries withdraw more fresh water than the global threshold allows (UNDP, 2014b). Many ecosystems that play vital protective and provisioning roles are being degraded beyond the point of recovery, which can magnify hazard levels, increase vulnerability and challenge resilience. Like climate change, the consumption of environmental resources is a reflection of inequality. Many sectors and territories with high levels of income live beyond their means and rely on the consumption of environmental resources from other areas.

### Changing demographics

Demographic change, including shifts due to migration and displacement, also influences

disaster risk patterns and trends. By 2050, the world's population will have increased to 9.2 billion (Lutz et al., 2014) and the percentage of the ageing population (over 60) in high-income countries is expected to reach 32 per cent (UNDESA, 2013). While the global population is expected to peak at 9.4 billion around 2070 and start to decline slowly by the end of the century (Lutz et al., 2014), countries and regions with rapidly growing, young populations are likely to see increasing hazard exposure, particularly in urban areas. Given the specific disaster risks posed by demographic change, countries and regions with ageing and declining populations are likely to see increases in vulnerability and reductions in resilience.

### The drive for competitiveness

Within the current development paradigm, both businesses and countries continuously strive to remain competitive. By reducing labour costs in the case of businesses or spending on social welfare and protection in the case of governments, the drive to remain competitive and to attract investment may increase the vulnerability and reduce the resilience of large sectors of the labour force. Conversely, however, the drive to increase energy and resource efficiency in order to reduce costs spurs investment in technologies that can reduce greenhouse gas emissions and relieve ecosystems.

### Non-linearity and uncertainty

These global drivers of risk are closely interrelated and concatenated, and they are increasingly shaping local realities like the situation in Mumbai. The perception of increasing complexity, interconnectivity and dependency of local realities on global processes erodes the capacity of local stakeholders to manage their risks and increases uncertainty and unease. Given the multiple feedback loops between these different drivers and their non-linearity, even slight changes in the evolution of any one driver can generate unexpected and radical changes in another. As uncertainty and unease replace certainty and



security in the future, disaster risk reduction may be entering the void.

Predicting what the impact of global climate change, energy consumption or population growth may look like in 20, 50 or 100 years has become something of a social obsession and can be disempowering. Ultimately, if the planetary system is going to collapse, why invest in managing today's risks? At the same time, however, economic stakeholders do not just react passively to change, but actually shape it. Understanding the economic, political and social forces that are currently driving risk can also help to identify gaps and points of inflection where change is possible.

## Notes

---

**1** <http://lsecities.net/media/objects/articles/maximum-city/en-gb> (accessed 11 January 2015).

**2** Municipal Corporation of Greater Mumbai, Population Census: <http://www.mcgm.gov.in/irj/portal/anonymous/qlvitalstatsreport>.

**3** Data from the World Bank Development Indicators: <http://data.worldbank.org>.

**4** Annex I countries include the industrialized countries that were members of the OECD in 1992, plus countries with economies in transition, including the Russian Federation, the Baltic States, and several Central and Eastern European States. For the full list of Annex I countries, see [http://unfccc.int/parties\\_and\\_observers/parties/annex\\_i/items/2774.php](http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php).

**5** [http://unfccc.int/ghg\\_data/ghg\\_data\\_unfccc/items/4146.php](http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php).

## Chapter 9

# Risk inequality



The concentration of capital generates social and territorial inequalities. The world is nearing what can be considered absolute levels of inequality, and sectors and territories without comparative advantages for capital accumulation are being left behind. In those areas, disaster risk is associated with an absence of development characterized by low levels of investment in risk-reducing infrastructure, an absence of social and environmental protection, and rural and urban poverty.

## 9.1 Multi-dimensional poverty, everyday risks and disasters

Multi-dimensional poverty experienced in hazard-exposed areas means that conditions of everyday risk become configured as patterns of extensive disaster risk.

In the wealthy town of Lenzie, East Dunbartonshire, Scotland, men live to an average age of 82. Just 12 kilometres down the road, in Calton, Glasgow, they die at 54 on average (Government of Scotland, 2009). Male life expectancy in Calton is lower than in the Gaza Strip, where men

can expect to live until the age of 71,<sup>1</sup> or in Iraq, where after 20 years of sanctions and war, male life expectancy is 66 years.<sup>2</sup> Only 12 countries in sub-Saharan Africa, including Sierra Leone, Chad and the Democratic Republic of Congo have a lower male life expectancy than Calton.<sup>3</sup> Given the link between poverty and disaster risk, it may come as no surprise that Calton also sees regular flooding (Box 9.1).

The case of Calton epitomizes how economic poverty, together with other poverty factors such as powerlessness, exclusion, low literacy and discrimination, translates into conditions

Box 9.1 Everyday and extensive risk in Calton

Calton is an underprivileged district in Glasgow, Scotland. Poverty, drugs and alcohol, crime and poor health are rampant. A full 44 per cent of its inhabitants are on incapacity benefits and 37 per cent live in workless households (Government of Scotland, 2009). This level of deprivation exists within walking distance of Glasgow’s most upmarket shopping district, a clear reflection of high levels of inequality in close vicinity.



In Scotland, mortality due to causes such as respiratory and liver diseases, accidents, drug and alcohol-related disorders, self-harm and assault in the most deprived areas like Calton are higher than in the least deprived areas by an order of magnitude on the Scottish Index of Multiple Deprivation (SIMD; Table 9.1).

Table 9.1 Male mortality (age 0-64, per 100,000) from selected causes within each SIMD deprivation quintile, 2000-2002.

SIMD quintile	Chronic lower respiratory disease	Chronic liver disease	Accidents	Intentional self-harm etc.	Mental and behavioural disorders due to drugs	Mental and behavioural disorders due to alcohol	Assault
5 (least deprived)	3	6	11	11	2	2	0
4	5	11	17	18	4	5	1
3	7	16	17	24	5	8	1
2	12	29	21	31	11	11	4
1 (most deprived)	18	61	27	48	29	20	11
All Scotland	9	23	18	26	10	9	3

(Source: UNISDR with data from the SIMD.<sup>4</sup>)

The high levels of deprivation in Calton also coincide with extensive disaster risk (Lindley et al., 2011). In addition to inequality and poverty, the inadequate design of the city's sewage systems and small urban watercourses mean that local flooding occurs on a regular basis (Cashman, 2007). Diminishing floodplains along the Clyde River have further exacerbated flood hazard in the area (Figure 9.1).

**Figure 9.1** Glasgow city centre at the end of the 18<sup>th</sup> century and the beginning of the 21<sup>st</sup> century



1795 - J. Gillies, National Library of Scotland

(Source: National Library of Scotland; Ordnance Survey.<sup>5</sup>)



2015 - Ordnance Survey, 2015

In 2002, Calton and Shettleston—another district in Glasgow where an estimated 80 per cent of the population live on welfare benefits and most do not have insurance (Tufail et al., 2004)—were among the areas worst affected by flooding (Cashman, 2007). Shettleston also experienced repeated extensive flooding between 1993 and 2005 (Werritty et al., 2007). A survey on flood impacts in 2006 showed very low response rates from the emergency services in Shettleston compared to other affected locations (ibid.), possibly reflecting the disenfranchisement of its population.

After the 2002 floods, the Metropolitan Glasgow Strategic Drainage Partnership (MGSDP, 2012a) implemented risk reduction measures against a 1-in-200-year flood, including the construction of 4.5 km of flood defence walls, six underground pumping stations, the creation of flood storage areas in three river basins and the planting of thousands of trees and bushes (MGSDP, 2012b). However, in areas such as Calton and Shettleston, flood risk is as much about social vulnerability as it is about hazard.

of everyday risk; these are associated with poor health, crime, drug addiction, domestic violence and homelessness (Wilkinson and Marmot, 2003), which in turn reinforce poverty.

The correlation between poverty and life expectancy is particularly pronounced in low-income countries. For example, Lilongwe, Conakry, N'Djamena, Banjul and Kigali all have life expectancies at birth of less than 50 years (Mitlin and Satterthwaite, 2013). In Chad, Sierra Leone, Burundi and Mali, under-five mortality rates among urban populations are staggeringly high at more than 150 per 1,000 live births, compared

to below 10 per 1,000 live births in middle and high-income nations (ibid.). But as the case of Calton shows, low life expectancy arises from these conditions of high everyday risk, even in the world's richest countries.

There is now a common understanding that low-income households and communities suffer a disproportionate share of disaster losses and impacts (UNISDR, 2009a; Rentschler, 2013; Lewis, 2011; Donner and Rodriguez, 2011;<sup>6</sup> Benson and Clay, 2004; DFID, 2004; UNDP, 2004; Wisner et al., 2003; Baker, 2012; UNDP, 2014a).



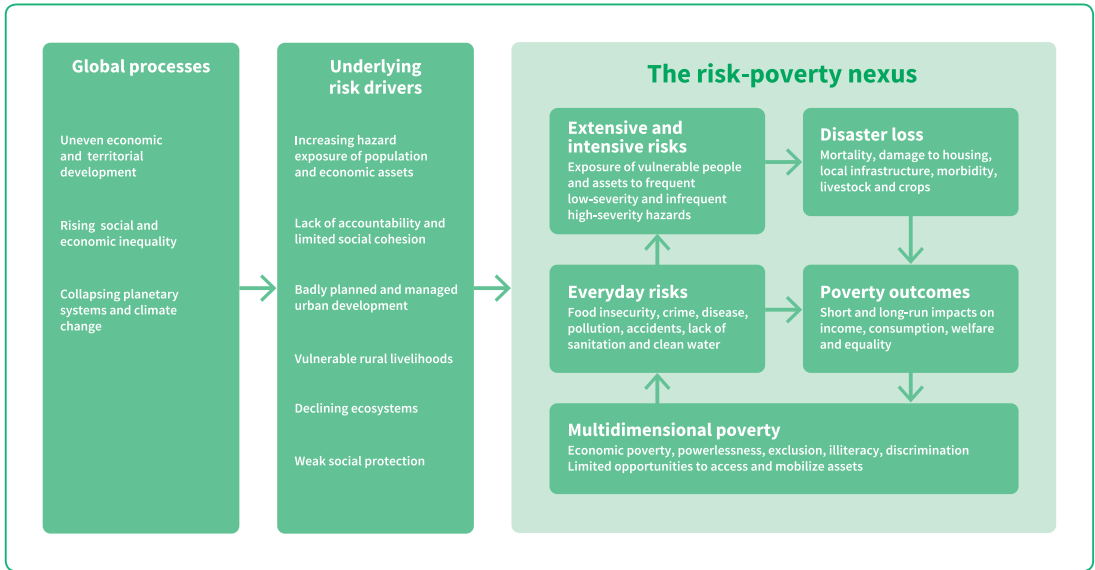
However, as in Calton, disaster risk is shaped not only by income poverty but by a range of social and economic factors that determine entitlements and capabilities (Shepherd et al., 2013). Access to services, political voice, and social and economic status directly affect disaster risk and resilience (Satterthwaite and Mitlin, 2014). Key factors in underprivileged areas include low-quality and insecure housing; limited access to basic services such as health care, public transport and communications, and to infrastructure such as water, sanitation, drainage and roads; a low asset base; and the absence of a safety net (ibid.). Higher mortality and morbidity rates among children, the elderly and women are directly linked to these different poverty factors (Anderson, 1994; IASC, 2006; Benson and Bugge, 2007; Aldrich and Benson, 2008; Walden et al., 2009; UNISDR, 2009a; World Bank, 2010; Nilufar, 2012; Shepherd et al., 2013).

People who are subject to multi-dimensional poverty are more likely to live in hazard-exposed areas and are less able to invest in risk-reducing measures. As such, conditions of everyday

risk become configured as patterns of extensive disaster risk (Figure 9.2), which in turn lead to accumulations of intensive risk in regions exposed to earthquakes, tropical cyclones and other major hazards.

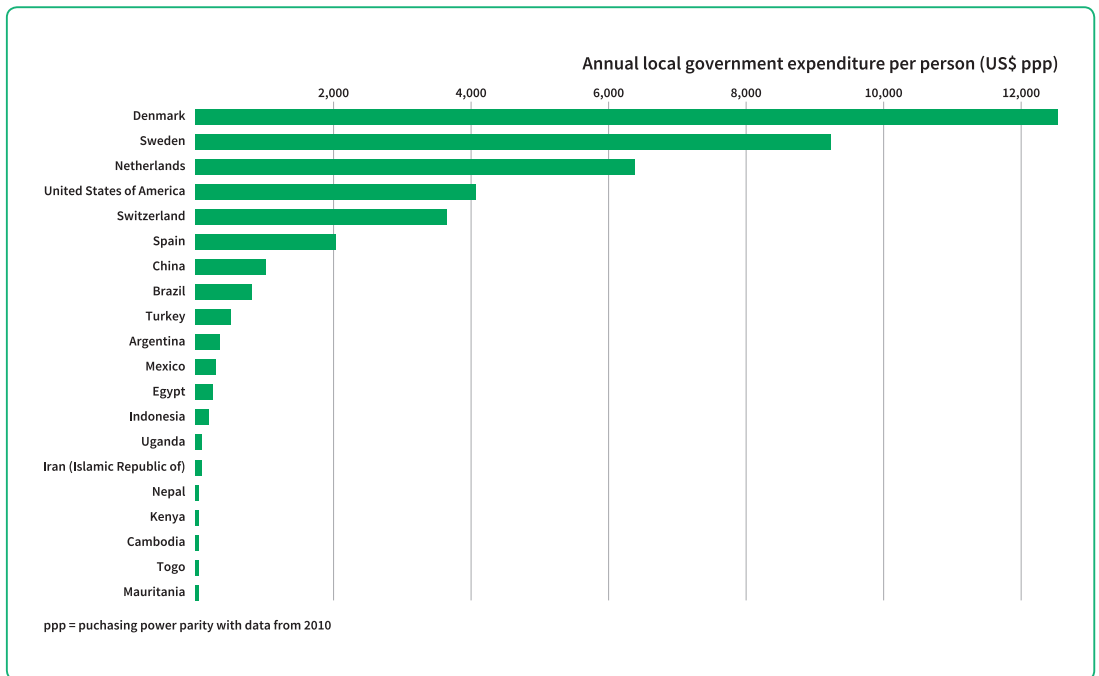
The lack of access to insurance and social protection mechanisms and the general difficulty of mobilizing assets to buffer losses then means that damage to housing, local infrastructure, livestock and crops feeds back into a range of disaster impacts and poverty outcomes (UNISDR, 2009a; Baez et al., 2009). Recurrent extensive disasters erode the asset base of households, leading to greater risk and lower resilience. In the case of people living at or below the poverty line, with a severely constrained ability to accumulate or mobilize assets, disaster risk will continue to be a factor that not only reflects but also drives poverty. For example, floods and droughts in Mexico make a significant contribution to lower human development and increased poverty. Between 2000 and 2005, the impact of disasters on human development was equal to a two-year loss of progress on average, and the effect on

**Figure 9.2** The disaster risk–poverty nexus



(Source: UNISDR.)

Figure 9.3 Annual local government expenditure per person



(Source: *United Cities and Local Government, 2010.*)

poverty was equivalent to an increase of 1.5 to 3.7 per cent (Rodriguez-Oreggia et al., 2012).

Evidence from microeconomic studies also shows that intensive disasters have a disproportional impact on the poorest households, which tend to lose a higher proportion of their productive assets. Similarly, these same households often have less capacity to mobilize assets to buffer losses and recover. As such, intensive disasters can lead to a broadening and deepening of poverty and inequality as well as longer-run impacts on health, education, nutrition and productivity.

Evidence from the 2007 earthquake in Peru shows that both measurable poverty as well as subjective poverty (poverty as perceived by those affected) increased considerably in the Ica Region, the most severely affected area in the country (Lucchetti, 2011). In the Philippines, analyses of rainfall data and household consumption patterns show that even smaller but more

frequent deviations from normal rainfall patterns directly impact the welfare of poor households, particularly those in rural areas with limited access to markets (Safir et al., 2013).

Health effects have also been shown to be significant, particularly for young children and the elderly: in the aftermath of Hurricane Mitch, the probability of undernourishment in children almost quadrupled in the regions hit by the hurricane, and children were 30 per cent less likely to be taken to a doctor when they were sick (Baez, 2007).

In many cities in low and middle-income countries, weak and under-resourced local governments do not have the capacity to manage the processes that are generating and accumulating disaster risk, nor to provide social protection (UNISDR, 2009a, 2011a, 2013a; Mitlin and Satterthwaite, 2013). While annual local government spending (Figure 9.3) in a high-income country



like Denmark can exceed US\$12,000 per inhabitant, in many low-income countries it is less than US\$5 per inhabitant (Satterthwaite and Dodman, 2013). This implies that weak local governance is both a poverty factor and a driver of risk.

While the impact of disaster on poverty has been documented repeatedly, what is missing is the recognition that disaster risk, and particularly extensive risk, is part of the DNA of poverty and inequality. In other words, it is rooted *within poverty* and not an externality.

Studies on the geography of risk often still present disasters and climate change impacts as a simple function of the hazard exposure of low-income populations. For example, a recent projection states that *325 million extremely poor people will be living in the 49 countries most prone to hazards in 2030, and therefore eliminating poverty cannot be achieved without addressing disasters* (Shepherd et al., 2013). However, this logic can be explored from a different angle. If poverty could be reduced, so would disaster losses and impacts. Disaster risk, and extensive risk in particular, is *intrinsic to poverty*.

## 9.2 Inequality and disaster risk

**The social processes that drive the disaster risk–poverty nexus are permeated with inequality. Inequality increases income poverty and creates processes of social and political exclusion. The result is a lack of social cohesion that contributes to disaster risk by eroding accountability and enabling corruption.**

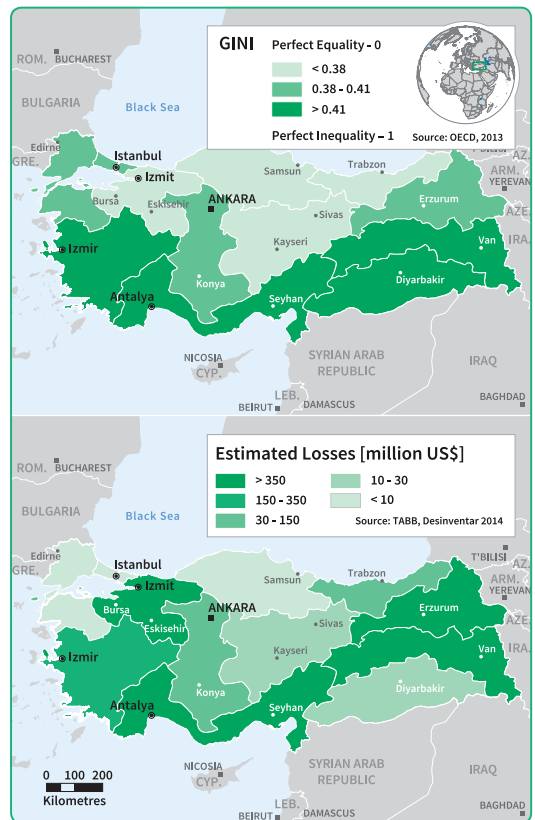
In Turkey, an upper middle-income country, income inequality has been decreasing over the last 30 years. However, this decrease began from a high starting point, and today the country still ranks second among OECD countries in terms of income inequality.<sup>7</sup> While the number of people

living below the poverty line has decreased dramatically over the last 10 years, the poverty threshold for Turkey has continuously risen. In 2013, it was calculated at US\$509 per month, which is significantly higher than the official poverty line.<sup>8</sup>

Inequality and poverty are highest in the southern and eastern regions of the country, which are less populated than the urbanized north and western coast. With the exception of losses associated with the large earthquake in Izmit in 1999, disaster losses in general reflect the distribution of inequality (Figure 9.4).

The social processes and power dynamics that drive the disaster risk–poverty nexus are permeated with inequality. Inequality (Box 9.2) drives

**Figure 9.4** Inequality and disaster losses in Turkey



(Source: UNISDR with data from the Turkish Disaster Data Bank (TABB) and OECD.)

Inequality has a number of dimensions that go beyond the mere unequal distribution of income. Many of these dimensions may have a more significant impact on disaster risk levels than income inequality alone. Asset inequality usually relates in particular to housing and security of tenure, but it can also refer to productive assets in farming communities or goods and savings in trading communities. Inequality of entitlements refers to unequal access to public services and welfare systems as well as inequalities in the application of the rule of law. Political inequality exists worldwide in the unequal capacities for political agency possessed by different groups and individuals in any society. Finally, the inequality of social status is often directly linked to space (e.g. informal settlements in urban settings) and has a bearing on other dimensions of inequality, including the ability of individuals and groups to secure regular income, to access services and to claim political space.

The direct impact that social status often has on the capacity of individuals or groups to manage risks and build resilience is regularly underestimated in research and particularly in quantitative assessments of vulnerability to disasters. The different dimensions of inequality that drive disaster risk at all levels need to be brought to the forefront of how disaster risk generation and accumulation are understood.

(Source: Satterthwaite and Mitlin, 2014.)

disaster risk levels not just because it increases income poverty (UNDP, 2013b) but also through other processes of social and political exclusion, which also affect lower middle-class families in societies with high levels of inequality. Such levels of inequality and a lack of social cohesion can contribute to disaster risk by eroding accountability, enabling corruption and dismantling a social contract that could provide incentives for risk-reducing behaviour. As explored in other chapters of this part of the report, inequality also redistributes disaster risk through processes such as uneven economic development, urban segregation and the overconsumption of resources. Disaster risk inequality is therefore an inherent characteristic of broader social, economic and political inequalities.

Inequality of access to infrastructure, services and safety nets has an influence on the resilience of different groups and individuals in society when affected by disaster losses. Inequality of access to land, income and asset bases affects how households and communities can manage their disaster risks. Finally, inequality of protection through established rights, laws and regulations, and inequality in voice and accountability

impact the capacity of countries to address the underlying drivers of disaster risk (UNISDR, 2009a, 2011a).

Globally, social and income inequality are recognized as having a direct relationship with the macroeconomic risks of fiscal crises and unemployment (WEF, 2014). At all scales, inequality also facilitates the transfer of disaster risks, through ineffective accountability and increased corruption, from those who benefit from taking the risks to other sectors and population groups who bear the costs (Birdsall and Londoño, 1997; Kawachi et al., 1997; World Bank, 2004; Hulme and Green, 2005; UNISDR, 2013a).

High levels of inequality thus limit both economic growth and social cohesion (Persson and Tabellini 1991; Birdsall and Londoño, 1997; Deninger and Squire 1998; Easterley 2002; Piketty, 2014). And extreme levels of inequality can turn into a serious global governance issue *per se*, as they can corrode social cohesion to the point where issues such as disaster risk are no longer viewed in terms of common values and priorities (Wilkinson, 2005; Fajnzylber et al., 2002).



## 9.3 Addressing poverty and inequality in the HFA?

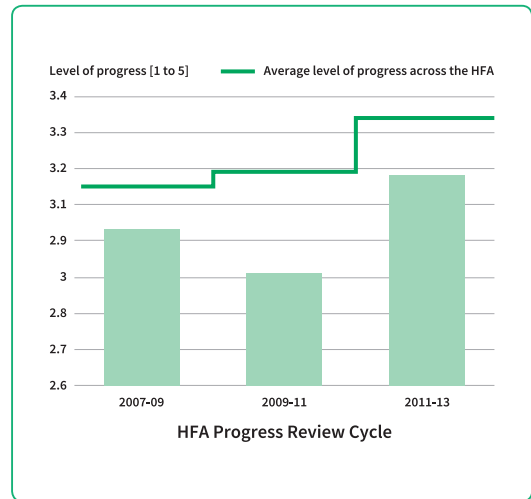
There is evidence of success in reducing poverty and inequality. However, much of this progress has not originated in the disaster risk management sector *per se*, but instead has been driven by other sectors, notably agriculture, food and social welfare.

The HFA does not mention inequality as a driver of disaster risk. However, under Priority for Action 4, the HFA includes a number of activities aimed directly at reducing the vulnerability and strengthening the social resilience of households and communities (Box 9.3).

Although government self-assessment reports show an improvement in these areas between the 2011 and 2013 reporting cycles, they point to a very low overall level of achievement (Figure 9.5) which is well below the average score across the different priorities for action.

As in other HFA key activities, the absence of consistent output indicators makes it difficult to assess progress. However, there is evidence of improving food security in many regions and

**Figure 9.5** Progress reported in integrating disaster risk reduction into social development



HFA Core Indicator 4.2: Social development policies and plans implemented to reduce vulnerability of populations most at risk.  
(Source: UNISDR with data from the HFA Monitor.)

increasing coverage of social protection. Much of this progress has not originated in the disaster risk management sector *per se*, but instead has been driven by other sectors, notably agriculture, food and social welfare.

### Box 9.3 Key activities related to social vulnerability and resilience in the HFA

*(d) Promote food security as an important factor in ensuring the resilience of communities to hazards, particularly in areas prone to drought, flood, cyclones and other hazards that can weaken agriculture-based livelihoods.*

*(g) Strengthen the implementation of social safety-net mechanisms to assist the poor, the elderly and the disabled, and other populations affected by disasters. Enhance recovery schemes including psycho-social training programmes in order to mitigate the psychological damage of vulnerable populations, particularly children, in the aftermath of disasters.*

*(i) Endeavor to ensure, as appropriate, that programmes for displaced persons do not increase risk and vulnerability to hazards.*

*(j) Promote diversified income options for populations in high-risk areas to reduce their vulnerability to hazards, and ensure that their income and assets are not undermined by development policy and processes that increase their vulnerability to disasters.*



### Food security

Food security has improved in recent decades. Since 1990, the global rate of undernourishment has fallen from 18.7 to 11.3 per cent (FAO et al., 2014) and 52 countries have managed to reach the hunger target of the Millennium Development Goals. However, current estimates indicate that more than 800 million people around the world are still chronically undernourished (ibid.), and there are marked differences in progress across regions. Sub-Saharan Africa still has higher rates of undernourishment than other regions, while the situation in West Asia has actually deteriorated (Figure 9.6).

This mixture of progress on the one hand and persistent challenges on the other shows that sustained political commitment, together with major investments in risk-sensitive food production and consumption, will be required if global and sustainable food security is to be achieved (UNISDR, 2013a; FAO et al., 2014). In light of processes such as ongoing land degradation, dwindling fresh water supplies, loss of biodiversity

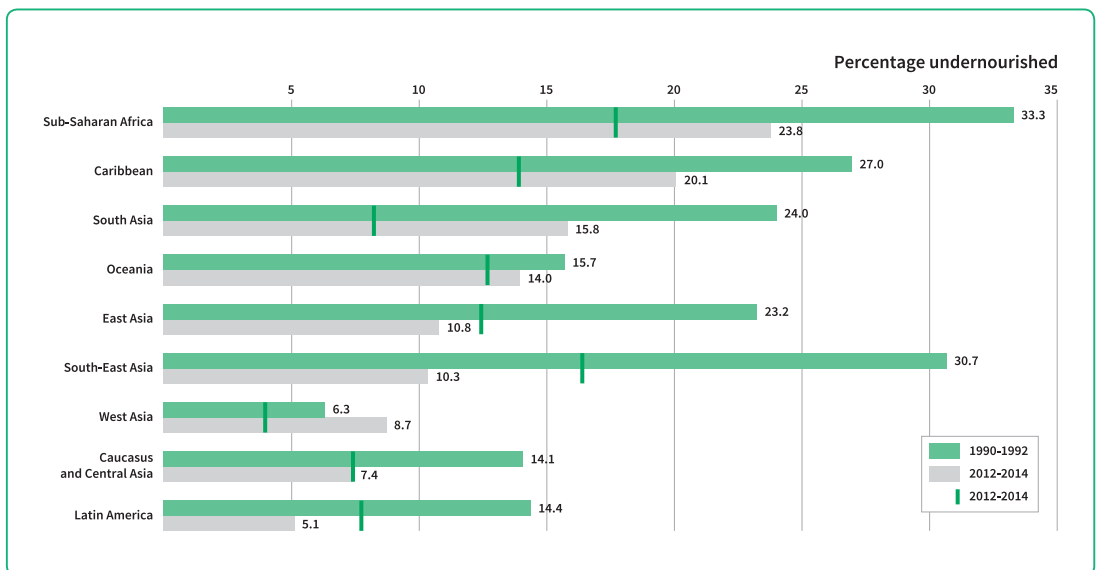
and climate change, the challenges are likely to increase in the future.

### Social protection

Social protection has received significant support from international aid budgets. For example, the World Bank alone allocated an average annual budget of US\$1.72 billion for social protection between 2007 and 2013 and approved 273 projects in 93 countries with a total value of US\$12 billion over the same period.

There are examples of successful initiatives in prospective disaster risk management that have effectively reduced vulnerability by combining disaster risk management with poverty reduction (UNISDR, 2011a; Arnold et al., 2014; GFDRR, 2014d). One such example is the Bangladesh Chars Livelihood Programme (CLP)<sup>9</sup>, in which public works for flood risk reduction are combined with asset transfers (both cash and in kind), market development, livelihoods diversification and a range of social development projects to build the long-term resilience and prosperity of the communities living in the hazard-prone

Figure 9.6 Trends in undernourishment: regional differences



(Source: FAO et al., 2014.)



chars in northwest Bangladesh (GFDRR, 2013c; Conroy et al., 2010). The combination of intensive and targeted welfare support and economic development at the individual, household and community level has produced real reductions in vulnerability (GFDRR, 2014d; Conroy et al., 2010).



However, social protection has generally been used more as a buffer for disaster losses than as a tool for prospective disaster risk management (Newsham et al., 2011). For example, a number of community-driven development initiatives aimed at reducing poverty and vulnerability have successfully reduced disaster risks without originally intending to do so (World Bank, 2006); this was mostly achieved by strengthening resilience using the network and infrastructure available during emergencies (GFDRR, 2014d).

One area of social protection in which adequate progress has not been made is the protection and involvement of people with disabilities. Disaster risk reduction programmes that target people with disabilities remain the exception, for example in the education sector, where disaster risk reduction may be taught to children in schools where most children with disabilities are not enrolled.<sup>10</sup>

More recent efforts to understand and address disability in the context of disasters and disaster risk management have made reference to the UN Convention on the Rights of Persons with

Disabilities, which highlights that States shall “ensure the protection and safety of persons with disabilities in situations of risk [...] and the occurrence of natural disasters”.<sup>11</sup> This premise has informed recent efforts to address the fact that persons with disabilities as well as the elderly remain at high risk in disaster situations and to let persons with disabilities contribute to disaster risk reduction efforts.

## 9.4 Strengthening social and economic resilience through financial risk-sharing mechanisms

**Risk financing is an area where significant progress has been made. While this area has attracted growing interest from governments, the private sector and international organizations, the ability of standard instruments to ensure the welfare of all remains limited in many countries.**

Under Priority for Action 4, the HFA also recognized the role that could be played by financial risk-sharing mechanisms, although this was not explicitly linked to inequality and vulnerability (Box 9.4).

Unfortunately, these key activities are not reflected in the HFA’s core indicator for social protection, nor in any of the other core indicators under Priority for Action 4. However, given the clear link between financial protection and resilience, these activities will be discussed in this chapter.

### Box 9.4 Key activities related to financial risk sharing in the HFA

*(k) Promote the development of financial risk-sharing mechanisms, particularly insurance and reinsurance against disasters.*

*(m) Develop and promote alternative and innovative financial instruments for addressing disaster risk.*

Again, the absence of consistent output indicators makes it difficult to assess progress, but the means of verification in the HFA Monitor provide evidence of innovation, suggesting that this is an area where significant progress has been made. As a mechanism to protect social and economic development against exogenous threats, risk financing has attracted growing interest from governments, the private sector and from international organizations such as the World Bank and the OECD.

Insuring assets and business operations against risks goes back to the risk faced by seafarers in the seventeenth century. Since its beginnings at a London coffee house in 1688, where marine traders bought insurance for their goods and ships, buying and selling disaster risk insurance has grown into a big business. In the early twentieth century, governments began to promote insurance as a way of strengthening resilience and avoiding social pressures for compensation. The first government insurance scheme was the US Federal Crop Insurance Program of the 1930s, which sought to protect farmers from the double effects of the Great Depression and the *Dust Bowl* (GFDRR, 2014b), a period of droughts and dust storms combined with inappropriate farming practices that began in 1934 and the impacts of which lasted well into the 1940s.

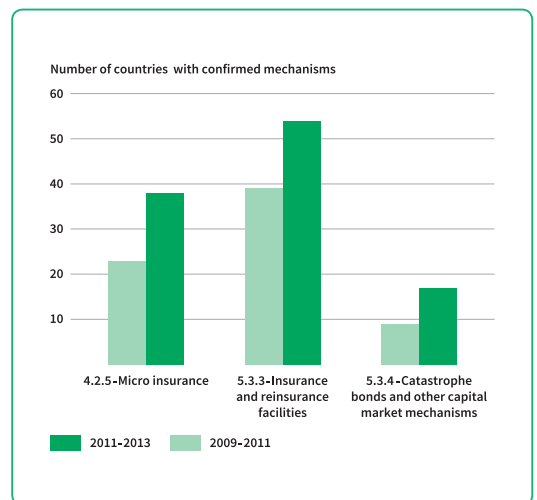
By the early twenty-first century, several mature domestic insurance markets had evolved, for example in Japan, the United States of America (most notably in California), Turkey and Mongolia, but only a limited number of high-income countries used catastrophe risk insurance to hedge their sovereign risk and to ensure financial liquidity in the case of a large-scale emergency (GFDRR, 2014b). Most of those countries paid insurance premiums to support the post-disaster reconstruction of damaged public infrastructure, such as Mexico’s Natural Disaster Fund (FONDEN), but more recently, national and regional sovereign risk pools have attempted to maintain financial

liquidity across a range of post-disaster requirements, thereby ensuring fiscal stability during a disaster event and for years afterwards (ibid.).

Interest in using insurance both as a means to strengthen disaster resilience and an incentive to invest in disaster risk reduction has grown since the adoption of the HFA. In HFA progress reports, countries give an account of their adoption of specific policies to expand insurance coverage, for instance through mandates or compulsory protection. At the national and regional level, risk pooling schemes and catastrophe bonds are becoming an increasingly common tool to manage risk. However, only a minority of countries have fully developed mechanisms to access capital markets for risk financing (Figure 9.7). The key challenge countries report is a lack of capacity in their domestic insurance sectors or limited awareness of the costs and benefits of catastrophe insurance amongst potential beneficiaries.

The key features and underlying assumptions of catastrophe insurance for homeowners, businesses and governments have undergone dramatic changes over the years, often triggered by innovations in low and middle-income countries

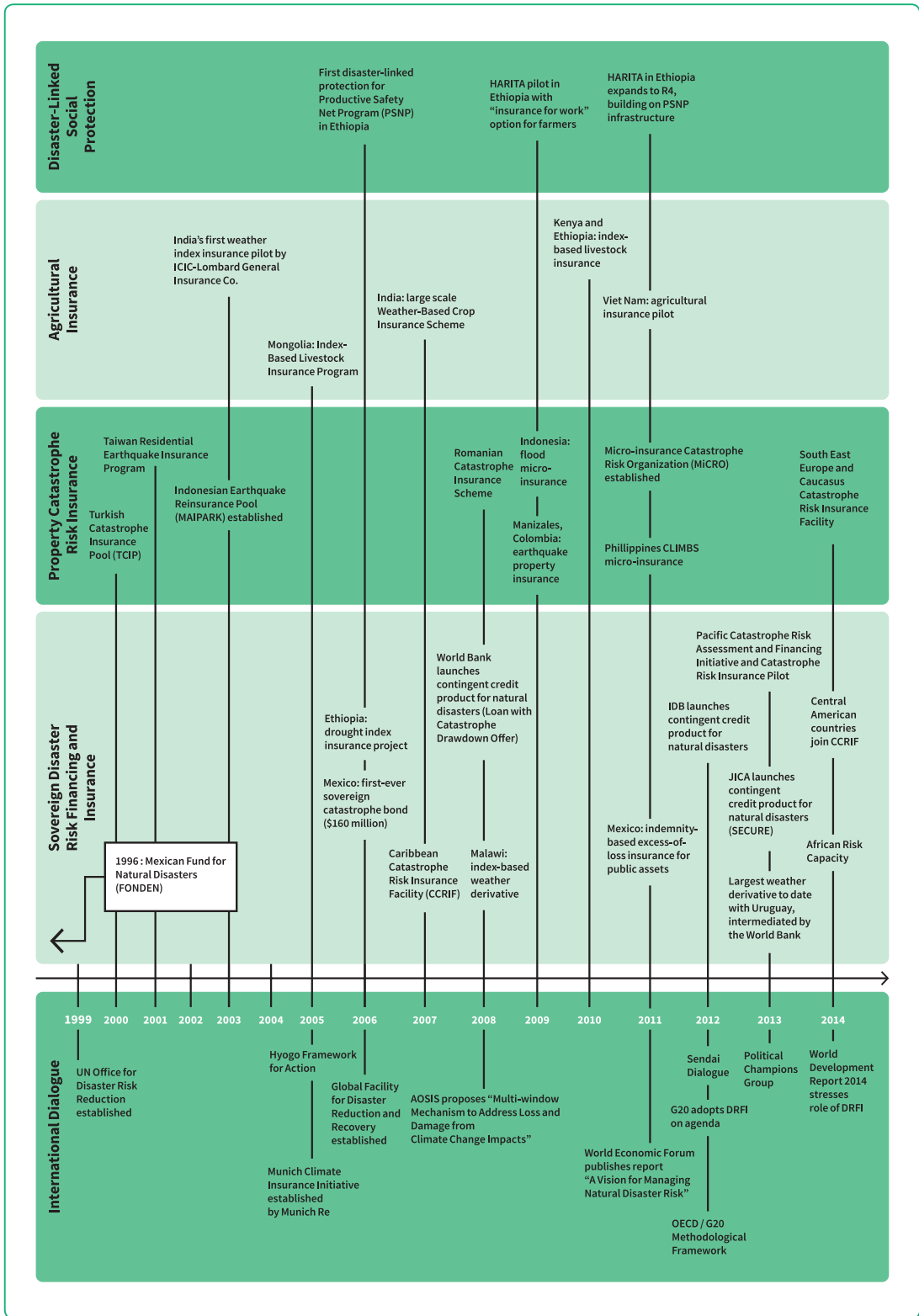
**Figure 9.7** Progress in insuring and financing risk



(Source: UNISDR.)



**Figure 9.8** Milestone programmes in disaster risk financing and insurance since 2000



(Source: GFDRR, 2014b.)

that acted as milestones for the development of new approaches (Figure 9.8).

Since 2005, these innovations have pushed the boundaries of existing insurance schemes and enabled access to financial instruments of different kinds, including parametric catastrophe bonds, weather derivatives, disaster-specific contingent credit, and regional risk pooling, even for low-income countries (UNISDR, 2011a; 2013a; GFDRR, 2014b). The new schemes include micro-insurance products that are often provided by civil society organizations and cater to low-income communities and smallholders, traders and small businesses, as well as regional schemes such as the Caribbean Catastrophe Risk Insurance Facility (CCRIF) and the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI; GFDRR, 2014b).

A number of countries have carried out institutional reforms to support the integration of disaster risk financing into a broader, strategic approach to disaster risk management (Ghesquiere and Mahul, 2010; World Bank, 2013; GFDRR, 2014b). Ministries of finance are increasingly taking the lead in the development of national and regional insurance and credit schemes, and governments are developing new institutional arrangements such as national risk boards that include insurance supervisors, disaster management agencies and the relevant line ministries (ibid.). National risk boards such as the one already implemented in Singapore are now being considered as a new potential arrangement for disaster risk governance in Jamaica, Morocco and Rwanda (ibid.).

However, challenges remain. Globally, the supply of insurance is increasingly well capitalized, while only a small proportion of households in low and middle-income countries have catastrophe insurance (Lloyd's, 2012). Detailed risk models are still not available for many of these countries, meaning that risk may not be properly priced, while

competition may tend to drive premiums down to unsustainable levels. In parallel, risks in some locations and industries are increasing to levels that become uninsurable (The Geneva Association, 2013). The question of who pays and who benefits becomes even more pronounced under such circumstances, as governments become the *de facto* insurers of last resort and their implicit liabilities mean that the risks generated become a public burden (UNISDR, 2013a).

## 9.5 Inequality: the future

**If inequality continues to rise, it may become a destabilizing global force that manifests not only in increasing disaster risk but also in decreasing capacities to manage those risks.**

If inequality is a driver of increasing disaster risk, future projections give no reason to be optimistic. Instead, inequality may well continue to increase in social, economic and territorial terms. As financial capital flows into competitive sectors and locations that provide opportunities for short-term gain, less competitive sectors and locations are left behind. As in the board game Monopoly, where there are winners, by definition there are also losers. Any progress in addressing vulnerability and social resilience, including progress through risk financing, may be ineffective if inequality continues to grow.

Socially, the divide between those who have access to financial capital and those who depend on wage labour for their needs continues to grow. All over the world, wealth has become increasingly concentrated since 1990 (Davies et al., 2012; Piketty, 2014; Credit Suisse, 2013). Wealth is distributed very differently within regions, though most exhibit high levels of inequality (Figure 9.9).

Increasing income inequality is closely linked to the race for competitiveness, in which businesses



continue to depress real wages in many sectors while governments likewise cut spending on social welfare and safety nets (ILO, 2013; UNISDR, 2013a). As a result, wages for large parts of the population have not kept up with economic growth, the benefits of capital accumulation have not trickled down, and working conditions have become more precarious for larger numbers of people. For example, labour productivity increased more than twice as much as wages in developed countries between 1999 and 2011 (ILO, 2013). At the same time, competitive new sectors in the world economy in areas like biotechnology and nanotechnology seem unlikely to generate significant future demand for unskilled or low-skilled labour (Castells et al., 2012).

In the United States, labour productivity grew by 75 per cent in the non-farm sector between 1980 and 2011, while wages increased by only 35 per cent. In China, where wage levels have tripled over the past decade, GDP increased at an even faster rate, resulting in the labour share going

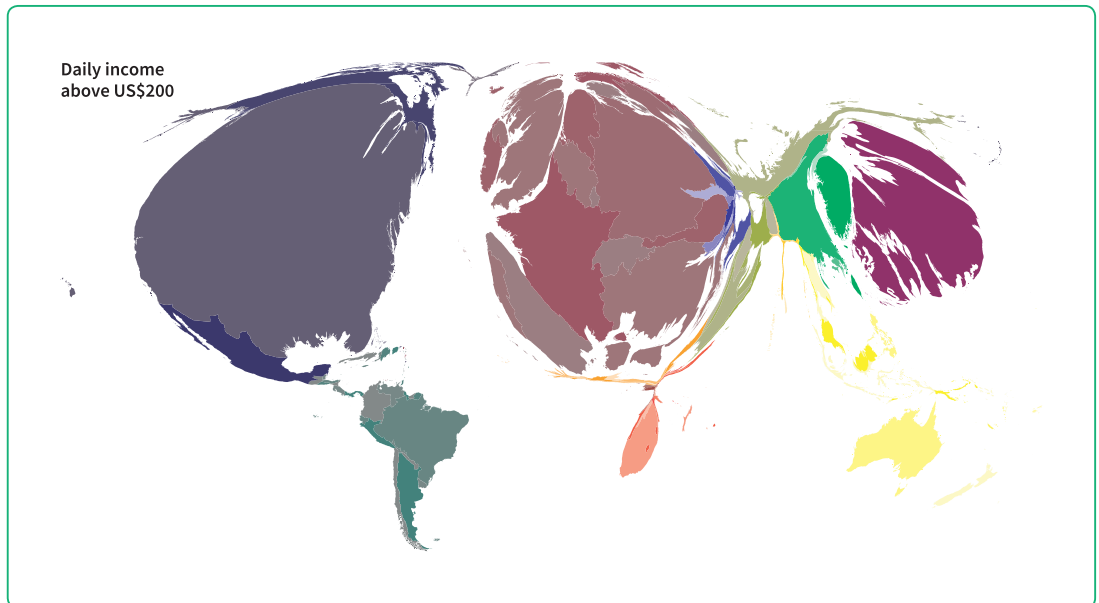
down (ILO, 2013). There has been a long-term trend towards corporate profits rising while wages fall. Income gaps between the top 10 per cent of earners and the bottom 10 per cent have widened (ibid.). However, what may be most important is that global median wealth (as a proxy for the wealth of the middle class) has decreased steadily since 2010 (Figure 9.10), highlighting that the economic recovery after the financial crisis of 2008 has, to date, been short-lived.

This global trend may persist, with a steady increase in inequality over decades to come (OECD, 2011; Piketty, 2014). This increase will continue as global economic output (and therefore income levels) is projected to continue to grow at a lower rate than return on capital (Figure 9.11). In other words, those who are dependent on income from labour for their well-being will struggle even more to create even a small asset base.

Should inequality continue to increase in this manner, even a growing middle class of



Figure 9.9 Global distribution of wealth



(Source: UNISDR with data from [www.worldmapper.org](http://www.worldmapper.org).)

**Figure 9.10** Minimum wealth of top 50%, 10% and 1% of global wealth holders (base year 2008 = 100)



(Source: Credit Suisse, 2014.)

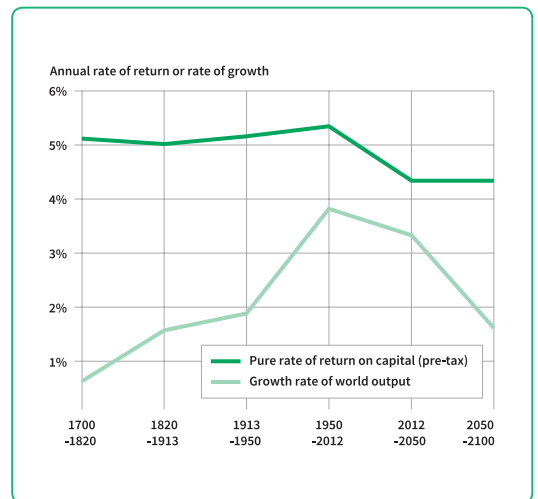
professionals will not be able to accumulate wealth in the same way as those with financial capital (Piketty, 2014).



At the household level, the middle class will continue to hold the majority of their assets in the form of property (houses) and labour (investments in education and skills). This increases their relative exposure and vulnerability to hazards disproportionately compared to those whose wealth depends on financial capital. As a result, growing income inequality will manifest itself as growing disaster risk inequality.

For example, the home of a typical middle-class family in the United States of America represents more than 50 per cent of the total value of the family's assets (Trawinski, 2013). In the absence of insurance, damage to or loss of this asset in a disaster could halve the family's wealth and constrain its ability to accumulate assets in the

**Figure 9.11** Economic growth vs income from capital



(Source: Piketty, 2014.<sup>12</sup>)

future, as its members would be forced to spend their savings on alternative accommodation. The percentage of homeowners with flood insurance in Louisiana at the time of Hurricane Katrina was as low as 7.3 per cent in some of the most severely affected counties (Kunreuther and Pauly, 2006).

If the return on capital continues to rise faster than economic growth, then inequality may become a destabilizing global force that manifests not only in increasing disaster risk but also in decreasing capacities to manage those risks. Similarly, if inequality is a challenge to global governance, it is also a challenge to disaster risk management. If successful and competitive countries are able to invest more in disaster risk reduction while unsuccessful and uncompetitive countries are unable to do so, then disaster risk inequality will continue to increase.

## Notes

---

- 1** Data from 2013. Source: UNDP Human Development Report 2014 database.
- 2** Data from 2012. Source: WHO Life Expectancy Indicators.
- 3** Data from 2012. Source: WHO Life Expectancy Indicators.
- 4** <http://www.scotland.gov.uk/Topics/Statistics/SIMD> (accessed 11 January 2015).
- 5** Maps provided to UNISDR by the National Library of Scotland and Ordnance Survey in January 2015.
- 6** <http://www.prb.org/Publications/Articles/2011/disaster-risk.aspx> (accessed 3 December 2014).
- 7** Using the Gini coefficient, World Bank data and OECD, 2011.
- 8** For the original data from the Turkish Union Survey, see <http://www.hurriyetdailynews.com/poverty-threshold-continues-to-rise-in-turkey.aspx?pageID=238&nid=53256> (accessed 11 January 2015).
- 9** <http://clp-bangladesh.org/work/overview> (accessed 3 January 2015).
- 10** [http://www.eenet.org.uk/resources/eenet\\_newsletter/eer1/page24.php](http://www.eenet.org.uk/resources/eenet_newsletter/eer1/page24.php) (accessed 11 January 2015).
- 11** <http://www.un.org/disabilities/default.asp?id=271>.
- 12** For the open source data underlying Piketty's analysis, see <http://piketty.pse.ens.fr/fr/capital21c>.

## Chapter 10

# For a few dollars more: The increasing hazard exposure of economic assets



As economic investment continues to flow to locations offering comparative advantages for capital accumulation, there will be a continuous increase in the exposure of economic assets to earthquakes, tsunamis, storm surges, floods and other hazards.

While several countries now seek to include disaster risk in their public investment planning, the limited availability of appropriate risk information and weak capacities at the local level still present serious constraints. And given the growing interconnectedness of urban systems, global supply chains and financial flows, disaster risk will become increasingly systemic.

## 10.1 Comparative advantages or contingent liabilities?

Disaster risk is rarely made explicit to investors and is often only discovered in the event of a disaster. This risk not only affects large businesses, but also impacts the national economies that receive investments, small and medium enterprises, and the labour force. Thus, hidden contingent liabilities come bundled together with the comparative advantages offered to business investors.

The Slough Trading Company Limited was founded in 1920, and in 1925 it established one of the world's first industrial estates on the western outskirts of London, United Kingdom. By providing ready-made factory buildings with art deco style offices on the street side, dedicated rail connections and its own power station, the Slough Trading Estate rapidly attracted business

investment. By 1932, high-profile companies like Citroen, Gillette, Johnson & Johnson, Mars and Berlei had set up shop on the estate, which currently accommodates 400 businesses across a wide range of sectors, including automotive, food processing, engineering, biotechnology, pharmaceuticals, logistics, information technology and telecommunications. Ninety years after its establishment, it is still Europe's largest industrial estate under single ownership.<sup>1</sup>

In many ways, the Slough Trading Estate ushered in a modern era of footloose, spatially flexible, economic and territorial development no longer constrained to specific places by the availability of raw materials, energy (especially coal), sea or canal transport, and labour. The estate prefigured a model of flexible accumulation (Harvey, 1989) in which investment was attracted to locations through a combination of objective advantages, such as *plug-and-play* factory space, purpose-built power and communications infrastructure, access to markets, and a large skilled work force, as well as through aesthetic and other intangible values. The art deco design that characterized many industrial and residential buildings in Slough during the inter-war period certainly projected an image of unashamed modernity that, 90 years ago, was a perfect fit for the ethos of this emerging model of economic development.

In today's globalized economy, countries and cities in all regions compete to attract foreign direct investment (FDI) using the same mix of objective advantages, including low labour costs, access to

**Figure 10.1** Art deco façade on the Berlei offices in Slough Trading Estate (now demolished)



(Source: <http://modernism-in-metroland.tumblr.com/ost/46923045449> accessed 11 January 2015.)

export markets, subsidized infrastructure, and intangible *soft* values such as quality of life and recreational opportunities. However, as underlined in GAR13 (UNISDR, 2013a), the level of disaster risk in those locations is rarely made explicit to investors and is often disregarded in the public investment that creates the necessary infrastructure or in the private investment that follows.

Given the predominance of private investment, the way it is regulated, incentivized and monitored largely determines the disaster risk associated with the growing hazard exposure of economic assets (UNISDR, 2013a). Many of the locations that have been highly successful in attracting investment, such as Miami (Box. 10.1), are also located in hazard-prone locations. While

**Box 10.1** Sea level risk and investment in Miami

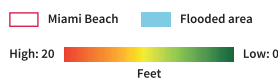
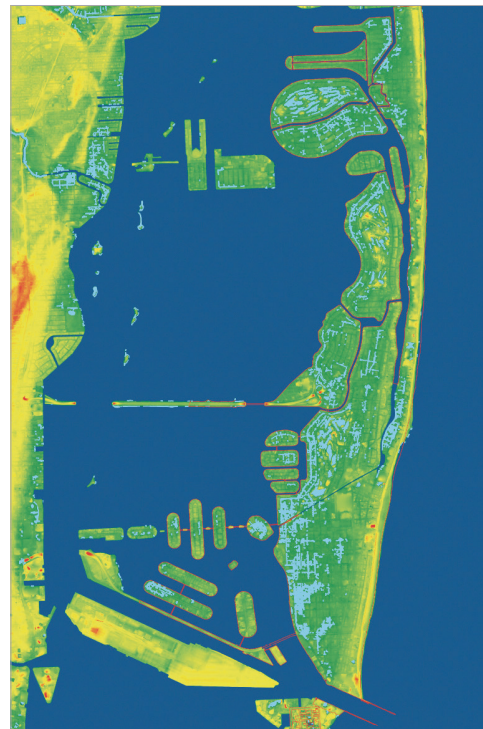
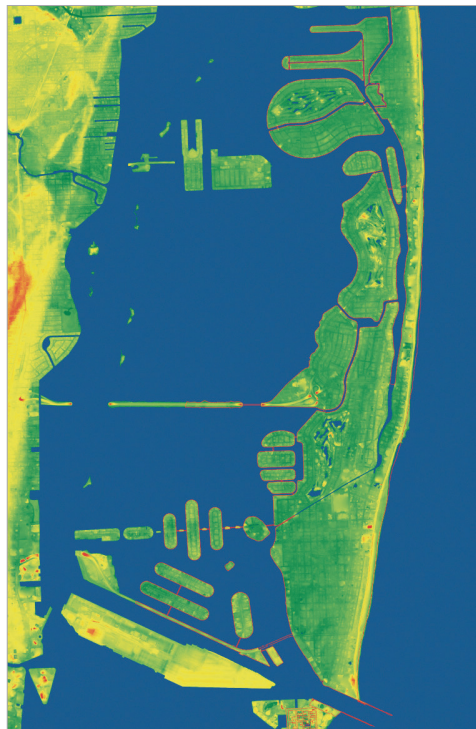
In Miami, rising sea levels and regular storm surges are already combined with exceptional geology and a weak sewage system, leading to recurrent flooding in parts of the city and contamination of drinking water supplies. In the future, further sea level rise will mean that parts of the world's busiest cruise ship port as well as the city's waterfront and the city's prime real estate will be submerged (Carter et al., 2014; WRI, 2014), as sea levels are estimated to rise by 2 feet (more than half a metre) by 2060 (WRI, 2014; Figure 10.2).



**Figure 10.2** Rising sea levels in Miami

Current sea level

Inundation footprint for sea level rise of 2 feet



(Source: Peter Harlem, Florida International University.)



Storm surges like the one experienced during Hurricane Wilma in 2005 are likely to happen more often. With only a one-foot rise in the sea level along Miami-Dade's coast, the probability of a 7-foot storm surge such as the one observed in Hurricane Wilma is expected to increase from 1 in 76 years to 1 in 21 years (WRI, 2014).

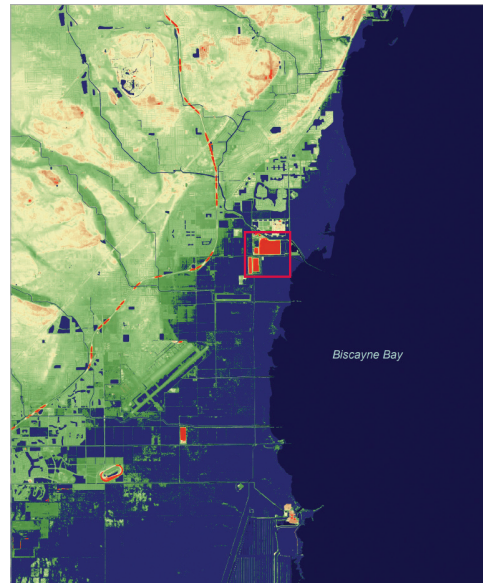
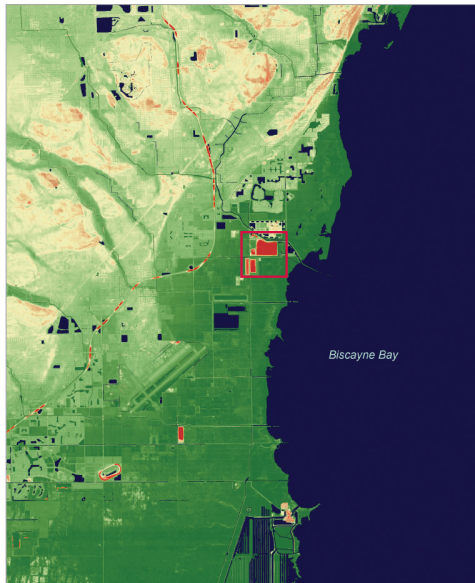
However new industrial and residential developments have no trouble finding investors and the required political and regulatory support (Bunten and Khan, 2014; Goodell, 2013).

In addition, an ageing nuclear power plant south of Miami, built in 1972 when the effects of climate change were not as well understood, could be affected by a sea level rise of just a few feet in the coming years (Figure 10.3). The construction of two new reactors was promoted by the Governor of Florida as recently as May 2014<sup>2</sup> and is being considered by the State Senate despite the fact that the plant has already experienced weather-related difficulties, notably during Hurricane Andrew in 1992 (Kopytko and Perkins, 2011; US Nuclear Regulatory Commission, 1994).

**Figure 10.3** Turkey Point Nuclear Power Plant threatened by sea level rise

Current sea level

Inundation footprint for sea level rise of 2 feet



Legend: Turkey Point nuclear power plant (red box), Flooded area (blue box)

(Source: Peter Harlem, Florida International University.)

the art deco architecture in Slough has gone largely unnoticed and unappreciated,<sup>3</sup> in Miami it has been promoted as a core lifestyle value to project *coolness* and attract investment. Given that the imperative of earning *a few dollars more* often outweighs considerations of sustainability, this generates increasing levels of intensive disaster risk.

This model of economic and territorial development increases the exposure of global capital stock and economic flows to hazards such as earthquakes, tsunamis, floods and tropical cyclones. But the resulting disaster risk is often only revealed to investors when a major disaster occurs, as companies like Toyota, Honda, Nissan, Texas Instruments and Hewlett-Packard learned to their cost following the 2011 floods in Thailand

(Airmic Technical, 2013). However, this risk does not affect businesses alone. It also impacts the national economies that receive investments (particularly when these are small and undiversified economies as in the case of SIDS), the small and medium enterprise sector that services larger businesses, and the labour force that may be affected either directly or indirectly (UNISDR, 2013a). In otherwise attractive but hazard-prone locations, hidden contingent liabilities come bundled together with the comparative advantages offered to business investors.

### Mispricing risk

Any risk offers opportunity and gain at the same time as it threatens to cause loss and negative impacts. The values assigned to disaster risk—and hence the way it is priced into decisions—always reflect a trade-off between opportunity and threat in the context of available information and the norms and rules societies use to socialize the gains or cover the costs. As such, there is a big difference between those who voluntarily bear risk in pursuit of opportunity and those who have to bear the costs involuntarily.

Currently, the absence of accountability in most societies in the face of both neglectful and deliberate risk generation means that consequences are rarely attributed to the decisions that generated the risks. At the same time, this lack of attribution creates perverse incentives for continued risk-generating behaviour. In effect, those who gain from risk rarely bear the costs. These costs are borne involuntarily by other social sectors and territories or transferred to the *commons*, where, as Chapter 12 highlights, they accumulate as unaccounted debt which neither the planet nor global society can continue to absorb.

There is also a lack of counterfactual evidence. At present, the business, economic, political and social case for disaster risk management still has to rely heavily on anecdotal substantiation and proxy indicators to prove its benefits for

economic growth, human and social welfare, and sustainable development. At the same time, the costs of the everyday and extensive risks faced by low-income households and small businesses are even less clearly understood than the costs of intensive risks. As a result, disaster risk continues to be mispriced at all levels: by small business owners, low-income households and local governments as well as large corporations, investors, high-income communities and national governments.

### Excessive discounting of risk

In general, opportunities for short-term capital accumulation continue to outweigh concerns about future sustainability, resulting in a massive discounting of all future risk, including disaster risk. The inadequate pricing of disaster risk and of broader externalities in economic activity means that disaster risk is discounted excessively in order to maximize short-term gains (UNISDR, 2013a). Moreover, there is no accountability for investments that generate disaster risks and are made by managers of large funds, banks, businesses and insurers, increasingly in cooperation with local and national governments (*ibid.*).

When risk management measures (including regulation and public investment) are seen to be applied inconsistently or incoherently, they can also act as disincentives (Burby, 2006; Bagstad et al., 2007). Examples can be found where local or national policies to attract investment and stimulate economic growth generate new risk or exacerbate existing risk, thereby directly contradicting policies for disaster risk reduction and undermining effective risk management, or vice versa (UNISDR, 2013a; Stehr, 2006; Berke et al., 2014; Burby et al., 1999).

In many ways, the incentives for the financial sector to misprice disaster risk or other externalities outweigh any incentive not to do so. In this sector, profitability is based on volatility, while stability and security make it harder to generate

short-term gains (UNISDR, 2013a). As such, the manner in which the sector contributes to risk accumulation is part of its very nature.

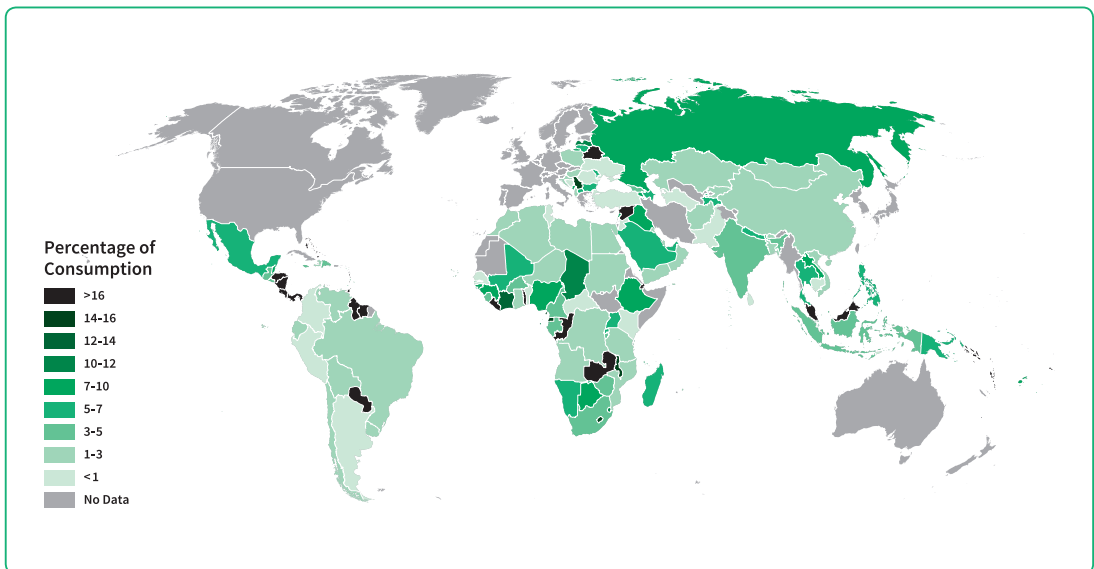
This conundrum is compounded by the fact that the current measures of success for both private actors and governments are not compatible with goals such as equity and biocapacity. Where short-term profit and return on investment are key performance indicators, the risk generated by high-yielding investments elsewhere in society is ignored or discounted. If the main metric for success is GDP growth, questions of social equity or the growing gap between the ecological footprint and biocapacity recede into the background. Instead, this concern for economic growth often skews priorities, shifting government attention from serving its citizens to servicing its debt. At the end of 2010, outstanding sovereign debt totalled US\$41 trillion globally (UNEP and Global Footprint Network, 2012), severely undermining the credit ratings of many countries (ibid.) and thus jeopardizing public spending and downward accountability.

### Avoiding regulation

In addition, tax havens and financial instruments that allow individuals, companies and governments to channel illicit funds or divert legal income to avoid levies, fees and taxes are beyond the reach of most forms of regulation. The scale of illegal financial flows and corruption is significant. The IMF estimates that offshore financial centres with limited jurisdiction held around US\$5 trillion in assets and liabilities at the end of 2009, while in comparison the cross-border assets and liabilities of the United States, France and Germany combined amount to US\$8 trillion (Gonzalez and Schipke, 2011). Other estimates of the extent to which multinational corporations use offshore financial centres for banking assets and foreign investment run as high as US\$18 trillion, which is roughly equivalent to a quarter of the world's GDP (Shaxson, 2012). Recent data shows that illicit financial flows reach significant levels in a number of countries (Figure 10.4).

The 130<sup>th</sup> Assembly of the Inter-Parliamentary Union unanimously adopted a resolution on risk-resilient development in March 2014 which

Figure 10.4 Illegal financial flows as a percentage of consumption



(Source: GFI, 2014.)

explicitly called upon parliamentarians to make “combating corruption and illegal financial flows a priority, as these significantly affect the mobilization and proper allocation of resources”.<sup>4</sup>

## 10.2 Risk spills

**The concentration of economic assets and activities in hazard-prone areas, coupled with increasing economic connectivity, increases the complexity of risks.**

At the same time, as globally connected economies depend on a range of increasingly complex interlinked and dependent systems, disaster losses in one sector now tend to spill over into others, causing cascading and concatenated impacts. The concentration of economic assets and activities in hazard-prone areas goes hand in hand with increasing economic connectivity, the complexity of value chains, and therefore the increasing complexity of risks. Due to the global integration of value and supply chains, the effects of relatively localized disasters can spill over a country’s borders into regional and global markets, creating new risks and increasing the vulnerability of other national economies to interruptions and volatility (UNISDR, 2013a). For example, following the Great East Japan Earthquake, Merck had to stop production in the only factory producing its Xirallic pigment, which is used in automotive paint (SCOR, 2013); this impact rippled through supply chains to affect the automotive industry in other regions.

Complex and interconnected risks have been defined using a range of terms, such as hyper-risks (Beck, 2009; Ray-Bennett et al., 2014), cascading effects (McGee et al., 2014), cascading failures (Buzna et al., 2007), cascading disasters (Haavisto et al., 2013) and synchronous failures (Kent, 2011). Such terms are usually employed when critical infrastructure and systems break down during disasters, as the terms give expression to the fact

that direct damage to and loss of physical assets create additional losses and downstream impacts, possibly triggering further direct losses in new disasters. Usually, these system breakdowns occur across sectors, geographies and different time scales and present a major challenge for the disaster risk reduction sector (OECD, 2014a).

The rapid evolution of information and communications technology, which is a key factor in competitiveness (Morris, 2010; Acemoglu and Robinson, 2012; WEF, 2013), has also become a driver of the increased social and territorial concentration of economic activity as well as risks. For example, 95 per cent of global equity market capitalization is concentrated in only 24 cities, making the financial services sector potentially more vulnerable than other, less concentrated sectors (Dobbs and Reemes, 2012). While this sector depends less on transport infrastructure such as ports and highways, it is highly vulnerable to interruptions of energy supply for its electronic transactions and on server capacity and telecommunications for data transmission. In response to this risk, the investment house Black Rock, which runs a platform that manages more than US\$13 trillion in assets, has built multiple redundancies into their server capacity, cooling systems and power supply, and is able to switch service and operations between the East and West Coast of the US in the case of disasters.<sup>5</sup>

## 10.3 Addressing risks to public and private investment in the HFA

**The way in which countries addressed rising exposure levels as part of the HFA has not been assessed with consistent output indicators at a global scale. As a result, there is little understanding of the level of progress, and most innovation seems to have occurred outside of the disaster risk management sector.**

While the HFA does not explicitly address the challenge of increasing exposure through economic



concentration and value creation in hazard-prone areas, Priority for Action 4 suggests a number of key activities that indirectly relate to *managing risks in the productive sectors and economic development planning*, notably via infrastructure protection and public-private partnerships (Box 10.2).

As in other areas, the absence of consistent output indicators makes it difficult to assess progress against these key activities systematically, and what little innovation can be identified has occurred largely outside of the disaster risk management sector and has not been captured in HFA progress reports.

### Infrastructure and critical facilities

Data on progress in ensuring that infrastructure and critical facilities are designed or built in a way that reduces disaster risk is hard to find. Major infrastructure projects normally incorporate hazard resistance specifications into their design and construction. However, as Japan discovered to its cost after the Great East Japan Earthquake and Tsunami, these specifications may not be sufficient to protect against the most severe events. In this way, building and safety codes can create a false sense of security and actually encourage greater investment in hazard-exposed areas, contributing to increased intensive risks (Halle-gatte et al., 2010).

Progress reported by governments in assessing the disaster risks associated with major development projects, in particular large infrastructure investments, point to limited success in this area (Figure 10.5).

While major infrastructure projects commissioned to multinational construction companies are likely to be built to hazard-resistant standards, the increasing damage to housing, local infrastructure, schools and health facilities in extensive disasters provides counterfactual evidence that land-use planning and building authorities in many low and middle-income countries do not apply policies, norms and standards in practice (UNISDR, 2013a). In their national HFA progress reports, many countries highlight the need to review and improve hazard resistance codes and standards on a regular basis. However, Bangladesh reports a lack of skills and human resources to monitor compliance and exercise enforcement, while Argentina reports disincentives to compliance due to real estate speculation and corruption, and Nepal highlights stark discrepancies between mandatory implementation and the actual adoption of codes.

Latin American countries such as Peru, Costa Rica, Guatemala and Panama have made sustained efforts to include disaster risk as a criterion in the planning and evaluation of public investment projects (Lavell, 2014; GIZ, 2012; UNISDR, 2011a). While these processes are

#### Box 10.2 Key activities related to economic development in the HFA

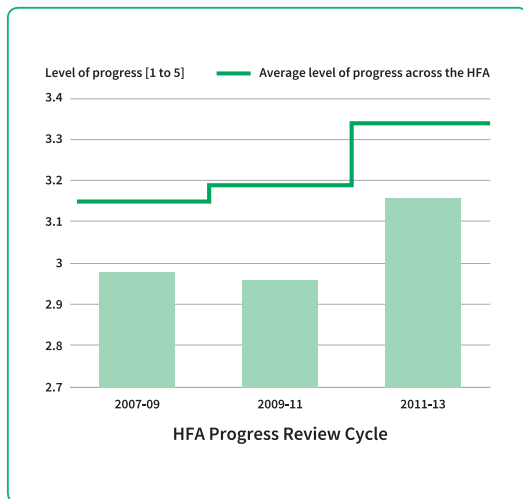
*(ii) Social and economic development practices*

*(f) Protect and strengthen critical public facilities and physical infrastructure [...] through proper design, retrofitting and re-building, in order to render them adequately resilient to hazards.*

*(iii) Land-use planning and other technical measures*

*(o) Mainstream disaster risk considerations into planning procedures for major infrastructure projects, including the criteria for design, approval and implementation of such projects and considerations based on social, economic and environmental impact assessments.*

**Figure 10.5** Progress in assessing disaster risk impacts of major development projects



(Source: UNISDR with data from the HFA Monitor.)

challenged by factors such as the availability of appropriate risk information and weak capacities at the local level, they certainly represent an innovative initiative to address risk systematically in public infrastructure and facilities.

In certain sectors, there seems to be evidence of progress. For example, 77 countries reported on

the implementation of activities to make hospitals safer and better prepared for emergencies and disasters. More than 50 of the 195 WHO Member States in the Americas, South-East Asia, Central Asia, the Eastern Mediterranean Region and Europe have implemented actions under the Safer Hospitals initiative, and a large proportion of them have adopted safer hospitals policies and programmes.<sup>6</sup> Twenty countries have formally adopted a national policy on safe hospitals and 17 have formally established national programs to this end. By the end of 2012, 32 countries in the Americas region had already adopted the Safe Hospitals initiative and started assessing their hospitals using the Hospital Safety Index (HSI). As of April 2013, the WHO reported that more than 1,800 hospitals had been assessed using this tool.

In many countries, there is also evidence of investments to strengthen or retrofit critical infrastructure to reduce disaster risk as well as to increase budget allocations for this purpose (Box 10.3). Different examples have demonstrated that investments in disaster risk reduction can reduce losses after major disasters, particularly in countries that have the financial capacity to make those investments.

**Box 10.3** Risk reduction investments in Germany and Mexico

In hydrological terms, the 2013 floods in Germany were even more severe than those observed in 2002 (Merz et al., 2014). However, in some cities the construction of flood protections played a key role in reducing losses. In 2002, Dresden and the surrounding areas along the Elbe River experienced losses of nearly US\$300 million in residential buildings alone (Thieken, 2009). Following the disaster, the Dresden authorities developed hazard maps for 20 and 100-year floods, implemented flood protection measures against 500-year floods and extended floodplains. As a result, the city managed to avoid severe losses in the 2013 spring floods. “Water volumes were managed thanks to a combination of various installations that protected the historic city centre” (Zurich Insurance, 2014), making the city a good example of disaster risk management.



Major investments in flood risk reduction were made in the State of Tabasco, Mexico, after devastating floods in 2007. As a result, a flood of the same magnitude in 2010 damaged and destroyed only a quarter of the number of houses affected in 2007. The overall estimated cost of damage and losses was reduced from more than US\$2.8 billion in 2007 to only US\$569 million in 2010. The reduction in loss and damage was equivalent to 7.8 per cent of this Mexican state’s GDP.<sup>7</sup>

There is also evidence of major investments in retrofitting critical facilities such as schools in a number of countries on the basis of hazard and risk assessments and in the context of internationally supported projects (Box 10.4).

In addition, countries like Japan are now using a risk-layered approach to disaster risk management in order to inform coastal development (Box 10.5)

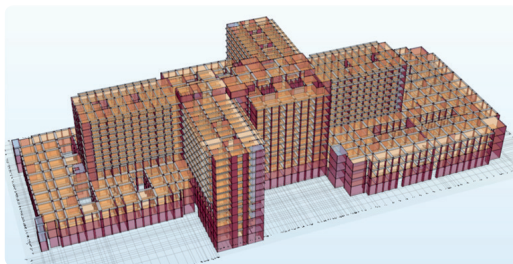
**Box 10.4** Application of seismic risk assessments for retrofitting public infrastructure in Istanbul

A series of hazard and risk assessments, including a micro-zonation study of earthquake hazard and risk assessment conducted by the Istanbul Metropolitan Municipality in cooperation with the Japan International Cooperation Agency (JICA), has informed investments in seismic risk reduction in Istanbul. These assessments were prompted by the devastating İzmit-Kocaeli and Düzce earthquakes in 1999, which resulted in more than 17,000 lost lives and around US\$20 billion in direct losses. The assessment initiative therefore had the full support of the municipal authorities and the public.



The results of these assessments were adopted for the Istanbul Metropolitan Municipality's disaster risk management master plan for the city and applied to the Istanbul Seismic Risk Mitigation and Emergency Preparedness Project (ISMEP). Conceived as a 14-year project, ISMEP started in 2006 with a budget of EUR 1.5 billion. By 2014, a total of 1,162 public buildings, including 726 schools, 39 hospitals (Figure 10.6), 59 health centres, and 80 other public facilities identified as the highest priority, were renovated or retrofitted, and 218 schools considered unsuitable for retrofitting (based on cost-benefit analyses) were reconstructed.<sup>8</sup>

**Figure 10.6** Structural model of Marmara University Training and Research Hospital Retrofitting, Restoration, and Reinforcement Project to finish in 2014



(Source: Government of Istanbul.<sup>9</sup>)

ISMEP and its evolution over time show how hazard and risk assessments can help a government understand the severity of risks and trigger on-the-ground risk reduction activities. However, seismic risk in Istanbul continues to increase from new construction in response to population growth and internal migration and as a result of the enforcement challenges associated with land-use plans and construction policies (GFDRR, 2014c). Retrofitting existing structures does not solve the problem of new risk created on a daily basis by urbanization.

**Sendai City**

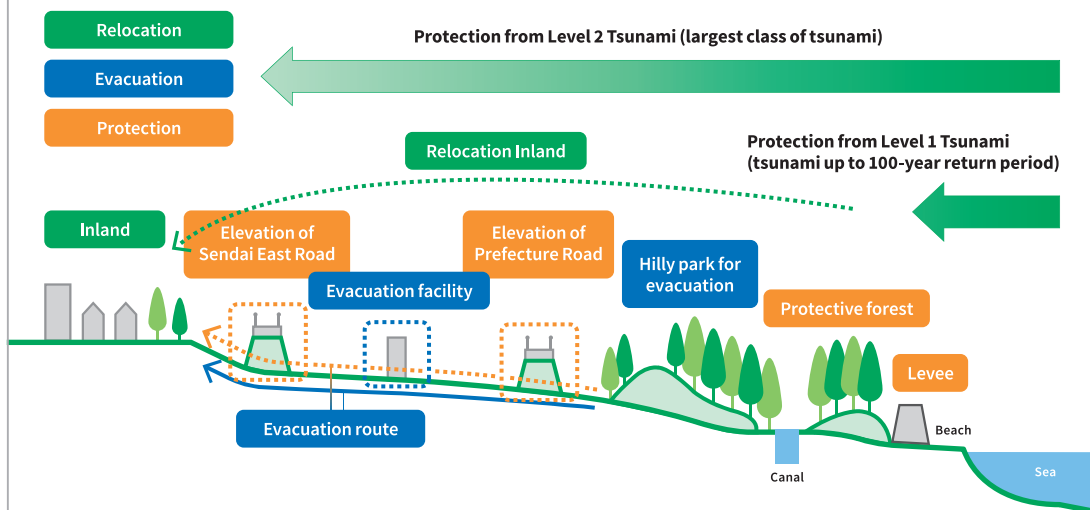
**Box 10.5** Layered disaster risk management strategies

The Great East Japan Earthquake in March 2011 was a hazard of unprecedented scale, with a magnitude 9.0 earthquake and subsequent tsunami affecting large areas of the Tōhoku Region. Prior to this event, risk assessments of this region had been based on limited historical data on earthquakes and tsunamis and therefore failed to predict the intensity of the earthquake and the height and extent of the tsunami. The tsunami waves flooded areas that were supposed to be protected by sea walls, and in several places the false sense of security provided by the hazard maps conspired against timely evacuation and response.



The failure of the risk reduction strategies in place in Tōhoku prompted the formation of a technical committee within the Central Disaster Management Council. A report issued by this committee in September 2011 ushered in a risk-layering approach to tsunami risk management (Government of Japan, 2011) which was swiftly translated into law, the *Tsunami DRR Regional Development Act* of December 2011.<sup>10</sup> This act is already being enforced in several regions, including Sendai City (see Figure 10.7).

**Figure 10.7** Sendai City's tsunami preparedness and response strategy



(Source: Sendai City, 2014 [adapted by UNISDR].)

The Level 1 tsunami management strategy targets the more extensive layer of risk (higher probability and lower expected loss), while the Level 2 strategy is designed for layers of intensive risk (lower probability and higher expected loss). Level 1 focuses on structural measures such as levees and protective forests, while Level 2 combines structural measures with other risk management strategies, with evacuation planning at the core (Table 10.1).

**Table 10.1** Level 1 and Level 2 tsunami management strategies

	Intensity	Objectives	Means of implementation
Level 1 Tsunami	Return period of 10-100 years	<ul style="list-style-type: none"> <li>· To protect human lives</li> <li>· To protect economic assets and activities</li> </ul>	<ul style="list-style-type: none"> <li>· Structural measures such as seawalls and levees</li> </ul>
Level 2 Tsunami	Return period of 100-1,000 years	<ul style="list-style-type: none"> <li>· To protect human lives</li> <li>· To reduce economic loss</li> <li>· To avoid causing cascading impacts</li> <li>· To improve resilience</li> </ul>	<ul style="list-style-type: none"> <li>· Structural measures such as seawalls and levees</li> <li>· Evacuation planning</li> </ul>

(Source: Government of Japan, 2011 [adapted by UNISDR].)





### Risk-sensitive business investment

The role of the private sector in both contributing to and managing disaster risk was never fully spelled out in the HFA. However, under Priority for Action 4, the HFA did include a key activity relating to the private sector:

*(l) Promote the establishment of public-private partnerships to better engage the private sector in disaster risk reduction activities; encourage the private sector to foster a culture of disaster prevention, putting greater emphasis on, and allocating resources to, pre-disaster activities such as risk assessments and early warning systems.*

Unfortunately, this activity was not included in the core indicators, meaning that its achievement has not been assessed using the HFA Monitor. From HFA progress reports, however, it has become clear that businesses, investors and insurers have not been given a clear or explicit role in the disaster risk reduction sector at the national level (UNISDR, 2013b). Very few multi-sector national platforms or committees have private-sector representation.

Evidence that private companies and investors do take disaster risk into account when deciding where to invest is now starting to emerge, particularly after the Japan and Thailand disasters of 2011 (UNISDR, 2013a; Ingirige et al., 2014).

### Risk sensitive business



However, at the international level, it was not until 2010 that the Private Sector Advisory Group for Disaster Risk Reduction was created<sup>11</sup> and even more recently that initiatives to facilitate risk-sensitive business investment<sup>12</sup> or the encoding of disaster risks in the financial sector have started to take shape.<sup>13</sup> These and other initiatives now indicate a growing concern in the private sector that increasing disaster risk threatens the sustainability of their investments.

Although the UN General Assembly had requested a strengthening of responses to complex emergencies as early as 1999,<sup>14</sup> the HFA provided little guidance or focus on the issue of complex and emerging risks. Just one key activity in Priority for Action 2 made reference to this topic:

*(o) Research, analyse and report on long-term changes and emerging issues that might increase vulnerabilities and risks or the capacity of authorities and communities to respond to disasters.*

The HFA core indicators did not make reference to emerging or long-term and complex risks, meaning that there is no clear sense of how much progress has been made in this area. In order to shape policy responses, some countries are now beginning to conduct exercises to identify emerging risks that have not been modelled (Kent, 2011).

For example, the UK uses the *reasonable worst-case scenario* methodology to identify emerging risks and potential widespread emergencies, including nuclear crises such as the one at Fukushima Daiichi in Japan in 2011 (Government of the United Kingdom, 2011). The method was reviewed as recently as July 2014 in order to identify areas for improvement as part of the UK national risk assessment process.<sup>15</sup> However, despite the existence of new approaches to identifying emerging risks, such processes are still in their infancy.

## 10.4 Planning from the future?

**As risk drivers are highly connected, dealing with risk in a hazard-specific manner means disregarding much of what may not have happened yet but will surely happen in the future.**

In 2011, Myanmar approved a law setting up special economic zones (SEZs) with incentives

that include a five-year tax holiday, 50 per cent income tax relief for five years on items exported overseas and on reinvested profits from overseas exports, a five-year exemption from customs duties on approved products, and the granting of 30-year land leases.

Myanmar has an AAL of US\$2 billion, which is mainly associated with tropical cyclones, floods and earthquakes. In 2008, Tropical Cyclone Nargis caused major devastation in areas not far from where the Thilawa Special Economic Zone (Figure 10.8) is being planned as a home to textile, manufacturing and high-tech industries as well as a deep-sea port.

Although an environmental impact assessment was carried out as part of the planning of the SEZ, the potential disaster risks to the zone and the businesses that invest there are not explicitly described (Myanmar and Japan Consortium for Thilawa Special Economic Zone Development Project, 2013). It seems that the lessons from the Chao Phraya River floods in Thailand in 2011 may have not been fully internalized by potential investors.<sup>16</sup>

If governments, businesses and investors continue to ignore or to discount the consequences of further increasing the hazard exposure of the global economy, the consequences are likely to be more shocks of the kind that occurred in Japan and Thailand in 2011. For example, if the global economy were to grow at an average of 4 per cent per year for the next thirty years and the distribution of capital stock between hazard-exposed and non-hazard-exposed areas remains unchanged, by 2040 the volume of hazard-exposed capital stock and thus of intensive disaster risk would approximately double. If hazard and vulnerability also increase due to climate change and other risk drivers, then the risk could increase exponentially.

Most risk assessments still tend to be based on linear models with limited capacity to identify

**Figure 10.8** Location of the Thilawa Special Economic Zone



(Source: UNISDR with data from UNOCHA, 2013.)

and manage complex and interconnected risks (OECD, 2014a). Despite the concatenated nature of many of the risk drivers, such assessments deal with hazard-specific risk in a way that ignores how different drivers affect each other and how impacts triggered by one hazard can prompt further impacts associated with another (Shimizu and Clark, 2014). This means disregarding much of what may not have happened yet but will surely happen in the future.

While there is certainly momentum in the global private sector to begin assessing risk to supply chains when making investment decisions, it is still unclear whether these efforts will be sufficient to manage the risks from increasing exposure due to economic concentration and investment. And it is even less clear whether the countries competing to attract foreign direct investment will begin to use effective disaster

risk management as a competitive advantage instead of failing to disclose risks to potential investors. The temptation to make *a few dollars more* often continues to take precedence over long-term planning and sustainability in areas with high levels of hazard exposure.

## Notes

---

- 1 <http://www.segro.com/Slough/About> (accessed 11 January 2015).
- 2 <http://www.world-nuclear-news.org/NN-Turkey-Point-expansion-gets-Florida-state-approval-1405141.html> (accessed 11 January 2015).
- 3 <http://www.c20society.org.uk/news/slough-town-hall-listing-refused-dcms-overturns-english-heritages-advice-again> (accessed 11 January 2015).
- 4 <http://www.ipu.org/conf-e/130/Res-2.htm>.
- 5 <http://www.datacenterdynamics.com/focus/archive/2014/03/blackrock-measuring-risk-data-center> (accessed 11 January 2015).
- 6 Progress presented at the 4<sup>th</sup> Session of the Global Platform for Disaster Risk Reduction: <http://www.preventionweb.net/globalplatform/2013/programme/sideevent/view/498>.
- 7 Figures from presentation given by Salvador Pérez Maldonado, Ministry of Finance, Mexico, at the first session of the Preparatory Committee of the World Conference on Disaster Risk Reduction in Geneva, July 2014.
- 8 Personal communication and figures from the Monitoring and Evaluation Department of the Istanbul Governorship, 26 November 2014.
- 9 Personal communication and figures from Kazim Gokhan Elgin, Director of the Monitoring and Evaluation Department of the Istanbul Governorship, 26 November 2014.
- 10 <http://www.mlit.go.jp/sogoseisaku/point/tsunamibousai.html>.
- 11 [www.unisdr.org/partners/private-sector](http://www.unisdr.org/partners/private-sector).
- 12 [www.preventionweb.net/rise/home](http://www.preventionweb.net/rise/home).
- 13 [www.un.org/climatechange/summit/action-areas/resilience-1-in-100-initiative/](http://www.un.org/climatechange/summit/action-areas/resilience-1-in-100-initiative/).
- 14 UN General Assembly resolution 46/182.
- 15 For more information on the national risk assessment process in the UK, see <https://www.gov.uk/risk-assessment-how-the-risk-of-emergencies-in-the-uk-is-assessed> (accessed 11 January 2015).
- 16 <http://myanmarthilawa.com/content/three-japanese-industrial-biggies-will-launch-special-economic-zone-myanmar> (accessed 11 January 2015).

## Chapter 11

# Segregated urban disaster risk



As urbanization mirrors economic growth, it often concentrates risk in hazard-exposed locations. In most low and middle-income countries it is also usually characterized by unequal access to urban space, infrastructure, services and security. This generates new patterns of both extensive and intensive disaster risk, particularly in informal settlements with deficient or non-existent infrastructure and social protection, and high levels of environmental degradation.

While the HFA has provided ample space for countries to engage in risk-sensitive urban development and some success stories have emerged, the rapid expansion of urban populations and weakly regulated investment flows remain a key challenge, particularly in low and middle-income countries.

## 11.1 *Blade Runner* and the future city

Speculative urban capital is invested in modern enclaves, while the low-income majority has access only to informal or sub-standard urbanization. The concentration of investment in urban centres drives intensive risk, while high levels of urban income inequality shape patterns of extensive risk.

*Blade Runner* is a neo-noir science fiction movie made in 1982 and set in a fictional Los Angeles in 2019. The movie painted a horrific portrait of future urban settings, with a powerful elite living in gleaming towers while the majority live at ground level in a toxic, polluted, dangerous and collapsed environment. Science fiction is just that: fiction. It is highly unlikely that *Blade Runner* will provide an accurate portrayal of life in Los Angeles—or that of any other major metropolitan area, for that matter—in 2019. However, reality does tend to imitate art. Current trends in

Figure 11.1 The 2019 Los Angeles cityscape as imagined in *Blade Runner*



(Source: <http://img.4plebs.org/boards/tg/image/1397/22/1397229362415.jpg>.)

urban development point to futures that resemble elements of the imagined world of *Blade Runner* (Figure 11.1).

For example, a number of larger cities in sub-Saharan Africa are currently being re-imagined as global cities that could become magnets for investment (Box 11.1). Described as smart cities

### Box 11.1 Urban futures in Africa

Over the last 5 to 6 years, new visions for urban futures have been driving plans for the development of several African cities. Major projects within existing urban centres<sup>2</sup> or entirely new satellite cities are inspired by high-profile city investments in Dubai, London and Singapore, with significant private-sector involvement. These developments and commercial centres include Hope City, a US\$10 billion development to be built outside Accra in Ghana, and Tatu City, a development planned on coffee-producing land outside Nairobi (Figure 11.2). Such new hypermodern cityscapes would enable those who live and work in them to largely avoid the dysfunctional infrastructure, insecurity and poverty that characterizes many existing urban areas, echoing some of the ideas put forward for a new generation of *charter* cities.<sup>3</sup>

At present, while these new plans have created interest for developers and investors, many have been stalled by disputes and court cases related to land acquisition, financing and resettlement. However, the benefits to the urban population currently living in informal settlements in prime locations near urban centres are unclear.

**Figure 11.2** Hope City, Accra, and Tatu City, Nairobi



**Hope City, Accra**



(Source: Watson, 2014.)

**Tatu City, Nairobi**



A more likely scenario is the emergence of new informal settlements outside the new cities. Public investment in these new projects may leave less cash for basic infrastructure and services and could accelerate further social and spatial segregation.

(Source: Watson, 2014.)

and eco-cities, these plans promise to modernize African cities and turn them into gateways for international investment. The need to attract investment is without question. However, it is unclear how these plans will benefit the urban population living in informal settlements, below the poverty line and with minimal access to urban services (Watson, 2014).

### **Economic growth and intensive disaster risk**

Economic growth and urbanization go hand in hand. In general, the countries with the highest GDP per capita are those with the largest proportion of their population living in cities (Satterthwaite and Mitlin, 2014; Figure 11.3). In low and middle-income countries, rapid urbanization is generally associated with rapid economic growth (IPCC, 2014).

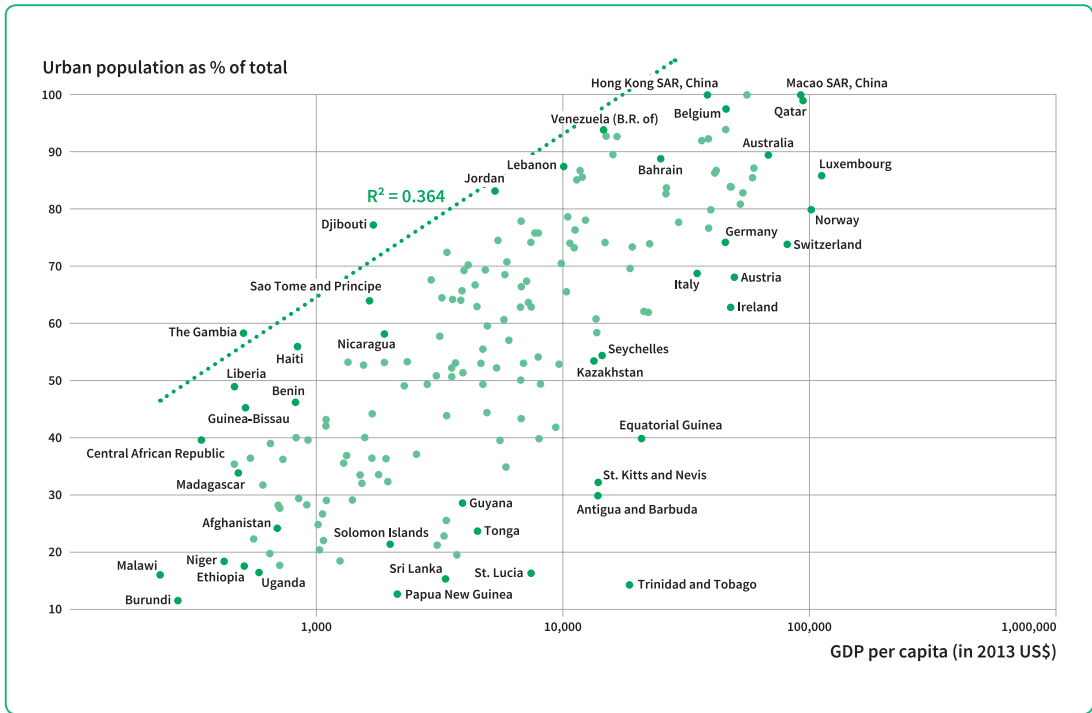
As such, urban growth accompanies global investment flows and increases the value of exposed assets in hazard-exposed areas, such as

cyclone and tsunami-prone coastlines and river basins. A recent risk analysis of 616 major metropolitan areas comprising 1.7 billion people (nearly 25 per cent of the world's total population) and approximately half of global GDP found that flood risk threatens more people than any other hazard (Swiss Re, 2014b). River flooding poses a threat to over 379 million urban residents, while earthquake and strong winds could potentially affect 283 million and 157 million, respectively (UN-Habitat, 2014).

This exposes whole cities and city regions to intensive hazards (UNISDR, 2011a; 2013a). As highlighted in Chapter 10, disaster risk is rarely taken into account in investment decisions, while rapid urban development can overwhelm the capacity of city governments to manage growth. For example, amongst the 611 cities with over 750,000 inhabitants in 2010, 47 had populations that had grown twentyfold since 1960 and 120 had populations that had grown more than



**Figure 11.3** Urban population (percentage of total) versus GDP per capita



(Source: UNISDR with data from the World Bank.)

tenfold (IPCC, 2014). Many city governments in low and middle-income countries are no longer in full control of urban development (ibid.).

**Urban segregation, inequality and extensive disaster risk**

Capital has always flowed into cities to provide the housing, services and infrastructure required to support production, consumption and government. However, urban development has become an increasingly important circuit for capital accumulation *per se*. Since the 1970s, more capital has flowed into urban development than into any productive sector (Harvey, 1985). Speculative urban development has therefore become fertile ground for both the generation and the transfer of disaster risks (UNISDR, 2013a).

Rapidly expanding city regions also generate their own risks, as landscapes and ecosystems are degraded and poverty and inequality shape

new extensive riskscapes. The larger populations and higher population density in cities not only mean that larger numbers of people are exposed to hazards, but also that the characteristics of the ecological system or environment are changed, thereby potentially increasing the level of disaster risk (Donner and Rodriguez, 2008).

For example, low-density urban expansion is a mechanism that directly or indirectly contributes to increased disaster risk. Expansion of the area of paved and impermeable surfaces increases peak run-off in storms and therefore magnifies flood hazard. Much of the speculative development for middle-income households reproduces inefficient suburban layouts (Box. 11.2), which waste the available land and energy and are ultimately unsustainable. Expanding cities may also exhaust resources such as water in the surrounding regions and contribute to the degradation of biodiversity and ecosystems (IPCC, 2014). Finally,

For any given set of social and economic requirements, there is always an optimum urban layout. Different urban layouts have vastly different percentages of land utilization and unit circulation lengths (Caminos and Goethert, 1978). This affects both the initial cost of urbanization as well as its future sustainability. Given that the costs of circulation and storm drainage are normally five times the cost of electricity and street lighting and 18 times the cost of water supply, adopting an efficient urban layout directly influences the local government's capacity to provide and maintain this basic element of flood risk-reducing infrastructure (ibid.).

Studies have found that the cost of infrastructure networks per hectare, including storm drainage in a typical modern suburban layout with square plots (see Figure 11.4), is approximately double the cost of an efficient grid layout with rectangular plots. At the same time, the proportion of land required for roads in the suburban layout is 38 per cent, compared to 21 per cent in the grid layout. Thus the suburban layout nearly doubles the area of impermeable paved surfaces, which in turn has critical implications for storm run-off. The length of roads per hectare in the suburban layout is approximately double that in the grid layout, meaning that services such as waste disposal and product delivery have to travel twice the distance to achieve the same result, increasing both costs and carbon emissions. In addition, the wasteful use of land means that there is less safe, well-located land that could be made available for low-income housing.

**Figure 11.4** Urban layouts

Grid layout with rectangular plots



(Source: Google Earth.)

Suburban layout with square plots



The implication is that an efficient layout reduces the cost of land per inhabitant by making more efficient use of that land. It also dramatically lowers the cost of installing and maintaining infrastructure, particularly storm drainage, which has a critical impact on the capacity of local governments and utility providers to provide such infrastructure. Moreover, efficient layouts decrease the impermeable paved area, mitigating flood hazard, and they shorten the distance that vehicles have to travel to provide basic services. Unfortunately, the influence of urban layout on these factors is too often ignored, even in low-income countries. This increases costs for both residents and their local governments, reduces sustainability, increases flood risks and contributes to climate change.

sprawling urban expansion results in major additional costs: the cost of providing utilities and public services can increase by 10-30 per cent, while costs for transport and travel can increase by up to 50 per cent (Global Commission on the Economy and Climate, 2014).

The combination of speculative urban development and weak regulatory capacity discussed in GAR13 (UNISDR, 2013a) leads to an increasingly social and spatial segregation of risk in cities, in particular in low and middle-income countries. Such conditions can contribute to the proliferation of other shocks and stresses, such as crime, high youth unemployment and political instability, all of which exacerbate vulnerabilities and social tensions. What results is a vicious cycle of risk generation (UN-Habitat, 2014a).

This problem takes a number of different forms. The apartheid laws of South Africa were an extreme case of large-scale, government-sanctioned spatial segregation. However, other cases reveal more subtle forms of segregation: One example is the Brazilian government's destruction of *favelas* in the 1960s, when inhabitants were removed to other segregated locations. On a smaller scale, more than 2,000 low-income families were evicted from high and middle-income residential areas in Santiago, Chile, between 1979 and 1985 with the stated objective of creating neighbourhoods that were uniform by socioeconomic group (Greenstein et al., 2000).

The application of land-use and building standards that exclude low-income households is a common method of encoding social segregation into apparently *technical* planning criteria. For example, until its revision in the mid-1990s, the main building code system in Kenya continued the application of top-down colonial standards and paid too little attention to the affordability of the regulatory provisions. Prior to the enactment of "Code 95", the cost of conventional building

materials was beyond reach for low-income and vulnerable groups, many of whom did not have access to housing finance and credit (UN-Habitat, 2014a). More recently, voluntary segregation has become a growing force, with the proliferation of gated communities and the concentration of commerce in new shopping and business centres providing increased security against crime but also minimizing the residents' interaction with other social groups in the city.

Cities have always been characterized by inequality. The Manchester of the mid-nineteenth century (Engels, 1845) offered horrific conditions of everyday risk for the majority of its inhabitants. Nowadays, most cities in higher-income countries are able to provide their residents with infrastructure, services and safety nets in a way that minimizes their disaster risk and strengthens their resilience (except in pockets of extreme deprivation like Calton, Glasgow). As cities grow wealthier, investments are made in infrastructure and services that reduce extensive risks and increase resilience. Engels would certainly not recognize the Manchester of the twenty-first century. However, in many cities inequality is increasing rather than decreasing, and it is estimated that around two-thirds of the global urban population now lives in cities where inequality has risen continuously since the 1980s (UN-Habitat, 2014b).

In many lower-income countries, city governments do not have the resource base or the political leverage to provide land and infrastructure for low-income households, with the result that a large part of urban development occurs informally and a variable proportion of the urban population (from 30 per cent in most middle-income countries to 90 per cent in many low-income countries) live in unsafe housing, on hazard-exposed sites and with little or no provision of services and infrastructure. This significantly increases their risk compared to better-off areas in the same cities.

The urban population living in informal settlements has actually grown over the last two decades, from around 650 million in 1990 to more than 860 million in 2012 (UN-Habitat, 2013).<sup>4</sup> This growth has severely undermined the relevance of the related target in the Millennium Development Goals: “By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers”.<sup>5</sup> At the same time, local and national governments often neglect to define, classify or quantify informal settlements and the corresponding risks and demands of their inhabitants (Sarmiento et al., 2014).

In some areas in Karachi, Pakistan (Hasan et al., 2010), there are more than 4,000 inhabitants per hectare (2.4 m<sup>2</sup> of space per inhabitant), compared to 200 persons per hectare (50m<sup>2</sup> per inhabitant) in high-income areas. In Tanzania, around 70 per cent of Dar es Salaam’s population lives in low-quality housing at risk of regular flooding (Kahn, 2014). In São Paulo, more than 85 per cent of at-risk households live in informal settlements, with more than half lacking access to appropriate sanitation and more than 30 per cent without access to paved roads (ibid.). In fact, health and sanitation problems within informal settlements exacerbate and create new risks. In Tanzania, for example, the lack of clean water and sanitation can lead to widespread outbreaks of waterborne diseases and malaria during flood episodes in informal settlements, thus creating further vulnerability (World Bank, 2011).

The implementation of land-use and building regulations becomes a major challenge in such settings (UNISDR, 2011a; Johnson, 2011), particularly where high population density exacerbates existing risks. Under such conditions, what two innovative architects said about Caracas almost a decade ago may hold true for many urban settings today: “Considering ideal conditions is a waste of time [...] The point is to avoid catastrophe” (Brillembourg and Klumpner, 2005).

## Concatenated urban risks

The growing complexity of interconnected urban systems in larger cities contributes to the structuring of the concatenated and potentially cascading disaster risks discussed in Chapter 10. These systems are directly shaped by the distinct features of individual cities and yet have common characteristics, notably their interconnectivity (Wamsler, 2014). For example, the increasing dependence of water, sewerage, waste management and health systems on electricity supply has resulted in a shutdown of these critical services during power outages associated with hazard events such as the Akalla tunnel fire in Stockholm in 2002 or Hurricane Sandy in New York in 2012 (ibid.).

In urban centres, risk is amplified by the degree of interdependence of sectors, utilities and infrastructure, particularly in those cities that act as key nodes in the global economy and national markets (Airmic Technical, 2013; OECD, 2009). For example, in cities with little built-in redundancy, failures in the power grid quickly spill over into telecommunications and transportation, which in turn impact production, banking and other sectors.



In late 2012, Hurricane Sandy brought about such system failures at the very core of a major global economic hub. Operations in the Port of New York and New Jersey were interrupted, leading to a disruption of cargo services and, crucially, maritime first responders. This had extensive and prolonged impacts on both the Port and the emergency response sector. The New York Stock Exchange was forced to close for two consecutive days, the only time this has happened since a major winter storm in 1888, and more than 20,000 flights were cancelled. Internet traffic around the globe was also affected due to the role of New York as a major hub for data traffic (National Hurricane Center, 2013; Smythe, 2013).<sup>6</sup>

While the direct damage from the storm depended on whether buildings or infrastructure had been designed to or above code, the indirect loss and impact was heavily influenced by interdependence (Haraguchi and Kim, 2014). For example, the health, transportation and electricity sectors suffered significant additional indirect damage from interruptions in the transport and building sectors (Table 11.1). These interdependencies mean that certain critical sectors need to be factored into risk reduction measures and investment plans to strengthen the city’s resilience (New York City Government, 2013; Haraguchi and Kim, 2014).

## 11.2 Addressing urban disaster risks in the HFA

Much of the progress made in addressing urban disaster risk is associated with strong urban planning and management in itself, particularly in higher-income countries. Therefore, a significant amount of effort has been made in the context of other frameworks, especially in climate change adaptation, rather than the disaster risk reduction sector. These efforts have given rise to innovative urban practices with risk reduction co-benefits.

Under Priority for Action 4, the HFA placed considerable emphasis and gave detailed guidance on the role of urban planning as well as building standards and regulation in disaster risk reduction, including the design of infrastructure and critical facilities such as hospitals and schools (Box 11.3).

Government self-assessment reports prepared using the HFA Monitor highlight progress over the last three reporting cycles, even though the progress in this area is considerably lower than in other priorities for action (Figure 11.5). This is also the case in other areas of Priority for Action 4.

Much of the progress made in addressing urban disaster risk is associated with strong urban

**Table 11.1** Direct and indirect damage from Hurricane Sandy

Sectors	Direct damage	Indirect damage
Electricity	9.9%	2.8%
Transportation	10.7%	19.4%
Health care	7.5%	2.4%
Building	7.0%	16.8%

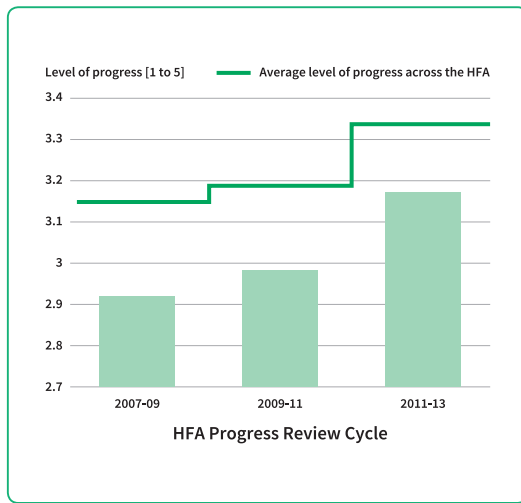
(Source: Haraguchi and Kim, 2014.)

**Box 11.3** Key activities related to urban development in the HFA

*(n) Incorporate disaster risk assessments into the urban planning and management of disaster-prone human settlements, in particular highly populated areas and quickly urbanizing settlements. The issues of informal or non-permanent housing and the location of housing in high-risk areas should be addressed as priorities, including in the framework of urban poverty reduction and slum-upgrading programmes.*

*(r) Encourage the revision of existing or the development of new building codes, standards, rehabilitation and reconstruction practices at the national or local levels, as appropriate, with the aim of making them more applicable in the local context, particularly in informal and marginal human settlements, and reinforce the capacity to implement, monitor and enforce such codes, through a consensus-based approach, with a view to fostering disaster-resistant structures.*

**Figure 11.5** Progress in managing risk in urban environments



*HFA Core Indicator 4.4: Planning and management of human settlements incorporate disaster risk reduction elements, including enforcement of building codes.*

*(Source: UNISDR with data from the HFA Monitor.)*

planning and management in itself, particularly in higher-income countries, or has occurred in the context of other frameworks, especially in climate change adaptation, rather than the disaster risk reduction sector.

Building on a tradition of supporting household and community efforts in informal urban development that began in the 1960s (Turner, 1972), there are numerous ongoing examples of innovative urban practices that may have risk reduction co-benefits. For example, an innovative approach to social housing in northern Chile provides families with half a house and lets them build the other half within a defined structure but according to their own priorities and means (Figure 11.6). In the north of Argentina, the Tupac Amaru social movement mobilizes low-income families to become the construction force behind their own community developments, complete with their own brick kilns and metalworking factories (McGuirk, 2014). In India, the National Slum Dwellers Federation has grown from a small, one-slum advocacy group

to a large network of community organizations across the globe that successfully negotiate tenancy rights and access to infrastructure and services for inhabitants of informal settlements (Patel and Mitlin, 2001).

Many governments now have policy frameworks in place to upgrade and regularize informal settlements, which may include the installation of risk-reducing infrastructure such as drainage and slope stabilization. However, as of 2011 around 40 per cent of low-income countries reporting against the HFA did not invest in reducing risk in vulnerable urban settlements (UNISDR, 2011b). In 2013, only some 60 per cent of low-income countries and less than 40 per cent of middle-income countries provided safe land and housing for low-income households and communities (UNISDR, 2013a). In other contexts, policy still focuses on eradication or relocation (Box. 11.4), which may further exacerbate risks and vulnerabilities.

**Figure 11.6** Social housing redefined: Quinta Monroy, Iquique, Chile



*(Source: Tadeus Jalocho and Christobal Palma.)*



Up to 20 per cent of Bangalore's population lives in informal settlements with no access to basic services. Over a five-year period from 2000 to 2005, the Bangalore Water Supply and Sewerage Board (BWSSB) implemented a programme to improve water delivery in the slums. By 2005, more than 5 per cent of slum households in the city had access to water and were fully functioning customers receiving bills and making payments. The programme allows shared connections between 8 and 12 households and specifically offers lower pricing for households located in the slums.



The project not only increased the number of households with access to the water network, it also reduced the residents' dependency on illegal connections and decreased the BWSSB's amount of non-revenue water being used.

In Harare and other major cities across Zimbabwe, a different approach was employed to deal with populations in informal settlements. For seven weeks starting in May 2005, a government-led clean-up campaign named Operation Murambatsvina was implemented with far-reaching impacts. Its aim was to eradicate illegal housing and alleged illicit business activities.

A total of 92,460 housing structures were destroyed and 700,000 people—nearly 6 per cent of the country's population—lost their homes. An estimated 2.4 million more people were indirectly affected by the campaign, and the informal work sector, which accounted for 40 per cent of all employment at the time, was destroyed. As a result, people who had been driven out of their homes were left even more vulnerable.

(Source: Satterthwaite and Mitlin, 2014.)

Within the disaster risk reduction sector itself, through initiatives such as the Making Cities Resilient campaign, the HFA has contributed to a growing awareness of disaster risk in the more than 2,000 cities that have signed up to date. Tools such as The UN-Habitat City Resilience Profiling Programme (CRPP; UN-Habitat, 2014a) or the UNISDR Local HFA Monitor and Ten Essentials now offer municipal governments the means to better understand the strengths and weaknesses of their current approaches to managing disaster risk. To date, 550 local government reports,<sup>7</sup> predominantly from municipal governments, have been submitted and show a mixed track record of achievements.



Local governments in high-income countries and in larger cities may have the capacity to carry out risk assessments and apply the results in land-use and zoning plans, in building regulations and

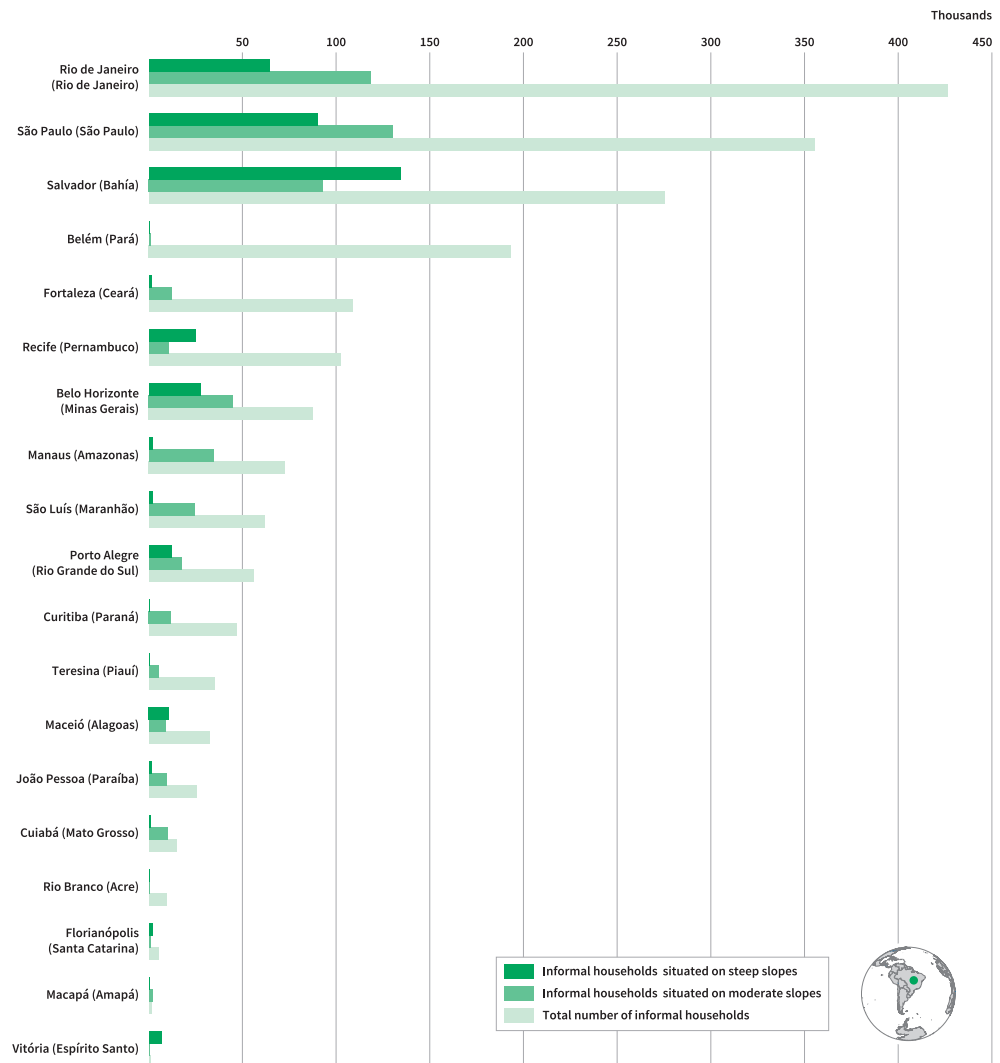
in the design and implementation of infrastructure projects. However, in many low and middle-income countries, the institutional capacity to support these approaches is usually insufficient, and in some cases it may be completely lacking. Many cities and small urban centres have lacked the sort of risk information, particularly in informal settlements, to inform planning decisions and investments that could reduce risk and build resilience even if they had the political will to do so (UN-Habitat, 2014a). However, there are exceptions, as seen more recently in Brazil (Box 11.5).

Building codes, zoning and land-use planning have been central measures to address existing urban risk and the accumulation of new urban risk. Over the last two decades, the development and improvement of new and existing building codes and standards in construction and reconstruction have been at the centre of urban risk management efforts (UNISDR, 2011a; UNEP and PSI, 2014). Bringing the private sector to the table early in urban planning processes can have

**Box 11.5** Strengthening capacities for disaster risk management in Brazil

Within only 70 years, Brazil went from being around 30 per cent to 84 per cent urban. This rapid urbanization process has been characterized by highly unequal urban development and land use. Real estate speculation has largely excluded low-income households from existing and new residential areas, obliging them to informally occupy areas that were outside of the formal land market. This led to a social construction of disaster risk over time. A number of Brazil's metropolitan areas, including Salvador, São Paulo and Rio de Janeiro, together contain more than one million informal households. Of those households, almost 60 per cent are located on moderate and steep slopes (Figure 11.7).

**Figure 11.7** Informal households situated on moderate and steep slopes in selected Brazilian cities



Note: Steep slope: equal to or greater than 30% (16.7°); moderate slope: between 5% (2.9°) and 30% (16.7°).

(Source: UNISDR with 2010 data from IBGE.⁹)



These areas are highly susceptible to floods and landslides. During the extended rainy season that affected Rio de Janeiro in January 2011, landslides and floods caused more than 900 deaths, 300 people went missing and more than 300,000 people were directly affected in just seven municipalities. Economic losses amounted to US\$1.8 billion.<sup>9</sup>

This has led to a change in how Brazil now approaches disaster risk reduction. In 2011 a cross-sector programme was initiated to discuss challenges and present solutions, resulting in the establishment of the National Centre for Natural Disaster Alert and Monitoring (CEMADEN). CEMADEN reports to the Ministry of Science, Technology and Innovation and has five priorities for action: developing early warning and monitoring systems; risk knowledge; reducing the losses and impacts of disasters; communication and education; and support to the civil defence system to strengthen emergency response (ibid.).

Brazil also reports that it has developed measures to manage the underlying risk drivers, such as reducing poverty and real estate speculation. The agenda of disaster risk management is now a priority for several ministries, based on the awareness that disaster is a social process, not an event.<sup>10</sup>

(Source: Alvalá et al., 2014.)

a direct influence on future risk levels, on compliance with building codes and planning standards, and on investments in retrofitting, and it can also lead to an enhanced dialogue between the public and private sectors (Johnson et al., 2012). However, there is only anecdotal evidence that this has occurred.

## 11.3 Urban risk: the future

**Ultimately, the capacity of cities to manage their disaster risks depends on their quality of governance. Some of the most promising developments in recent years are the cases of cities that have been able to regain control of their planning and management and to strengthen their urban governance through innovative partnerships between local governments, households and communities.**



Given the volume of capital that will flow into the urban development and infrastructure sectors in the coming decades (UNISDR, 2013a), how disaster risk is managed in urban areas will clearly have

a critical impact on whether future disaster risks can be reduced or not. Some 60 per cent of the area expected to be urbanized by 2030 remains to be built. The projected expansion of urban land cover between the years 2000 and 2030 is in the range of 56 to 310 per cent.<sup>11</sup> By 2030, an estimated US\$25 trillion to US\$30 trillion will be invested in new infrastructure, including urban road construction, water and sanitation, energy and transport systems, and buildings. It is expected that roughly US\$700 billion a year will be spent on financing new urban infrastructure in low and middle-income countries over this period (UN-Habitat, 2014).

Whereas in the last two centuries the largest cities were located in the wealthiest nations, low and middle-income countries are now home to three-quarters of the world's urban population and have most of its largest cities (IPCC, 2014), a reflection of dramatic economic growth and the accompanying changes in social, political and industrial relations and structures (Satterthwaite, 2007; Sassen, 2012).

Urban centres have always concentrated and will continue to concentrate business and opportunity (Dobbs and Reemes, 2012)—as well as the accompanying risk. However, much of the

projected growth will not take place in the megacities of Asia, but in “middleweight” cities such as Foshan in China and Surat in India (Dobbs et al., 2012). These cities are projected to contribute two-thirds of global growth by 2025 (ibid.) and to host more than half of the world’s middle or “consuming” class (ibid.).<sup>12</sup>

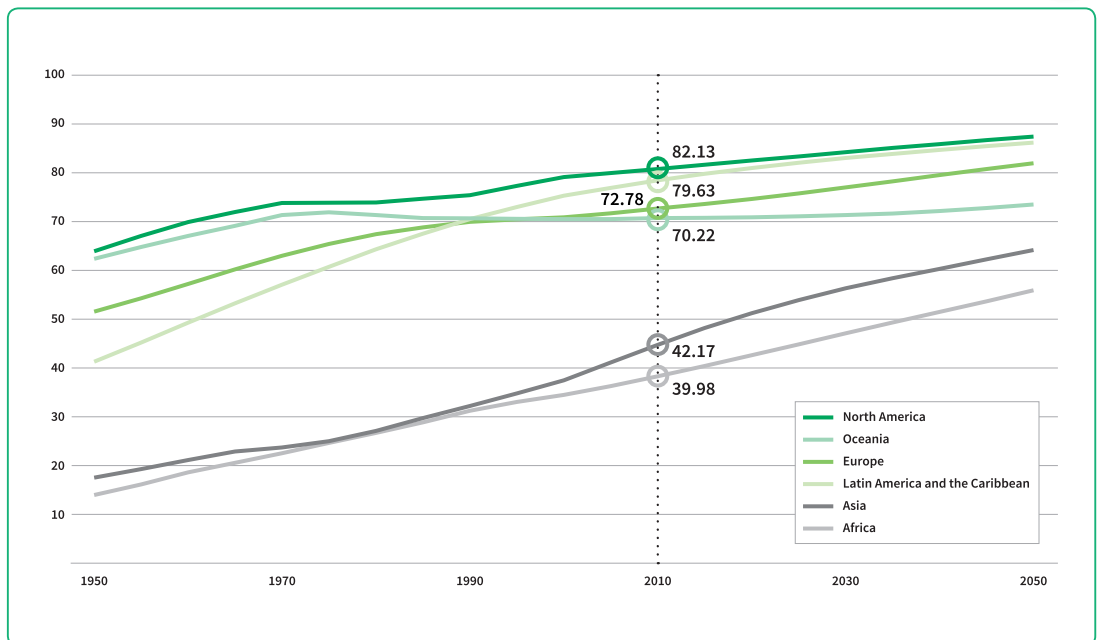
The combination of speculative urban development for a wealthy minority with informal urbanization for a low-income majority in cities with weak capacities for urban planning and management is likely to continue to drive urban disaster risk. In the coming decades, most urban growth is likely to occur in regions like South Asia and sub-Saharan Africa (Figure 11.8); without radical change, it will epitomize the growth in segregated disaster risk. Many countries in these regions have relatively weak urban governance. Governance and system failures to support regulatory functions have undermined the quality of building controls and created significant vulnerabilities. These include the insufficient quality

of underlying laws and regulations;<sup>13</sup> ineffective administration; insufficient qualifications on the part of local building code officials, local designers and contractors; an inadequate focus on risk management; opaque, bureaucratic procedures; and corruption (GFDRR and UN-Habitat, 2014).

For example, India is projected to see its number of urban dwellers increase by 404 million over the next 35 years, which means that around 50 per cent of the country’s population will live in cities by 2050 (UNDESA, 2014b). In sub-Saharan Africa, similar growth rates mean that 55 per cent of the region’s population will live in urban areas by 2050 (ibid.). This represents what has been described as a *tsunami of urbanization*.<sup>14</sup> Unless planned and managed, this development is likely to be accompanied by an equally powerful tsunami of disaster risk.

## Urban growth

Figure 11.8 Urban growth in geographical regions



(Source: UNDESA, 2014b.)

The incapacity of most low-income and some middle-income countries to provide safely located land for low-income households means that the growth of informal settlements may continue to be the dominant model through which people without access to formal land and housing markets resolve their housing needs. Despite the large number of studies and publications on urban risk and the rapid expansion of urban areas, interest and investment in urban poverty and risk reduction have only recently reached significant levels on the international stage (Satterthwaite and Mitlin, 2014).

In all income geographies, one can find notable exceptions of well-governed cities that have managed to provide infrastructure and services for their inhabitants. There have also been numerous projects with international support, such as the provision of electricity to slum dwellers in Mumbai and Ahmedabad in India (World Bank and ESMAP, 2011) and the improvement of sewerage systems for the urban poor in Viet Nam (World Bank and Australian Aid, 2013). However, it is highly likely that new urban growth in South Asia, sub-Saharan Africa and other regions will tend to magnify and exacerbate disaster risks (Mitlin and Satterthwaite, 2013).

Ultimately, the capacity of cities to manage their disaster risks depends on their quality of governance. Some of the most promising developments in recent years are the cases of cities that have been able to regain control of their planning and management and to strengthen their urban governance through innovative partnerships between local governments, households and communities. For example, in Medellin and Bogota in Colombia, innovative urban governance was able to dramatically reduce crime, improve transport and the provision of services, and enhance the quality of urban living in general.

Through integrated urban projects, the city of Medellin undertook large-scale investments to

provide public services to informal settlements on the hills surrounding the city, particularly transport, education, housing and green space. These were presented as an investment in the city as a whole, stressing solidarity and the need to reduce inequality and promote opportunity. One key element of this initiative was the municipality's ability to work with civil society organizations, which had a presence in, knowledge of and legitimacy in their neighbourhoods. A metro and cable car transportation system was built, enabling citizens in informal hillside settlements to travel to work or accomplish other business in a matter of minutes, whereas previously the same journey took hours. Green spaces and bicycle lanes were built throughout the city. New "library parks"—a combination of a public library, park, and community centre with architecturally attractive structures—serve the purposes of education, recreation and social cohesion, as well as being major tourist attractions. In Medellin, homicide rates went down from 381 per 100,000 people in 1991 to only 29 in 2007.<sup>15</sup> In parallel, both Bogota and Medellin made major investments in assessing and reducing disaster risk.

The experience of these and other cities shows that probably the single most important factor in addressing urban risk is to strengthen urban governance in a way that involves and empowers citizens and builds partnerships with civil society and the private sector. In contrast, stand-alone technical interventions to retrofit schools or hospitals are unlikely to be sustainable and may quite literally drown in a rising tide of risk.

Effective urban governance will have to recognize the direct relationship between functioning infrastructure, environmental sustainability, productivity, equity and quality of life. By extension, this means that the social and environmental drivers of disaster risk will also have to be taken into account.

And yet, unfortunately, disaster risk is still rarely mentioned as cities compete to attract investment. Investments in new smart or eco-cities do not seem to address underlying issues of inequality in access to services and infrastructure. If these issues are not addressed, a more probable scenario is one of emerging *Blade Runner* cities where evictions and relocations make way for new enclaves to attract global investment against a backdrop of increasing urban inequality and disaster risk.



## Notes

---

- 1 Accessed 11 January 2015.
- 2 The definition of “urban” varies according to context. For more information on the characteristics of urbanization in Africa, see Henderson et al., 2013.
- 3 [http://www.ted.com/talks/paul\\_romer](http://www.ted.com/talks/paul_romer).
- 4 However, one should note that the percentage of people living in informal settlements has declined over the same time period in all regions apart from West Asia (ibid.).
- 5 <http://www.un.org/millenniumgoals/environ.shtml>.
- 6 <http://research.dyn.com/2012/10/hurricane-sandy-initial-impact/> (accessed 8 December 2014).
- 7 Total number of online and offline local government reports submitted using the Local HFA Monitor as of October 2014.
- 8 <http://www.sidra.ibge.gov.br/bda/tabela/listabl.asp?z=cd&o=20&i=P&c=4012> (accessed 15 December 2014).
- 9 Source: [http://www.mi.gov.br/pt/c/document\\_library/get\\_file?uuid=74dde46c-544a-4bc4-a6e1-852d4c09be06&groupId=10157](http://www.mi.gov.br/pt/c/document_library/get_file?uuid=74dde46c-544a-4bc4-a6e1-852d4c09be06&groupId=10157) (accessed 15 December 2014).
- 10 Personal communication, Ministry of Science, Technology and Innovation, Government of Brazil.
- 11 Intergovernmental Panel on Climate Change Fifth Assessment Report, Working Group III, 2014.
- 12 The “consuming class” is defined as the share of the population with disposable income of more than US\$10 per day or US\$3,600 per annum (at 2005 ppp).
- 13 “Quality” has at least two broad meanings here: i) a legal meaning focused on the functional effectiveness of the law in delivering policy objectives and ii) a technical meaning that considers the relevance of the technical standards established by law.
- 14 Joan Clos, Executive Director of UN-Habitat, at the opening of the 6<sup>th</sup> World Urban Forum in Naples, Italy, 3 September 2012: <http://www.un.org/apps/news/story.asp?NewsID=42795> (accessed 11 January 2015).
- 15 <http://www.iadb.org/en/topics/citizen-security/impact-medellin,5687.html> (accessed 11 January 2015).

## Chapter 12

# Welcome to the Anthropocene: Overconsumption and biocapacity



As overconsumption progressively overwhelms the capacity of planetary systems, risk to the world’s social and economic system as a whole is increasing to potentially catastrophic levels. Climate change, declining biodiversity and depleted water availability will lead to increasing disaster risks.

While the HFA has recognized the role of climate change in driving risk, its interpretation has not allowed full recognition of the fact that those risks are not evenly shared. Increased inequality transfers and concentrates those risks in low-income households, territories and economies.

# 12.1 In search of a missing planet

The global ecological footprint currently exceeds the earth’s biocapacity by far. Current economic growth models rely on high levels of CO2 emissions and the increasing consumption of environmental resources, including freshwater, forest and marine resources.

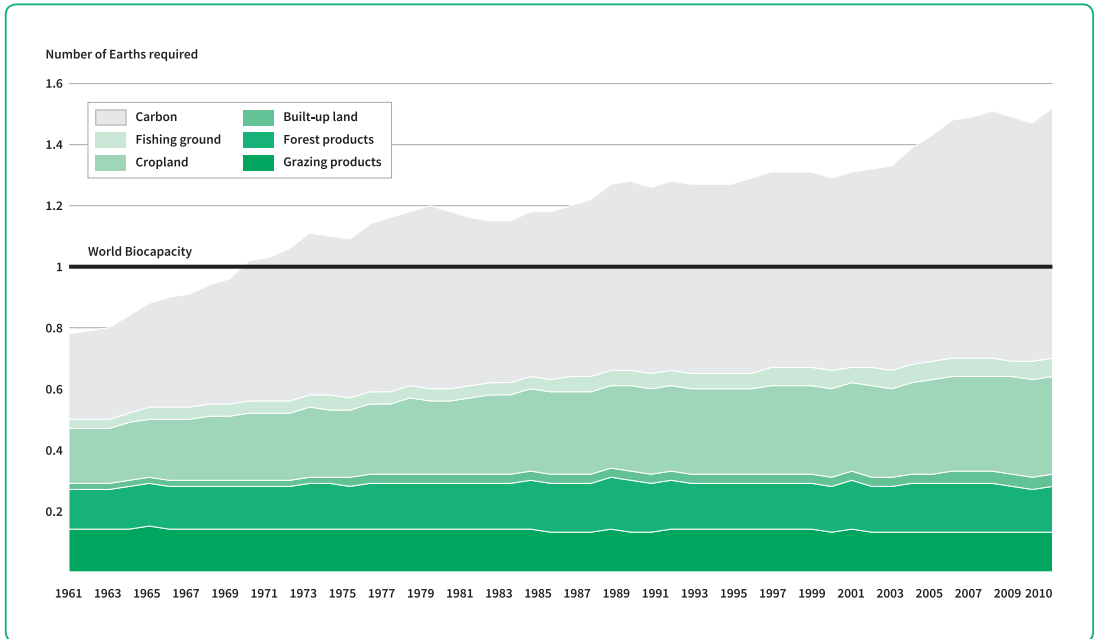
Today, the Fijian island village of Vunidogolo is still relatively unknown, but it is already on its way to making history. The permanent relocation of its entire population as a precaution against

rising sea levels made headlines in countless news outlets and social media posts. After the village suffered repeatedly from heavy floods and storms, the government of Fiji decided on this radical move, and in January 2014 all residents of Vunidogolo were relocated to higher ground.

Vunidogolo is not alone. More than 650 communities all over Fiji are threatened by loss of coastal land and damage to infrastructure from sea level rise and storm surges, and more than 40 communities have already been identified for relocation within the next 10 years.<sup>1</sup> The people



Figure 12.1 Human demand already exceeds the planet’s capacities



(Source: Global Footprint Network, 2013.)

of Vunidogolo are not responsible for the greenhouse gas emissions that are contributing to global climate change and rising sea levels. Those emissions are associated with high levels of energy consumption in other parts of the world. However, the residents of the village are quite literally paying the price: they contributed around one-third of the total cost of construction, farm and fish pond development incurred in the course of relocation.

The current approach to economic growth depends on an increasing and unsustainable overconsumption of energy, fresh water, forests

and marine habitats, clean air and rich soil (Nair, 2014). The ecological footprint currently created by this overconsumption of energy and natural capital now exceeds the capacity of the planet to provide the resources used and to absorb waste, including greenhouse gas emissions. Somewhere around 1970, consumption surpassed the planet's biocapacity for the first time. It is estimated that consumption now exceeds the biocapacity of the planet by around 50 per cent (Figure 12.1).

As GDP per capita grows, so do consumption and waste (Box 12.1).

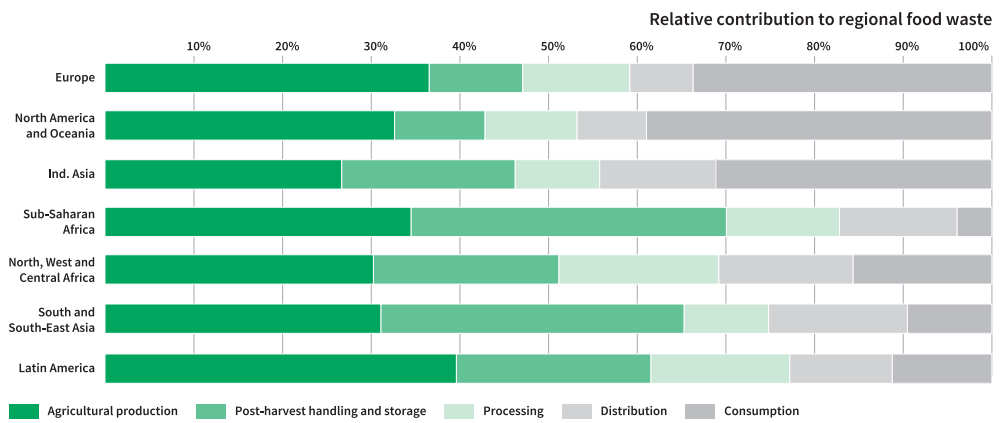


**Box 12.1** Destructive consumption and distribution patterns

Current consumption and distribution patterns have a direct impact on climate, water, land and biodiversity, which in turn mediate disaster risk. For example, more than a quarter of global agricultural production is lost or wasted (FAO, 2012) along the supply chain, from production to storage, processing, distribution and consumption (EIU, 2014).

As Figure 12.2 highlights, Europe, the United States of America and a group of industrialized Asian countries including China, Japan and the Republic of Korea are mainly responsible for food waste in consumption, while losses in the production phase are particularly high in Latin America, Europe and sub-Saharan Africa.

**Figure 12.2** Relative food loss and waste by region and by phase of the food supply chain



(Source: FAO, 2013b.)

Only the United States of America and China emit more greenhouse gases than the estimated 3.3 gigatonnes of CO<sub>2</sub> equivalent emitted by global food waste in 2007. Food waste now accounts for up to 10 per cent of human-generated greenhouse gas emissions, in comparison to 35 per cent from the energy sector and 18 per cent from industry (UNEP, 2012; FAO, 2012; Vermeulen et al., 2012).

This form of waste also comes at a high cost: worldwide, the equivalent of US\$750 billion, or the GDP of Switzerland, is wasted every year (FAO, 2012). This type of waste contributes directly to food insecurity (EIU, 2014) and consumes large amounts of scarce ground, surface water (equivalent to the annual discharge of the Volga River or three times the volume of Lake Geneva) and productive land (equal to 28 per cent of global agricultural land area in 2007). These two critical resources shape the vulnerability of those who depend on them (FAO, 2012; Mekonnen and Hoekstra, 2011).

Food waste contributes to tighter global food availability and more volatile food prices, which in turn threaten food security and resilience in substantial parts of the population of sub-Saharan Africa and South Asia in particular (EIU, 2013; UNISDR, 2013a).

Energy consumption increases with rising GDP per capita; however, as highlighted in Chapter 13, the relationship is non-linear. The total global primary energy supply more than doubled between 1971 and 2011, while the global population grew by 86 per cent over the same time frame (OECD and IEA, 2013). This has contributed to significant increases in CO<sub>2</sub> emissions (IEA, 2013; OECD and IEA, 2013), particularly in rapidly growing and urbanizing economies such as India and China. In 1980, for example, electricity consumption in India was less than a tenth of the world average. By the year 2010 it had increased by 358 per cent, compared to a world average of 88 per cent.<sup>2</sup> Largely based on coal, the country's electricity generation accounts for almost half (48 per cent) of its total CO<sub>2</sub> emissions (von Hauff and Kundu, 2002).

Overconsumption now exceeds the capacity of a number of different planetary systems. In this context, Rockström et al. (2009) identified nine different *planetary boundaries* which can be grouped as follows: boundaries defining a safe global level of depleting non-renewable fossil resources, such as energy (coal, oil, gas), and fossil groundwater; boundaries defining a safe global level of use of the living biosphere, including the exploitation of ecosystems, protection of biodiversity and consuming renewable resources, such as land use; and boundaries defining a safe global level of the planetary system's capacity to absorb and dissipate human waste flows, including carbon, nitrogen, phosphorus, and toxic chemicals such as pesticides. At least three of these boundaries

(climate change, biodiversity loss and the nitrogen cycle) have already been breached (ibid.).<sup>3</sup>

Climate change is probably the best known of these *planetary boundaries*, and its relationship with increasing disaster risks has already been clearly established (IPCC, 2012 and 2014). Disaster risk is magnified by climate change (UNISDR, 2009a, 2011a; IPCC, 2012; SEI, 2014). Climate change is already altering the frequency and intensity of many weather-related hazards (IPCC, 2014) as well as steadily increasing the vulnerability and eroding the resilience of exposed populations that depend on arable land, access to water, and stable mean temperatures and rainfall (UNDP et al., 2013).

#### Climate change impact

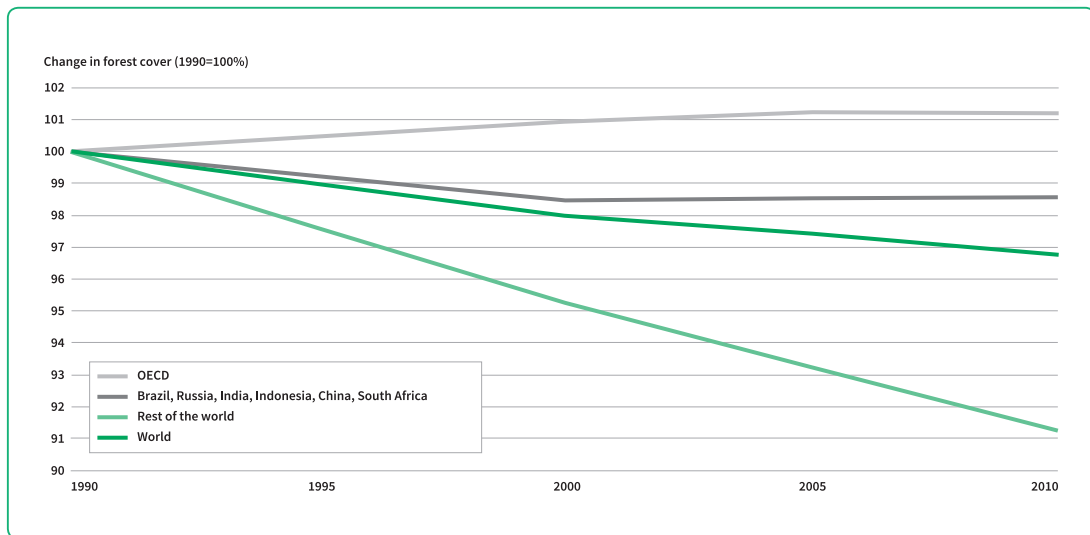


At the same time, breaking through other boundaries also has implications for disaster risk. Economic growth is often associated with ecosystem destruction and degradation, for example with the conversion of mangrove forests into shrimp farms, primary forests into plantations to produce palm oil or soya, or wetlands and floodplains into urban developments, or with the processes of land degradation and aquifer exhaustion associated with intensive agriculture.

#### Impacts, adaptation & vulnerability



Figure 12.3 Global trends in forest cover, 1990-2010



(Source: OECD, 2012.)

One underlying driver of disaster risk is the loss of biodiversity, including the loss of forests (both in terms of size and diversity), wetlands, coral reefs, mangroves, areas under sustainable management and protected areas, the loss of threatened species and marine stocks, and the degradation of regulatory and provisioning ecosystem services (IPCC, 2012; UNISDR, 2009a, 2011a, 2013a; World Bank, 2013). In particular, the loss of forests, wetlands and coastal areas with mangroves and coral reefs have direct implications for risk (IPCC, 2014; PEDRR, 2010; Chatenoux and Peduzzi, 2013).

Forest cover reduces landslide and drought risk in particular (UNISDR, 2011a), but as in the case of wetlands, mangroves and coral reefs, global coverage was in decline until recently, except in OECD countries (Figure 12.3). For example, between the adoption of the HFA in 2005 and 2013—in a period of only eight years—the Amazon is estimated to have lost approximately 70,000 km<sup>2</sup> of its rainforest, an area the size of Ireland or Panama.

Global data on the loss of critical regulatory ecosystem services, including forests, mangroves, wetlands, coral reefs and aquifers, as well as data on climate change highlight that many ecosystems are now approaching tipping points beyond which recovery is difficult or impossible, with unpredictable but potentially dangerous implications for future disaster risk.

The impact of water scarcity has also been discussed extensively (UNISDR, 2013a; Erian et al., 2012; IPCC, 2012). In the regions most heavily affected, it will have a direct relationship with disaster risk, both in terms of increasing agricultural and hydrological drought hazard as well as increasing vulnerability. Agricultural production, and thus also rural incomes, will be increasingly challenged, which will undermine resilience to drought and other hazard impacts. The increasing cost and declining availability of drinking water in urban areas will particularly affect low-income communities, which already have very unequal access to this resource. Again, this is a challenge to resilience and to the capacity of households and communities to manage disaster risks.



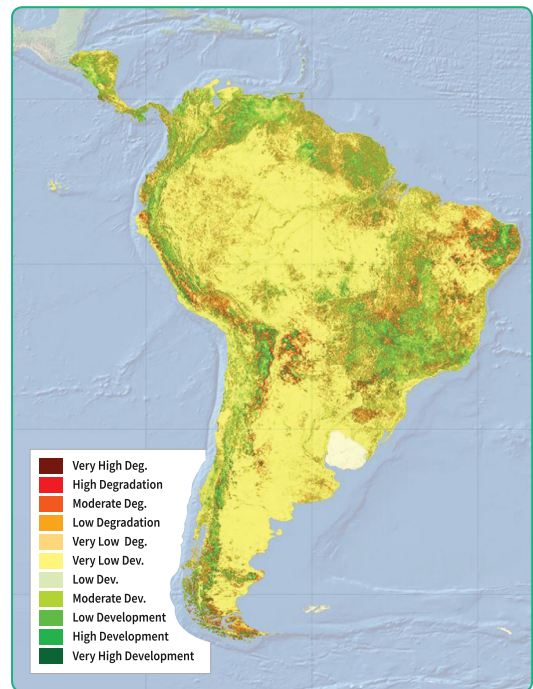
Globally, land degradation is another key driver, particularly when it comes to drought risk (UNISDR, 2013a; Erian et al., 2012). The effects of land degradation are often irreversible, and where land rehabilitation is attempted it is usually costly and labour-intensive (Erian et al., 2014). Already ten years ago, it was estimated that more than 30 per cent of the world's land surface was vulnerable to degradation (WMO, 2005).

In Africa, 52 per cent of land is considered degraded (Erian et al., 2014). Countries with severe land degradation (i.e. 75 per cent of their land) include Lesotho, Djibouti, Sierra Leone, the Democratic Republic of Congo and Zambia. Another 24 countries, including South Africa and Nigeria, as well as some low-income countries such as Swaziland, Zimbabwe and Eritrea, show severe land degradation to the tune of 50-75 per cent of their land area.

In South America, a more complex process of land degradation and change in vegetation cover can be observed (Erian et al., 2014). There has been significant degradation in some parts of Brazil, Argentina and Peru in particular, resulting in a total of almost 500 million hectares of land degraded in South America (Figure 12.4). Of that area, more than 165 million hectares show moderate to severe degradation, amounting to more than 10 per cent of the continent's total land area (Erian et al., 2014). However, the dynamics of vegetation cover and investments in land development mean that more than 12 per cent of the total land area can be considered highly developed, outweighing the overall scale of degradation. However, this figure obviously hides the high levels of local soil degradation that have significant impacts on communities and local economies (ibid.).

The real cost of land degradation is difficult to assess. However, as an example of how significant the associated costs are, Table 12.1 shows the

Figure 12.4 Land degradation in South and Central America



(Source: Erian et al., 2014.)

estimated loss value of land degradation in the Syrian Arab Republic, including cultivated, range and forest lands.

Given that the different planetary systems are concatenated, breaching any one boundary affects the others, and all of them have an impact on disaster risk. As the overconsumption of energy and natural capital breaks through successive planetary boundaries, it has ushered in a new era that some scientists are now calling the *Anthropocene*: an epoch in which human activities have a significant impact on the planet's ecosystems (Rockström et al., 2013). The concept of the Anthropocene has still not been adopted as orthodox scientific nomenclature, but one of its salient and defining characteristics is that of increasing disaster loss and impacts as indicators of planetary systems in distress.

Given that its causes and consequences are global and that it threatens the very foundations of

**Table 12.1** Value loss of crops, land and employment from drought in the Syrian Arab Republic

Total Affected Land Use Type	Level of Severity					
	Severe	Moderate	Slight	Severe	Moderate	Slight
Rangelands	Land value lost [US\$ per ha]			Number of jobs lost [per ha]		
	350	150	50	0.3	0.15	0.07
	Severe	Moderate	Slight	Severe	Moderate	Slight
Rainfed cropland	Land value lost [US\$ per ha]			Number of jobs lost [per ha]		
	600	300	90	2	1	0.4
	Severe	Moderate	Slight	Severe	Moderate	Slight
Forest	Land value lost [US\$ per ha]			Number of jobs lost [per ha]		
	1500	600	200	1	0.5	0.1
	Severe	Moderate	Slight	Severe	Moderate	Slight

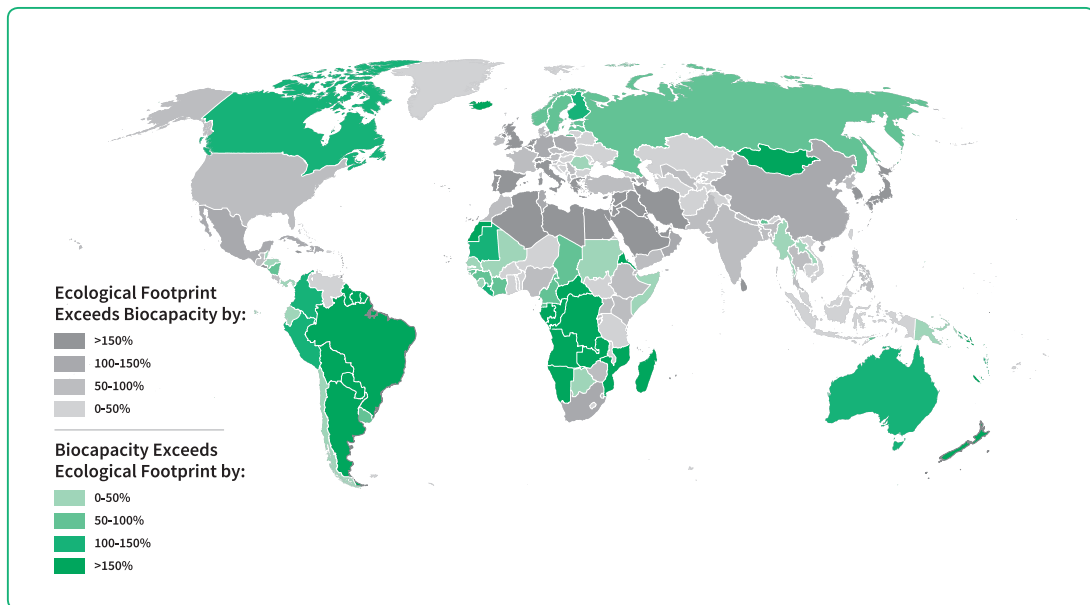
(Source: Erian et al., 2014.)

social and economic life on the planet, overconsumption could be characterized as a meta-driver of risk. However, as with other risk drivers, overconsumption is also permeated with and characterized by social and territorial inequality. As the example of Vunidogolo highlights, many of the disaster risks associated with the overconsumption of energy and natural capital are not borne directly by those who benefit from the wealth generated, but are instead transferred to other

sectors and geographies. Furthermore, breaching the planetary boundaries then becomes another driver of risk inequality by redistributing disaster risks and the associated losses and impacts.

Many economically successful countries have already exceeded their own biocapacity and have then become dependent on *importing* biocapacity from other countries (Figure 12.5).

**Figure 12.5** The ecological wealth of nations



(Source: Global Footprint Network, 2013.)

## 12.2 Progress in policy and planning under the HFA

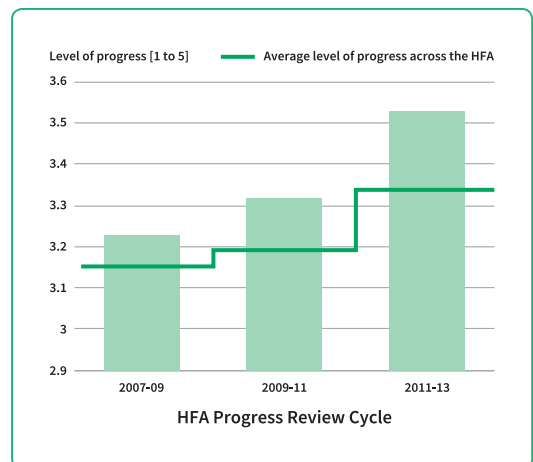
The environment sector has been able to apply the HFA in part, and the climate change agenda has generated important momentum in political and economic terms. But while disaster risk management has now been relatively well integrated into agendas related to biodiversity, water, sustainability, energy and climate change, environmental management and climate change mitigation have not played a large enough role in the implementation of the HFA.

Under Priority for Action 4 (Box 12.2), the HFA placed considerable emphasis on environmental management (Box 12.2).

This is one of the few areas under Priority for Action 4 where HFA progress reports highlight above-average levels of achievement (Figure 12.6). While little of this progress is associated with the disaster risk management sector *per se*, the environmental sector has been able to use the HFA to strengthen international and regional policy and to exert an influence on practice. At the same time, the climate change sector has generated important additional support and momentum in political and economic terms.

Disaster risk management has now been relatively well integrated into agendas related to biodiversity, water, sustainability, energy and climate change. At the policy level, many regional and international frameworks and initiatives now make explicit reference to disaster risk and risk management, such as the Rio+20 outcome document (United Nations, 2012); the UN Convention to Combat Desertification;<sup>4</sup> the Ramsar Convention on Wetlands;<sup>5</sup> and the Convention on Biological Diversity.<sup>6</sup> In addition, the Special Report on Managing the Risks of Extreme

**Figure 12.6** Progress reported in reducing disaster risk through environmental management



HFA Core Indicator 4.1: DRR as an integral objective of environment-related policies and plans, land-use management and climate change adaptation. (Source: UNISDR.)

**Box 12.2** Key activities related to environmental management in the HFA

*(a) Encourage the sustainable use and management of ecosystems, including through better land-use planning and development activities to reduce risk and vulnerabilities.*

*(b) Implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction, including structural and non-structural measures, such as integrated flood management and appropriate management of fragile ecosystems.*

*(c) Promote the integration of risk reduction associated with existing climate variability and future climate change into strategies for the reduction of disaster risk and adaptation to climate change, which would include the clear identification of climate-related disaster risks, the design of specific risk reduction measures and an improved and routine use of climate risk information by planners, engineers and other decision-makers.*

Events and Disasters to Advance Climate Change Adaptation (SREX) published by the IPCC in 2012 addressed how critical disaster risk management is to climate change adaptation.

In 2012, member states of the International Union for Conservation of Nature (IUCN) were asked to use HFA Priority for Action 4 as guidance on how to strengthen “nature-based” disaster risk management in their environmental policies and practices (UNEP, 2014). At the same time, a growing number of regional frameworks highlight the need to take disaster risk into account in environmental management and vice versa (ibid.).

There have also been successes in evaluation and planning. For example, the overwhelming majority of HFA progress reports for 2013 (a total of 94) confirmed that disaster risk considerations have been integrated into environmental impact assessments (EIAs; UNISDR, 2013b). New frameworks have been developed that merge disaster risk considerations in practice with the application of EIAs and strategic environmental assessments (SEAs), such as the ten-step guide produced by the Caribbean Development Bank or the use of EIAs to climate-proof projects in Australia, Canada and the Netherlands (Agrawala et al., 2010; UNEP, 2014). In Sri Lanka, the government used the SEA approach to develop a comprehensive sustainable development framework for the reconstruction of the Northern Province, taking into account major hazards such as storm surges, flooding, tsunami and sea level rise (PEDRR, 2010).

Due to the absence of consistent output indicators, it is more difficult to measure how much of this progress at the policy level has translated into meaningful practice. However, anecdotal evidence paints a picture of growing momentum in some areas and challenges in others.

### Climate change

Climate change has emerged as a sector in itself at the national, regional and international levels,

with its own institutional arrangements, global framework and funding mechanisms. Since the formulation of the Nairobi Work Programme at the Conference of the Parties in 2006, a plethora of strategies, frameworks and funding mechanisms has certainly created the impression of convergence and coherence of climate change agendas with those of disaster risk reduction and sustainable development (UNEP, 2014).

However, this impression contrasts with a lack of true institutional and practical integration (SEI, 2014). Several countries, such as the Philippines, Viet Nam and others in the Pacific region, have managed to take the opportunity to effectively merge regulation and technical guidelines as well as national policy frameworks and budgets for disaster risk reduction and climate change adaptation. However, those countries remain the minority, and most national policies, while citing the respective other domain, maintain distinct boundaries in concepts, plans, methodologies, reporting lines, responsibilities, budgets and other areas (ibid.).

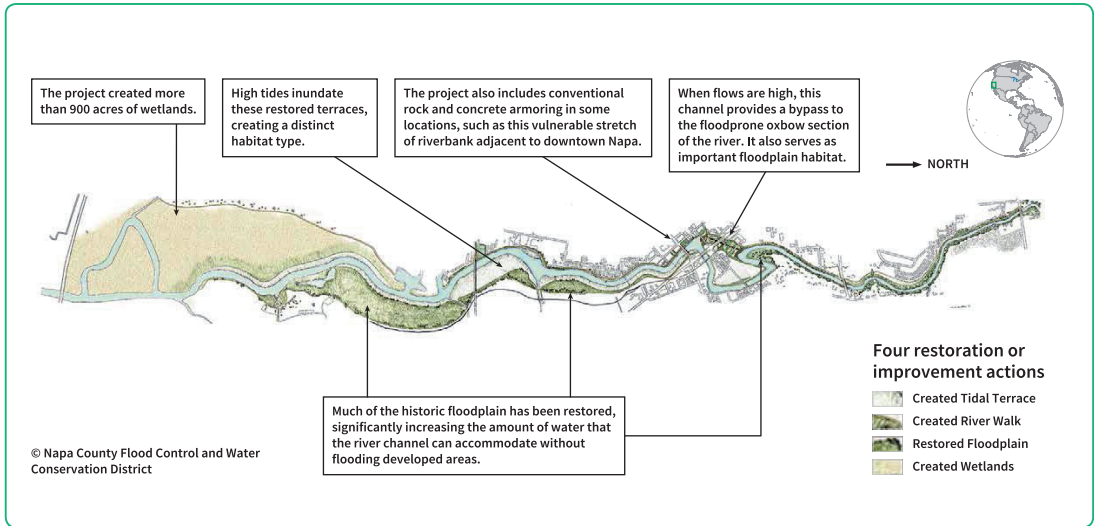
At the same time, a large number of climate change adaptation projects have strong disaster risk reduction components even though they are not labelled as such (UNISDR, 2009a). In addition, the climate change sector has probably had far more political influence at all levels than the disaster risk reduction sector itself. In fact, it is likely that the disaster risk reduction sector profits from the momentum generated by the climate change sector, even if the two are still weakly integrated in practice.

### Environmental management

A number of approaches and tools in environmental management now take explicit account of disaster risk. For example, integrated water resource management integrates disaster risk considerations into the management of excess supply and/or scarcity of water (UNEP, 2014). The European Union’s Floods Directive and the



**Figure 12.7** Living river flood control through green-grey infrastructure, Napa Valley, California



(Source: Conservation International, 2014.)

Mekong River Commission’s Water Resources Management-based Basin Development Strategy are examples of such strategies with significant spatial coverage and high levels of ambition (European Commission, 2007; MRC, 2010).

Similarly, national and regional approaches to incorporating disaster risk reduction into environmental management can be found in the context of forest fire management (e.g. in Jamaica and Lebanon), coastal zone management (e.g. in Belize, Viet Nam and Kenya), and protected areas management (e.g. in Mali, New Zealand and Nepal) (UNEP, 2014). The application of these tools in practice would seem to be gaining momentum.

However, there are still only few examples of integrated community-level approaches that have been scaled up with success. One exception is the grassroots approach to water management at the border between Guatemala and Mexico, where local initiative has turned into national strategy (IUCN, 2012). In the Guatemalan municipality of Tacaná, 14 micro-watershed councils successfully engaged with the municipal authorities to develop a coordinated alliance of government

and non-governmental organizations at the sub-national level. The success of this coordination led to replication in other municipalities and ultimately to the creation of a national micro-watershed commission in Guatemala (ibid.).

**Ecosystem approaches to disaster risk reduction**

Another practice with enormous potential which has yet to be fully realized is that of payment for ecosystem services (UNISDR, 2009a). Though difficult to assess in economic terms, the regulating services of ecosystems—such as soil protection and flood management—may be their greatest economic value (UNEP, 2014). However, working examples are still few and far between, and the practice remains far from mainstream (UNISDR, 2011a, 2013a).

New approaches also blend grey and green infrastructure in a way that maximizes different ecosystem services, including the reduction of flood risks. For example, in Napa Valley, California, green infrastructure in the form of wetlands creation and protection as well as floodplain restoration is combined with a set of grey infrastructure investments such as conventional rock and concrete flood protection (Figure 12.7).

Mangrove conservation and restoration is another area where considerable efforts have been invested, though the results are still mixed. For example, 9,050 hectares of mangroves were planted in West Bengal, India between 1989 and 1995 with a success rate of only 1.5 per cent (Lewis, 2001). Mangroves can reduce flood impact by protecting against storm surge, reducing wave heights by up to 50 centimetres and reducing surface waves from wind by more than 75 per cent (McIvor et al., 2013). However, the conditions for successful restoration are not found everywhere.

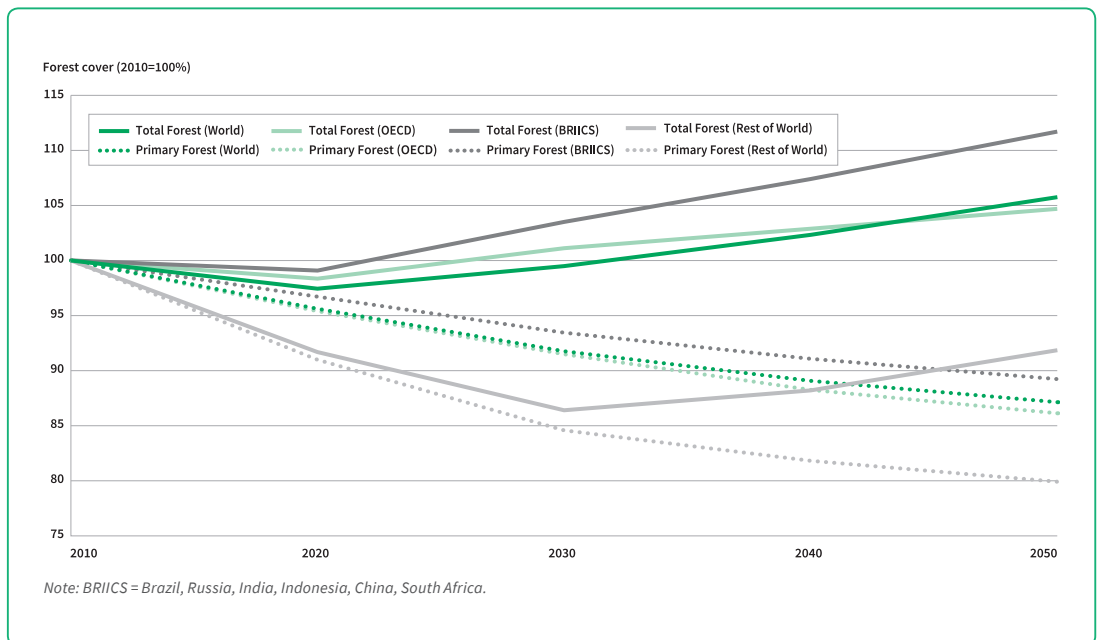
To address these challenges, hybrid approaches using mangrove reforestation in combination with common structural solutions have also been developed to reduce delta and coastal vulnerability and to create socioeconomic benefits at the same time (Winterwerp et al., 2003). For example, in north-central Java, Indonesia, mangrove belts were widely promoted but did not stabilize eroding coastlines and could not be restored successfully due to the morphology of the shoreline.

Instead, the coast continued to degrade at an alarming rate (Winterwerp et al., 2014). However, a combination of permeable structures on the one hand and engineering techniques on the other enabled enough sediment to accumulate, thus creating sufficient elevation for the mangroves to colonize naturally (ibid.).

While anecdotal examples of successful (and unsuccessful) approaches to ecosystem and environmental management abound, it is difficult to measure their global impact. However, significant investments in restoring and protecting natural capital are being made, and they have proved to be effective in reversing the loss of biodiversity and ecosystem decline at the local level (OECD, 2012). For example, efforts in reforestation and natural forest regeneration, particularly in OECD countries and emerging economies, are projected to show results from 2020 onwards, with a significant increase in overall forest cover projected to continue up to 2050 (Figure 12.8).

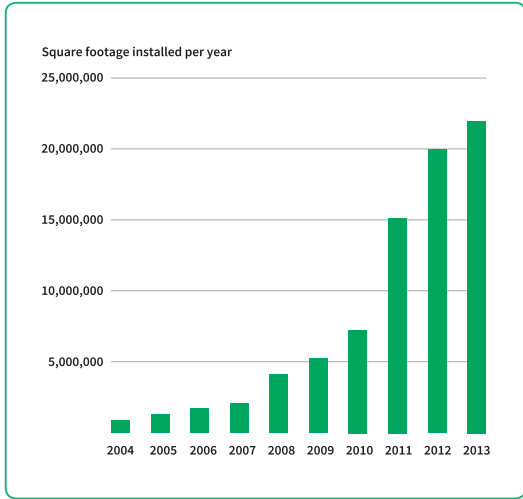


Figure 12.8 Global forest area change, 2010-2050



(Source: OECD, 2012.)

**Figure 12.9** Estimated increase in green roof development in North America



There is also momentum in the adoption of local solutions, for example in the case of green roofs. Highlighted in previous editions of the GAR (UNISDR, 2011a and 2013a), these roofs exemplify an approach to building design that: increases thermal performance, reducing energy consumption while providing more comfortable living and working conditions; reduces urban heat islands, improving air quality; provides additional green areas in cities; and at the same time regulates run-off during heavy rains, reducing flood risk.

The dynamism of the green roof industry is illustrated by the fact that in North America alone, approximately 20 million square feet (1.86 million square metres) of green roofs were installed in 2012, up from about 5 million square feet in 2005 (Figure 12.9). This is still a minute percentage of new roof area (Green Roofs for Healthy Cities, 2014). But it does illustrate the kind of momentum that is now taking shape in the application of innovative approaches which provide social, economic and environmental benefits as well as disaster risk reduction co-benefits, and which are being driven from the bottom up by households, communities, businesses and local governments.

## 12.3 Breaching the boundaries

The pursuit of economic growth depends on an increasing and unsustainable overconsumption of energy, fresh water, forests and marine habitats, clean air and rich soil. The ecological footprint currently exceeds the planet's biocapacity by around 50 per cent, and future projections—without a serious shift in thinking and practice—look even worse.

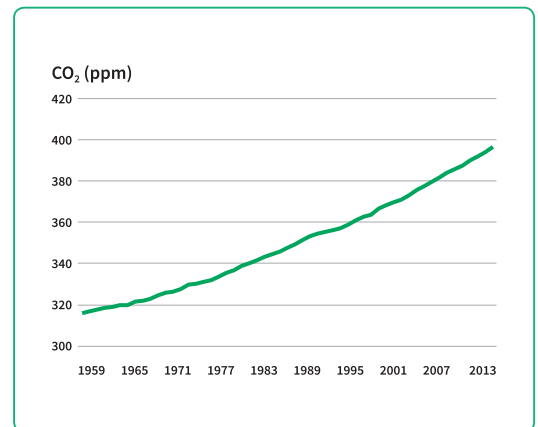
If current projections of economic growth and consumption continue, by the year 2030 the biocapacity of the planet will have been exceeded by around 200 per cent. In other words, two additional planets will be required to sustain consumption and absorb waste. As a meta-driver, this poses the risk of the ultimate *kata-strophe*.

The planetary boundary for CO<sub>2</sub> emissions has been set at 350 ppm,<sup>7</sup> but current levels are already close to 400 ppm and rising (Figure 12.10).

Annual global CO<sub>2</sub> emissions rose by 54 per cent between 1990 and 2011 (IPCC, 2013). Emissions



**Figure 12.10** Growth in emissions results in high levels of CO<sub>2</sub> in the atmosphere



(Source: UNISDR with data from NOAA.<sup>8</sup>)

per capita vary greatly, with North America continuing to be far ahead of all other regions (IEA, 2013). Emissions per unit of GDP decreased across all of the largest emitters,<sup>9</sup> particularly in China and Russia, due to increasing energy efficiency along the energy value chain, among other improvements. However, this has not been sufficient to compensate for increasing emissions per capita: for example, India and China respectively doubled and tripled their per capita emissions between 1990 and 2011 (OECD and IEA, 2013).

Globally, half of the emissions budget that was established in order to limit climate change to 2°C had already been depleted by 2011 (IPCC, 2013). If current emissions continue, this budget will be completely exhausted by 2045, consequently leading to a temperature change well above 2°C.

Due to processes such as changes in ice sheets, ocean warming, vegetation change occurring over long time scales and complex feedback, the climate will continue to be affected by these changes for hundreds or perhaps thousands of years even if temperatures are stabilized (ibid.). Therefore, even if emissions were to be capped today, climate change would continue to generate risk and create “reasons for concern” (see Box 12.3). These include climate-related extremes such as floods, cyclones, wildfires, droughts and heat waves, as identified with very high confidence by the IPCC (IPCC, 2014). In turn, those extremes would alter ecosystems, the supply of food and water, urban systems, and ultimately human well-being. Climate-related hazards will also continue to exacerbate existing vulnerabilities and exposures (IPCC, 2012, 2014). If emissions continue to grow unchecked, that risk can become catastrophic.



**Box 12.3** The five “reasons for concern” (RFCs) of the IPCC’s Fifth Assessment Report

Dangerous anthropogenic, i.e. human-induced, climate change will continue to drive risk. There are five “reasons for concern” that scientists and policymakers have identified as critical to human, economic and ecosystem well-being:

- 1. Unique and threatened systems:* Climate change will affect already threatened ecosystems and cultures with warming of 2°C. Arctic sea ice and coral reef systems that have particularly low adaptive capacities will be in severe danger.
- 2. Extreme weather events:* Risks from extreme events are already moderate and expected to rise with increasing temperatures. Higher levels of warming may exacerbate risks from certain types of events, such as heat waves.
- 3. Distribution of impacts:* Unevenly distributed risks generally affect disadvantaged communities the most. Climate change impacts are already known to be regionally differentiated, with high risks of unevenly distributed impacts for warming above 2°C.
- 4. Global aggregate impacts:* The risks of global aggregate impacts encompassing both biodiversity and the global economy are moderate with warming of 1°C to 2°C. Aggregate impacts increase with rising temperatures, leading to high risks associated with warming of 3°C or more.
- 5. Large-scale singular events:* The risks associated with abrupt and irreversible changes in some physical systems and ecosystems are moderate for warming between 0°C and 1°C, with Arctic ecosystems and coral reef systems already experiencing irreversible changes. Disproportionate increases in risks are expected as temperatures change between 1°C and 2°C, with high risks associated with 3°C or more warming due to the potential of sea level rise from ice sheet loss.

(Source: IPCC, 2014.)





Energy generation, and therefore consumption, also contribute to the depletion of natural resources such as water. Global water demand will increase dramatically even if agricultural production practices become more water-efficient (OECD, 2012). This increase will be driven mainly by growing demand for electricity generation and manufacturing in emerging markets such as Brazil, China and India (Figure 12.11).

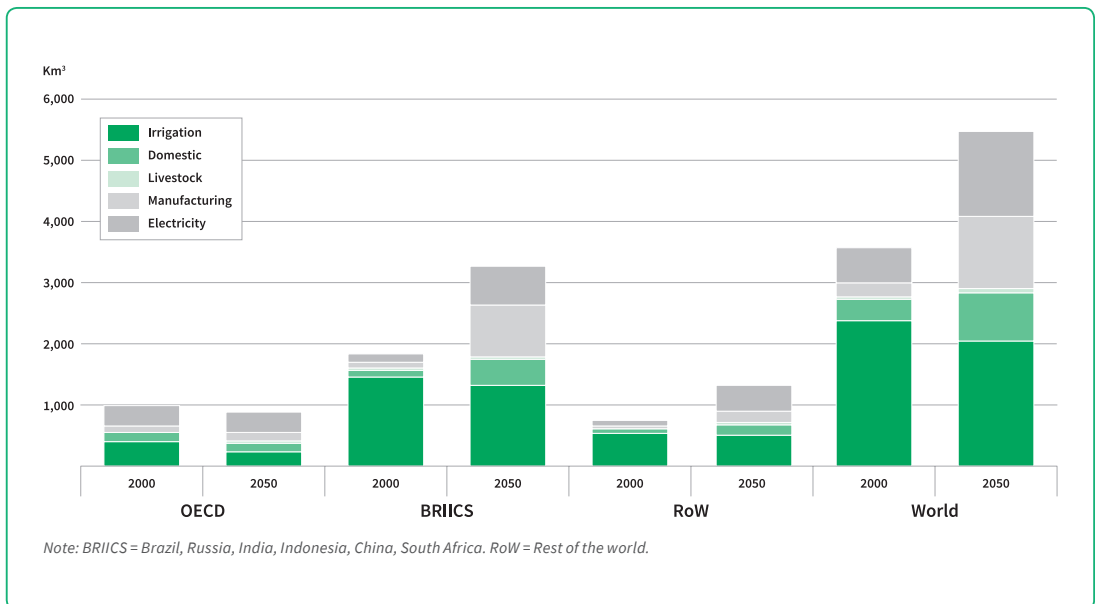
By 2050, it is estimated that 40 per cent of the global population will be living in river basins that experience severe water stress, particularly in Africa and Asia (Figure 12.12). Groundwater depletion is projected to become a severe challenge for agriculture and urban water supplies, and though water supply should improve overall, it appears likely that more than 240 million people will not have access to drinking water by 2050 (OECD, 2012). This does not bode well for disaster risk reduction.

Current projections show that the speed and scale at which ecosystem decline could proceed,

not least due to sea level rise, may render existing efforts to manage disaster risk insufficient and ineffective. For example, the global reduction of *wetland* areas—an estimated 50 per cent since the beginning of the twentieth century—will lead to a severe reduction in global and especially local capacity to absorb water during floods and to reduce peak flows (TEEB, 2013). For coastal wetlands, i.e. wetlands in the world's major river deltas, a 52 per cent decline was recorded between the 1980s and early 2000s (Coleman et al., 2008). Global estimates of future wetland loss are not currently available, but local and regional projections draw a bleak picture. For example, the area south of Freeport in Texas is projected to lose significant areas of wetland cover due to sea level rise by 2050 (Figure 12.13).

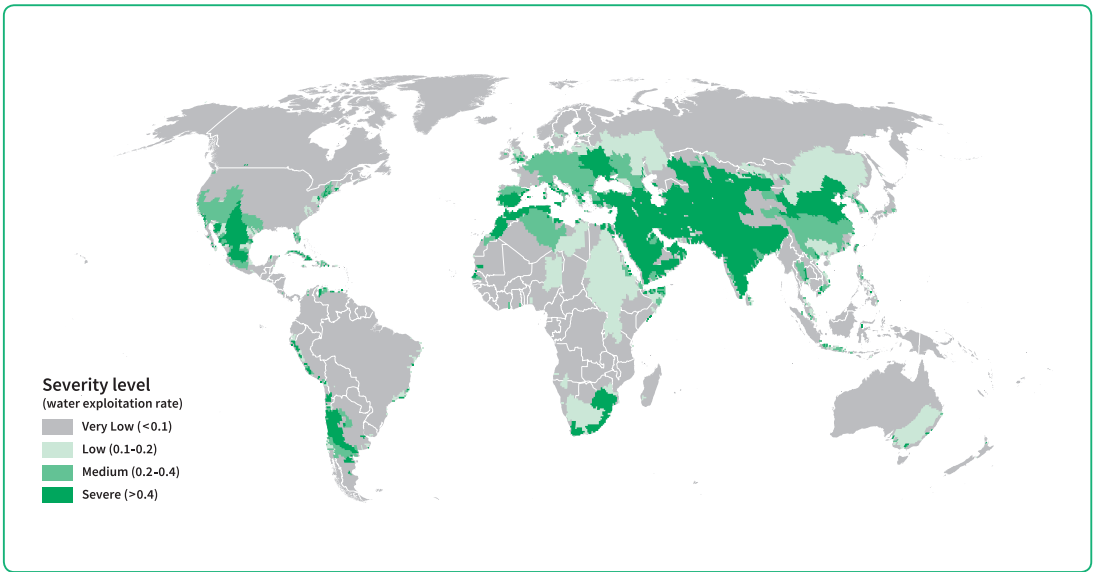
The cost of lost wetlands due to damage from lack of storm protection is potentially significant. In the United States, the cost of losing 1

Figure 12.11 Global water demand by 2050



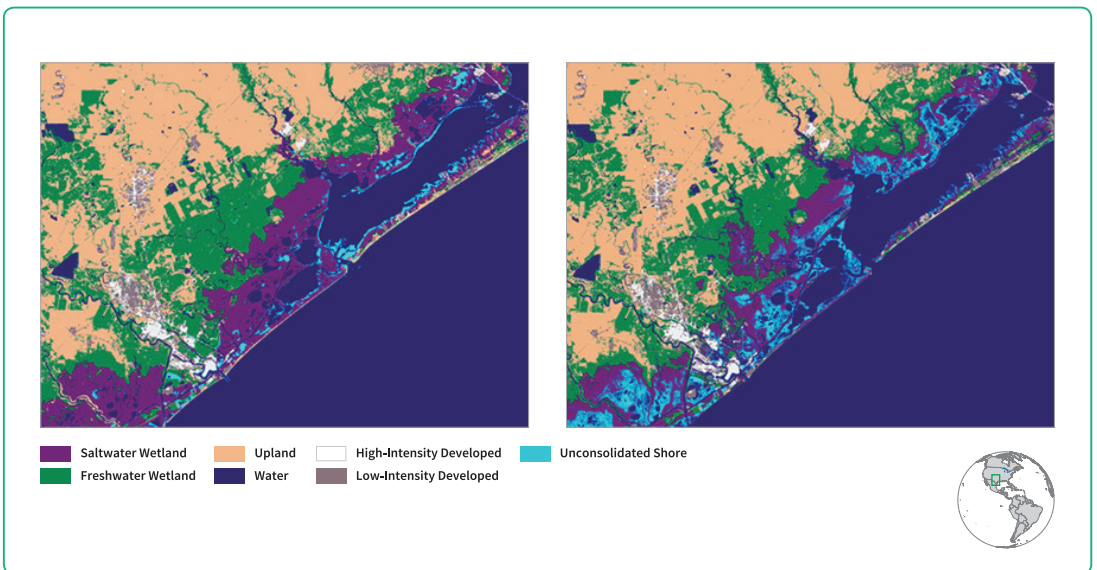
(Source: OECD, 2012.)

**Figure 12.12** Population projected to be living under severe water stress by 2050



(Source: OECD, 2012.)

**Figure 12.13** Projected changes in coastal wetland cover in Texas by 2050



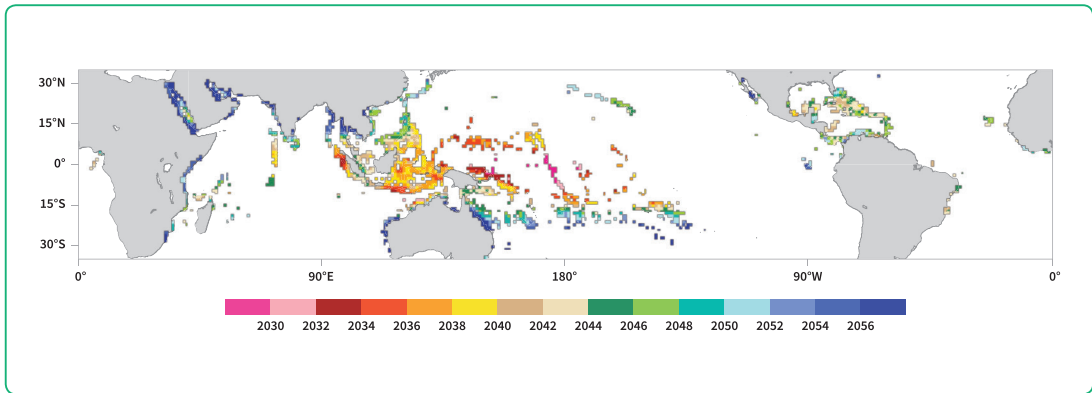
(Source: NOAA (<http://coast.noaa.gov/digitalcoast/dataregistry/#>.)

hectare of coastal wetlands has been estimated at US\$33,000 (Constanza et al., 2008).

Other biodiversity hotspots such as mangrove forests and coral reefs are also degrading at a rapid pace. FAO estimates that the total coastal

mangrove area worldwide declined from 188,000 km<sup>2</sup> in 1980 to 152,000 km<sup>2</sup> in 2005, a loss of 20 per cent over only 25 years (2007). Coral reefs have been proved to act as buffers to storm surges but are also on the decline. For example, it is estimated that 85 per cent of oyster reefs were

**Figure 12.14** Projections of coral reef decline



(Source: van Hooijdonk et al., 2013.)

lost between 1930 and 2003 (Butchart et al., 2010). Globally, a total of 90 per cent of reef locations are projected to experience severe bleaching by 2050 (Figure 12.14).

The destruction of planetary systems promises the ultimate *kata-strophe*. Under the most stark projections, the planet will have lost all its glaciers and have sterile oceans within just a few hundred years. There is no doubt that there will always be winners and losers in the shifting equations of overwhelmed planetary systems. But current assumptions regarding social and economic development and urbanization will hold little water. It is still unclear whether or not the plethora of local initiatives promoting green infrastructure, renewable energy, biodiversity restoration and other areas can gain traction quickly enough to change course. Even if it is too little, too late, these initiatives still provide hope. Ultimately, the key question is how to protect a planet that provides the basis for human and social well-being without simply protecting a paradigm that is currently destroying it.

## Notes

- 1 <http://aosis.org/reports-fiji-latest-country-to-relocate-climate-refugees> (accessed 11 January 2015).
- 2 World Bank data: <http://data.worldbank.org>.
- 3 There is some debate as to the definition of the exact values that constitute these planetary boundaries. Moreover, researchers are in agreement that not all boundaries apply globally, and instead it is local conditions that will define when critical thresholds have been reached. Moreover, there is some difficulty in interpreting the data for policymaking, and assigning arbitrary acceptable limits may create new risks (<http://www.nature.com/nature/journal/v461/n7263/full/461447b.html>). Despite these caveats, the debate on planetary boundaries has been a useful door-opener to a more profound debate on unsustainable current consumption patterns. For more information on the discussion of planetary boundaries, see <http://www.nature.com/news/specials/planetaryboundaries/index.html>.
- 4 <http://www.unccd.int/en/about-the-convention/Pages/About-the-Convention.aspx> (accessed 11 January 2015).
- 5 [http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38%5E20671\\_4000\\_0\\_\\_](http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38%5E20671_4000_0__)
- 6 <http://www.cbd.int/sp>.
- 7 350 ppm has been identified as the limit if global warming is not to exceed 2°C, where ppm = parts per million, i.e. the ratio of the number of gas molecules to the total number of molecules of dry air.
- 8 <http://co2now.org/Current-CO2/CO2-Now/noaa-mauna-loa-co2-data.html>.
- 9 The largest emitters since 1990 are (in order of magnitude) China, the United States of America, the Russian Federation, India and Japan (IEA, 2013).





# Conclusion: Making development sustainable

**As the global community moves towards establishing objectives and targets under the Sustainable Development Goals (SDGs), which for the first time will be framed for universal application, there is an urgent need to reinterpret disaster risk reduction so that it weaves and flows through development as a set of mutually supportive approaches and practices. Without effective disaster risk management, sustainable development will not be sustainable and the SDGs will not be achieved.**

**Disaster risk reduction can be achieved. Decades of experience in managing disasters and reducing climate and disaster risk have produced a wealth of knowledge and good practice which can be applied within social and productive sectors and which make good financial sense.**

## 13.1 The need for change

**Accumulated disaster risk now directly challenges the capacity of many countries to make the capital investments and social expenditure required to achieve sustainable development.**

Apart from overconsumption and inequality, the current development paradigm also generates and accumulates disaster risk, which has impacts in three different dimensions.

Firstly, public and private investment decisions that fail to take hazards into account may generate risks, losses and impacts for those who made the investments, as companies such as Toyota discovered to their cost during the 2011 Chao Phraya River floods in Thailand.

2011 Thailand floods



Secondly, and as multiple examples from this report and previous editions of the GAR have shown, those risks, losses and impacts are often not borne by the risk takers but are instead transferred to other social sectors or territories. This is the case, for example, in speculative urban

developments that may increase flood risks for households in informal settlements in other areas of a city.

Thirdly, and as exemplified by climate change and the destruction of biodiversity, other risks are transferred to the *commons*. As a consequence, the different planetary systems on which all people depend for survival are now at risk, a scenario in which there are ultimately no winners.

As such, the world is moving beyond an equilibrium state, be it in social, economic, political or environmental terms. Models of the future are characterized by increasing uncertainty, as *outliers* beyond the boundaries of what can be expected are becoming the *new normal*.

The worst-case implications are *kata-strophe* on a global scale, as overconsumption overwhelms the biocapacity of planetary systems, while rapidly increasing and unevenly distributed disaster risk erodes the resilience of those most in need of development. Accumulated disaster risk now directly challenges the capacity of many countries to make the capital investments and social expenditure which will be required to achieve sustainable development.



As a result, if the expected outcome of the HFA, *the substantial reduction in disaster losses, in lives and in the social, economic and environmental assets of countries and communities*, is ever to be achieved, there is a growing consensus that the development drivers of risk, for example climate change, the overconsumption of natural capital, poverty and inequality will have to be addressed.

In order to do so, it is essential to manage disaster risks more effectively. However, this in turn implies reinterpreting the way disaster risk reduction has been approached and practised to date. Managing risk, and not just the disasters that arise from unmanaged risk, has to become *the new normal* in development practice. Otherwise, sustainable development will not be sustainable.

## 13.2 No Planet B

**While income and energy consumption must rise in low-income countries to ensure social progress, beyond a given threshold rising income and energy consumption no longer correlate closely with social development. This shows that sustainable development is possible.**

If the entire global population were to consume at the per capita average of the United States of America, the equivalent of four planets Earth would be required in order to provide the necessary biocapacity. Unfortunately, at this point in time there is only one planet Earth, which makes a development paradigm based on economic growth and which generates overconsumption and inequality untenable.

There is now a growing consensus about the need to move towards a low-carbon economy, which in turn implies transformation in other areas, for example in agriculture and urban development (Rockström et al., 2013). Implicit values about

development do seem to be changing, challenging and overturning deep-rooted assumptions about economic growth, social well-being and risk.

Global annual CO<sub>2</sub> emissions are now approaching 5 tons per capita. Until very recently, the orthodox view was that increases in energy consumption have a positive and necessary impact on social and human development (von Hauff and Kundu, 2002). Similarly, it has generally been assumed that continuously increasing GDP is necessary for countries to achieve social well-being and human development. Both of those assumptions are now being overturned.

As Figure 13.1 shows, the relationship between increasing energy consumption and human development (as measured by the Human Development Index) is non-linear. At one end of the curve, even slight increases in energy consumption lead to major gains in human development. However, beyond a certain point the development gains from higher energy consumption are increasingly tenuous. For example, the consumption of CO<sub>2</sub> in the United States of America (approximately 20 tons per capita) is nearly four times that of Switzerland, although both countries have similar levels of human development.

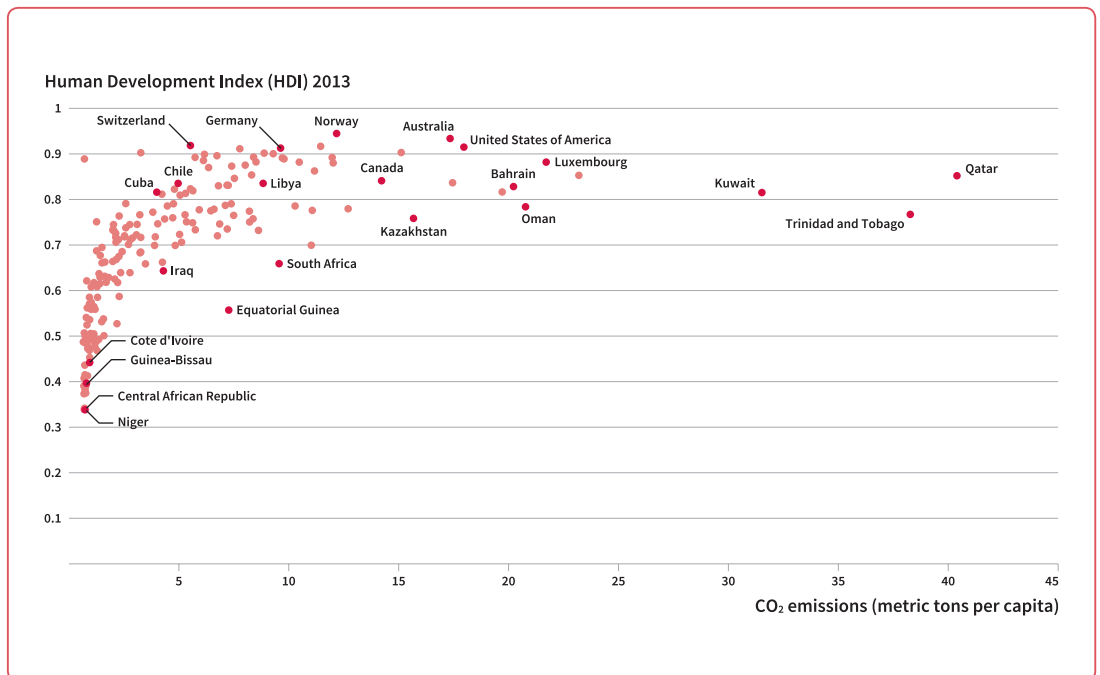
This example shows that human development and low levels of energy consumption are not incompatible. Currently the inflection point in the curve may be around the global average of 5 tons of CO<sub>2</sub> per capita. This still implies emission levels which are far too high to address climate change and achieve sustainability, even though many low-income countries will still have to drastically increase their energy consumption in order to achieve viable levels of development. However, as energy efficiency increases and new technologies come on stream, it is likely that the inflection point will shift upward and to the left, offering higher levels of human development for lower levels of energy consumption.

Similar inflection points can be observed with respect to social progress (Porter et al., 2014), life expectancy (Jackson, 2009) and perceptions of well-being or happiness. As with energy consumption and human development, the relationship between economic growth and social progress changes as income rises (Figure 13.2). At lower income levels, small increases in GDP are associated with large increases in social progress. However, as countries reach high levels of income, the quick wins in social progress arising from economic development are exhausted. For example, Costa Rica, an upper middle-income country with a GDP per capita of US\$11,165, has achieved a level of social progress higher than Italy (GDP per capita: US\$26,310).

Both of these examples highlight that achieving human development and social progress is not dependent on continuous economic growth and increasing energy consumption. In other words, sustainable development is possible.

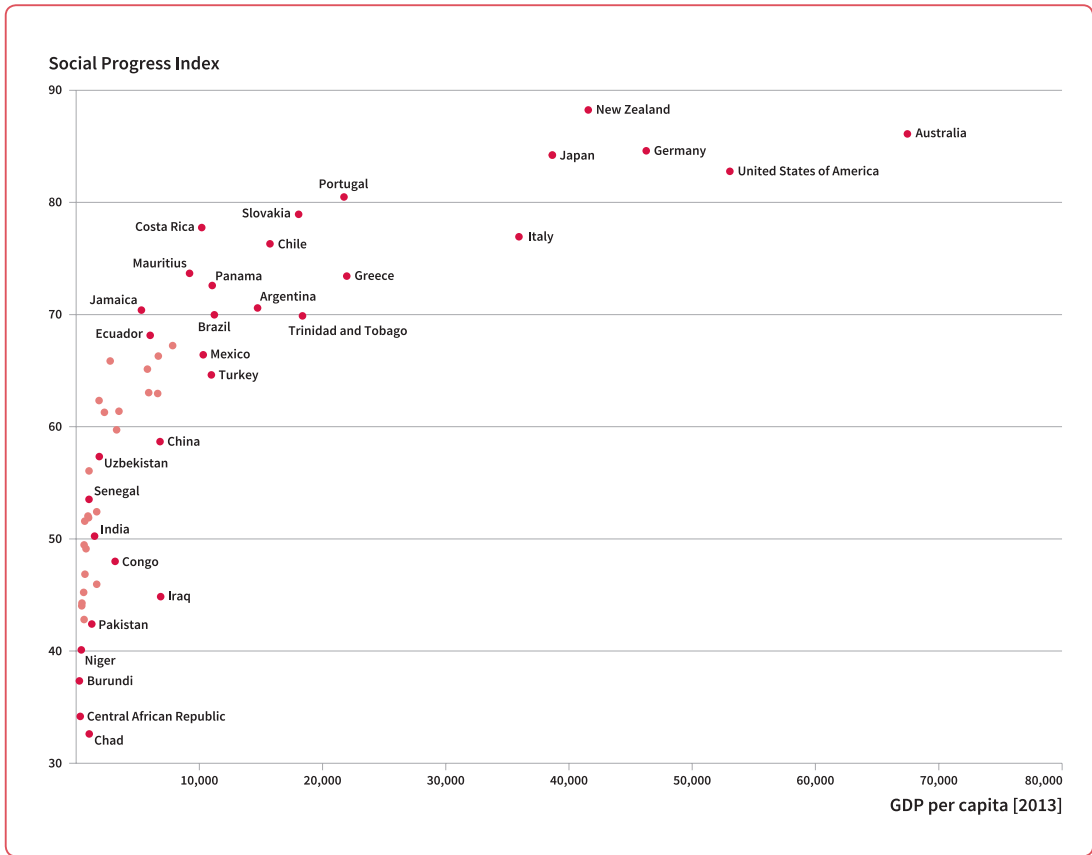
There is now increasing momentum to transform development practices, many of which directly address the underlying risk drivers and contribute to reduced disaster risk. For example, reducing energy consumption and moving to renewable energy reduces the risk of catastrophic climate change; protecting and restoring regulatory ecosystems can reduce weather-related hazard; and climate-smart agriculture can enhance food security. All three previous editions of the GAR have consistently identified and highlighted such practices with co-benefits for disaster risk reduction. These practices range from green roofs and ecosystem approaches to flood management, to innovative approaches to social protection and participatory approaches to urban development. While currently still seeds, these incipient practices do show how new approaches to development transformation are addressing the underlying risk drivers and reducing risks.

**Figure 13.1** The non-linear relationship between human development and energy consumption



(Source: Costa et al., 2011.)

**Figure 13.2** The non-linear relationship between social progress and GDP



(Source: Social Progress Index 2014.<sup>1</sup>)

## 13.3 Managing internalities

**Managing the risks inherent in social and economic activity, rather than mainstreaming disaster risk reduction to protect against external threats, is very different to the current approach to disaster risk reduction.**

The use of human life years as a common currency to measure disaster loss now provides a more complete picture of the true magnitude and impact of disaster loss. This approach highlights that disaster risk is now as much a threat to human development and social progress as avoidable diseases such as tuberculosis and malaria in low and middle-income countries.

The SDGs are likely to feature an important health goal with a view to reducing the global disease burden, for example by ending epidemics of all communicable diseases by 2030. Reducing disaster risk can now be considered equally important if a more sustainable and equitable development paradigm is to be achieved.



Up to now, the relationship between disaster risk reduction, climate change and sustainable development has been addressed through the concept of *mainstreaming*. However, *mainstreaming disaster risk reduction into sustainable development or into climate change adaptation* or, for

that matter, *mainstreaming poverty reduction, ecosystem protection or good governance* are by definition still derived from the conception that disasters and climate change are externalities to be reduced rather than endogenous or internal characteristics of development.

Managing these *internalities* inside development is thus a very different approach to mainstreaming disaster risk reduction to protect against *externalities*. It implies that managing risks should be a defining characteristic of sustainable development. Managing risks—rather than disasters as indicators of unmanaged risk—now has to become endogenous to the DNA of development instead of an exotic add-on that needs to be mainstreamed.

Managing disaster risks requires three mutually supportive approaches or practices:

- **prospective risk management:** preventing or avoiding the accumulation of new and future risks by making risk-sensitive development choices, including in disaster recovery and reconstruction;
- **corrective risk management:** mitigating or reducing existing risks by investing in corrective measures, including early warning and preparedness; and
- **compensatory risk management:** taking measures to support the resilience of individuals and societies in the face of residual risk that cannot be effectively reduced.

These three approaches support all three international agendas under negotiation in 2015: disaster risk reduction, climate change and sustainable development (Table 13.1). Furthermore, they can facilitate the integration of these agendas through the understanding that both disaster risk and climate change are ultimately manifestations of unsustainable development.

Prospective disaster risk management is probably most closely aligned to the notion of sustainability. However, as stressed above, this is not just another way of saying *mainstreaming*. Instead, it points to the need to develop new parameters, principles and tools that transform existing thought and practice from within.

Maybe most importantly, while corrective and compensatory risk management can be interpreted within the current understanding and practice of disaster risk management, prospective risk management is far more disruptive of this paradigm, given that its effectiveness depends more on political than on financial capital.

### The numbers add up

Managing the different layers of disaster risk through appropriate combinations of prospective, corrective and compensatory strategies is essential if the global AAL of US\$314 billion, associated with earthquakes, tsunamis, tropical cyclones and floods in the built environment, is to be reduced and if sustainable development is to

**Table 13.1** Managing disaster risks to support disaster risk reduction, address climate change and promote sustainable development

	Prospective	Corrective	Compensatory
Disaster risk reduction	Preventing or avoiding the generation of new risks	Reducing or mitigating existing risks	Strengthening financial and social resilience to disasters
Climate change	Climate change mitigation	Climate change adaptation	Strengthening resilience to climate risks
Sustainable development	Contributing to the sustainability of new development	Strengthening the sustainability of existing development	Strengthening resilience to everyday risks and shocks

(Source: UNISDR.)



be achieved. Investing in disaster risk reduction is thus a precondition for developing sustainably in a changing climate. However, it is a precondition that can be achieved and that makes good financial sense.

If risk is not reduced, these expected future losses will become a critical opportunity cost for development. In particular, in those countries where disaster risk now represents a significant proportion of capital investment and social expenditure, the capacity for future development will be seriously undermined. In such circumstances, sustained, let alone sustainable, development will be difficult.

It is currently estimated that US\$90 trillion will have to be invested in infrastructure (urban, land-use and energy systems) by 2030 (Global Commission on the Economy and Climate, 2014). This amounts to an average of US\$6 trillion per year over the next 15 years. Additional investment for a transition to low-carbon infrastructure is estimated at around US\$4 trillion in total or another US\$270 billion per year (*ibid.*). If these investments are not made in a risk-sensitive way, the global AAL will continue to increase, even without taking into account likely increases in hazard due to climate change and other factors. In many countries this increase in risk could make the difference between achieving sustainable development or not.

Benefit-cost ratios (BCRs) of disaster risk reduction can only be assessed within specific local contexts and for specific disaster risk management strategies (Shreve and Kelman, 2014), and as such there is no single magic number. In the case of corrective disaster risk management, the costs may exceed the purely economic benefits (UNISDR, 2011a; Kunreuther and Michel-Kerjan, 2012). However, in countries with a high proportion of their current capital stock at risk and low levels of new investment, corrective disaster risk management becomes very important. And if the

indirect benefits of reducing risks are factored in, the BCR of corrective investments may be more attractive.

Typical BCRs for prospective disaster risk management would seem to lie in a range from 3:1 to 15:1 (Shreve and Kelman, 2014) and a broad-based estimate of 4:1 has been suggested (Mechler et al., 2014; Government of the United Kingdom, 2012) in order to give an order of magnitude of the potential benefits of making future investments in a risk-sensitive manner.<sup>2</sup>

If this BCR is applied to the likely new investments in infrastructure, this would imply that an annual global investment of only US\$6 billion in disaster risk reduction over the next 15 years<sup>3</sup> would result in total benefits of US\$360 billion in terms of avoided losses over the whole lifetime of the investment (for example, 50 years for infrastructure).<sup>4</sup> This amounts to an annual reduction of new and additional AAL by more than 20 per cent. Such substantial reduction in expected losses comes at a comparably low cost when put in relation to current flows into climate change mitigation or future investment requirements for power, telecommunications and transport infrastructure (UNCTAD, 2014).

Given that the BCR ratios and discount rates applied to specific investments will vary widely, the above figure only indicates the likely order of magnitude of the required investment. However, given that new infrastructure investments gradually replace existing vulnerable infrastructure, this level of investment would not only protect new development: the global AAL would gradually be reduced. This highlights that disaster risk reduction is not only essential to sustainable development, it is also a sound investment.

**Figure 13.3** The future of disaster risk management



(Source: UNISDR.)

## 13.4 The future of disaster risk management

Therefore, as the global community moves towards establishing objectives and targets under the Sustainable Development Goals (SDGs), which for the first time will be framed for universal application, there is an urgent need to reinterpret disaster risk reduction so that it weaves and flows through development as a set of mutually supportive approaches and practices.

As discussed in Chapter 6, disaster risk reduction itself is rapidly evolving. New stakeholders, including city governments, businesses and the financial sector are driving change. Innovations in areas as diverse as risk governance, risk knowledge, cost-benefit analysis and accountability are challenging old assumptions and creating new opportunities (Figure 13.3).

Rather than a *programme* or *framework* for action, GAR15 presents a discussion on the future of disaster risk management that takes note of this ongoing innovation. Its purpose is to stimulate further reflection, debate and improved practice as countries begin to address the challenges posed by the new international agreements on disaster risk reduction, climate change and sustainable development in 2015 and beyond.



## 13.5 Reforming governance to manage disaster risks

**While countries will continue to require a dedicated and specialized disaster management sector to prepare for and respond to disasters, managing disaster and climate risks in development requires a new approach. It requires strengthened governance arrangements in sectors and territories to minimize the discounting of future risk as well as transparency and accountability as risks are generated, transferred and retained.**

### **The continued need for a specialized disaster management sector**

The governance arrangements required to manage disasters are not the same as those required to manage risks. The management of disasters as events—in particular disaster warning, preparation and response—is a specialized area of governance for which, with important caveats, many of the institutional and legislative arrangements developed over the last thirty years or so are appropriate.

Therefore, countries will continue to require a dedicated and specialized sector to manage disasters, emergencies and other incidents, including maritime, aviation, industrial and environmental accidents. To the extent that risk levels continue to grow, there will be more rather than less demand for specialized disaster management organizations. In other words, countries should continue to develop their capacities for disaster management, including the specialized professional skills, institutional arrangements, policies and legislation required for this purpose.

### **Enhanced sector and territorial governance arrangements to manage disaster risks**

In contrast, managing disaster *risks* makes it necessary to strengthen sector and territorial governance arrangements. Rather than specialized arrangements for disaster risk governance, the key question is how governance in general can be

enhanced to minimize the discounting of future risk as well as transparency and accountability as risks are generated, transferred and retained (Wilkinson et al., 2014; UNISDR, 2011a; Lassa, 2010).

This implies the need to relax and dispel the notion that disaster risk management has to be a *sector* and to shift the focus towards weaving risk management *into* development. Managing disaster risks should cease to be seen as an exotic practice for which responsibility has been assigned to a specialized sector (Gall et al., 2014c). Instead, it should become a normal part of day-to-day development planning and decision-making across all development sectors. The differentiation between risk governance and development governance is a false one and contributes to the current situation where the costs of risk generation and accumulation are externalities that remain hidden and unaccounted for, limiting accountability at all levels.

This has several implications. Firstly, the capacity of countries to manage their disaster risks will depend on the overall quality and strength of governance. This implies that it is highly unlikely that countries where corruption is rife, where there is no freedom of the press, where there is civil or military conflict, or where there is little respect for human rights in general will be able to manage their disaster risks effectively (Alexander and Davis, 2012). The governance of disaster risk is never autonomous from the quality of governance in general. Strengthening the quality of overall governance is therefore critical to strengthening the governance of disaster risk.

Secondly, it implies that the priority given to managing disaster risk will be closely associated with the priority given to addressing the underlying risk drivers. The political priority accorded to reducing poverty and inequality, protecting and restoring biodiversity, and planning and managing sustainable urban development will largely determine the political priority assigned to reducing disaster risk.

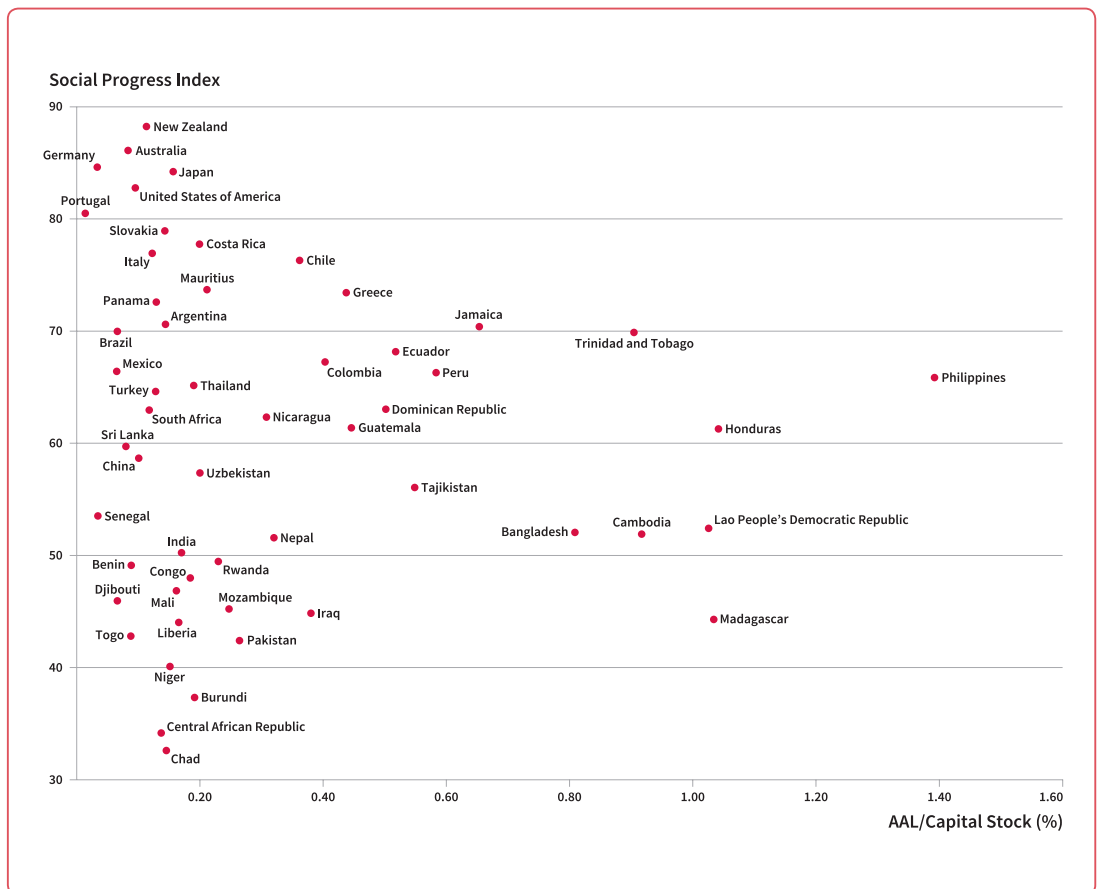
Thirdly, if disaster risk is driven into previously unknown orders of magnitude and into new domains, the ability to manage known risks will be only one pillar of effective risk management. Instead, the general agility required to manage risks as they emerge by anticipating, adapting and continuously transforming may be more important—particularly where it builds general as opposed to specific resilience (Pelling, 2014; Cavallo and Ireland, 2014; Ray-Bennet et al., 2014). This implies that managing disaster risks should be seen as part of a broader approach to managing risks of all kinds.

The concept of social progress is useful as it incorporates many of the characteristics that

will be required to manage risks effectively: basic human needs, foundations of well-being, and opportunity.<sup>5</sup>

As such, countries that score highly on the Social Progress Index are likely to have greater capacity to manage and reduce their disaster risks. This is important because it implies that sound disaster risk management is not only a prerogative of high-income countries, but rather of all countries that have achieved a certain level of social progress. For example, while Mauritius and Iraq exhibit very similar levels of disaster risk, Mauritius has attained a far higher level of social progress and is therefore better positioned to manage its risks (Figure 13.4).

**Figure 13.4** Social progress and average annual loss



(Source: UNISDR with data from Global Risk Assessment and the Social Progress Index.)

## Change is in the air

Many of the required governance reforms have already been described in detail in previous editions of the GAR (UNISDR, 2009a, 2011a, 2013a). Managing disaster risks requires strong local governance and the willingness and capacity of local authorities to work in partnership with low-income households and communities and civil society. Strong political authority at the national level is required to ensure that policies, strategies and legislation are implemented across sectors and in regional and local governments. It is likewise necessary to fully engage the private sector at the national, city and local levels.



The management of disaster risks needs to be part of a broader approach to risk management that also looks at biological, technological, financial and other risks. In addition, robust social accountability can be strengthened through public information and transparency. Greater synergy needs to be generated between the management of disaster risk and that of climate change, and between those two areas and sustainable development.

These general principles will need to be interpreted in the light of constitutional, political and administrative arrangements in each country. While models may exist for disaster management, no single model can exist for disaster risk reduction. The specific configuration of regulation and incentives and of central policies and local implementation will vary immensely from country to country (Gall et al., 2014c). Success will depend on the adoption of appropriate policies, strategies, norms and standards in each sector and at each level of territorial government.

The question of where the locus of responsibility for disaster risk reduction should reside within government remains unresolved (UNISDR, 2011a,

2013a; Wilkinson et al., 2014; UNDP, 2014a). This is partly due to the “no size fits all” issue common to all governance questions and partly due to the limited understanding of how distance and power-sharing dynamics between different tiers of government and co-responsibility mechanisms across departments play out in specific contexts.

Some countries are already taking steps to manage disaster risks within a broader governance framework. Finance and planning ministries in a number of countries, including Costa Rica, Panama and Peru, are working to integrate disaster risk management into public investment planning and evaluation. In Mexico, the sophisticated risk financing arrangements put in place for disaster risk management are part of a broader strategy to strengthen financial resilience in the public sector. In Peru, a new institutional framework has been put in place to manage disaster risks, while new legislation in Colombia strengthens accountability not just for disasters but also for disaster risk generation. Another recent innovation has been the introduction of chief risk officers at both the city and national levels as a mechanism to ensure coherence in risk management efforts.<sup>6</sup>

How effective these emerging governance arrangements turn out to be will only be seen with time. However, they do highlight that reforming disaster risk reduction is not merely a theoretical construct. Driven by their own experiences, countries are already experimenting with new forms of risk governance.

## 13.6 From risk information to risk knowledge

**Risk awareness and knowledge must be expanded and enhanced. To this end, the social production of risk information has to be transformed and the provision of information has to be turned into a social process of producing risk knowledge.**

### Transforming the social production of risk information

A first step towards the enhanced management of disaster risk is through greater risk awareness and knowledge. The social production of risk information itself needs to be transformed, with a shift in focus from the production of risk information *per se* towards information that is understandable and actionable for different kinds of users: in other words, risk *knowledge* (CDKN, 2014; GFDRR, 2014a). Risk information needs to be embedded as risk knowledge in all development decision-making processes. For example, while finance ministers require numbers that depict risks to the national economy, development sectors or global businesses will require information on the risks to specific portfolios of assets, while land-use planners will require geographic information on hazard levels. This implies the need to move from the kind of global risk information presented in this report towards far more granular information relevant to specific users, sectors and territories.

This transition will require change in the way risk data and information are currently produced and transformed. On the one hand, it will require governments to invest in the collection, management and dissemination of risk information, including disaster loss and impact statistics, hazard models, exposure databases and vulnerability information. At the same time, governments need to put standards and mechanisms in place to ensure openness and transparency so that users not only have access to the information they need

but are aware of its underlying assumptions and limitations.

A change of perspective in the production of risk information is also required, from measuring risk as an objective externality that can be reduced towards a deeper understanding, identification and estimation of the causes and consequences of risk generation and accumulation in a way that reveals risk as both an opportunity and a threat.

### Sensitivity to extensive risk

An increasing sensitivity to extensive risk is crucial to strengthening overall risk awareness. Because of its pervasiveness in time and space, extensive risk relates directly to the day-to-day concerns of households, communities, small businesses and local governments and can therefore stimulate and leverage social demand for disaster risk management. Extensive disasters provide real-time and locally specific indicators of how risk is generated inside poverty in everyday life. As a result, disasters of this sort provide a window to understand risk in the here and now, rather than in an abstract future.

At the same time, precisely because it is the risk layer that most internalizes social, economic and environmental vulnerability, extensive risk is the most susceptible to effective management through an appropriate combination of prospective, corrective and compensatory measures. Understanding how extensive risk is generated from conditions of everyday concerns, including fragile employment markets and livelihood options as well as limited access to health care and education, not only reaffirms and demonstrates how risks are socially constructed but can also facilitate practical action to reduce them. A focus on extensive risk and local development may hold the key to incremental and sustainable changes in development practices in a way that weaves the management of disaster risks into the creation of social and economic opportunity. Visualizing patterns and trends in extensive risk



is empowering precisely because most extensive risks are “manageable” and can be addressed through relevant and effective public policies and private action.

Awareness of extensive risk does not in itself lead to transformation. Citizens, households, small businesses and local governments often accept and retain high levels of disaster risk because of highly constrained access to the assets and resources required to reduce those risks. However, a message that centres on aspects of prosperity, choice and quality of life rather than on notions of avoided deaths, vulnerability reduction and cost savings may be able to link substantive individual desires and social needs to the management of risk, even in contexts where development choices are highly constrained.

### **Risk knowledge and changing values**

This perspective also has implications for current efforts to boost public awareness, education and risk information, which tend to reflect and reinforce the orthodox conception of disasters as external threats to development. Rather than revealing opportunities or empowering actions to change development practices, these efforts actually dissimulate the drivers that generate and accumulate risk in the first place. Shifting the emphasis from awareness of disasters as external events towards the process of risk generation and accumulation in development is therefore critical.

The importance of incorporating this approach into formal and informal education and into public awareness campaigns with a particular focus on children and young people as well as taking advantage of social media and new technologies for visualization cannot be overstated. As awareness gradually shifts from disaster losses and impacts to the underlying drivers of risk, a vision of a different way of practising development could gradually emerge, as could effective ways and means of addressing the risk drivers.

## **13.7 Assessing the costs and benefits of managing disaster risks**

---

**Understanding the costs and benefits of managing disasters will become a key tool for future success. This means understanding and measuring the trade-offs implicit in decisions; their benefits in terms of reduced poverty and inequality, environmental sustainability, economic development and social progress; and who retains the risks, who bears the costs and who reaps the benefits.**

### **Encoding disaster risk metrics into public and private investment**

Disaster risk management always weighs risk against opportunity and future threats against current needs. A second way in which the management of disaster risks can be enhanced is by ensuring that the associated costs and benefits are fully encoded into public and private investment at all levels, into the financial system and into the design of risk-sharing and social protection mechanisms.

All development decisions, whether they are related to capital investment, social expenditure or environmental protection, have the potential to either reduce or increase risks. Risk metrics are critical to inform such decisions and to identify the costs, benefits and trade-offs implicit in each decision.

If demand were led by governments, businesses and a financial sector concerned with sustainability and competitiveness, risk metrics could then cease to be an exotic commodity generated inside a self-contained risk assessment community. These metrics could become integrated as a normal part of government, business planning and decision-making processes.

Accessible and transparent probabilistic risk estimates are critical for assessing the costs and

benefits of public and private investments in development. In the case of countries and national governments, reliable and resilient critical infrastructure then becomes an integral component of strategies to enhance competitiveness and sustainability and to attract investment (UNISDR, 2011a). In business, reliable and resilient supply chains are also critical to competitiveness, sustainability and reputation (UNISDR, 2013a).

At present, the application of cost-benefit analysis in disaster risk management is usually limited to considering the avoided replacement costs of damaged buildings or infrastructure versus the additional costs of reducing risks. This analysis needs to be expanded to highlight the trade-offs implicit in each decision, including the downstream benefits and avoided costs in terms of reduced poverty and inequality, environmental sustainability, economic development and social progress as well as a clear identification of who retains the risks, who bears the costs and who reaps the benefits.

This approach will not only provide a much more compelling case for disaster risk reduction but also help to clarify questions of accountability, namely who exploits and benefits from the opportunities represented by risk, who suffers the consequences if risks are not managed, and who bears the costs. Currently ongoing work to measure the costs and benefits of ecosystem services (TEEB, 2013) may provide guidance for the development of new risk metrics that can enable disaster risk reduction to play such a transformational role.

Adequate risk metrics produced in this way could enable both public-sector and business investment decisions to take a layered approach to managing risk.

Fundamentally, this involves determining the optimum balance in terms of how much to invest in prospective, corrective and compensatory

disaster risk management strategies (UNISDR, 2011a). Normally it is more cost-effective to reduce than to retain the more extensive layers of risk and to use compensatory mechanisms to address those risks which cannot be reduced in a cost-effective manner. Similarly, it is generally more cost-effective to avoid the creation of new risk than to reduce existing risk.

If the definition of costs and benefits is expanded to include not only those applicable to business and to government but a *shared value* approach that includes the value of wider societal and environmental costs and benefits, then risk layering can dramatically change the character and impact of public and private investment decisions.

### Encoding disaster risks into the financial system

Disaster risk metrics can and should also be fully encoded into the financial system. New initiatives such as the *1-in-100 Initiative*<sup>7</sup> have already begun to point in that direction, recommending that disaster risk metrics should be available to institutional investors, including pension and sovereign wealth funds. These metrics should be used to measure not only the potential risks inherent in portfolios of assets, which can represent a risk to those investing in these instruments, but also the broader risks posed by the investments.

For example, if a given investment portfolio is excessively concentrated in urban development in highly hazard-exposed locations, then it poses risks to investors themselves that need to be made explicit (e.g. by measuring the AAL as a percentage of the exposed portfolio). At the same time, the risks posed by these investments to the regional economies and urban centres where they are made also need to be stated explicitly.

Risk metrics can also make it possible to identify the risk financing gaps that governments

may face when confronted with large disasters. As highlighted in Chapter 5, many governments lack the financial resilience to absorb the impact and recover from a 1-in-100-year loss. Similarly, disaster risks need to be considered in a broader view of the risks associated with lending to governments, businesses or households in hazard-exposed countries. This encoding of disaster risk into financial decision-making should be regarded as a basic principle of sound risk management.

Disaster risk metrics also need to be considered in the formulation of credit and debt ratings, in indices that measure the attractiveness of sectors and countries for investment, and in performance forecasts for both businesses and countries. Disaster risks should also be disclosed by way of statutory reporting on the part of businesses, financial institutions and governments. Encoding risk metrics into these broader investment metrics is critical to changing investor behaviour and increasing awareness of disaster risks in a broader risk perspective.

### **Expanding offers of risk financing and social protection**

At the same time, this broader approach to calculating the costs and benefits of risk management may also provide a better rationale for the expansion of risk financing and social protection measures to low-income households, small businesses and weak local governments.

Many innovative mechanisms for insurance and social protection have been piloted. However, unless the parameters for calculating their costs and benefits change, it is unlikely that there will be a significant shift in the current situation where the insurance and reinsurance sector is overcapitalized while a vast majority of households and businesses in low and middle-income countries have no access to insurance or other forms of risk financing.

If the broader benefits of strengthened resilience and rapid recovery could be calculated, then it is likely that the benefit-cost ratio of investments in social protection and accessible insurance cover would become more attractive. Currently, the fact that disaster impacts such as deteriorating health and nutrition or lost educational opportunities are not considered part of the opportunity cost arising from a lack of social protection is an obstacle to increasing coverage substantially.

### **Extensive risk and social demand**

Everyday risk and extensive disaster risk are not externalities to poverty reduction; they are central characteristics of poverty. National and international poverty reduction, access to education and improvements in health cannot be achieved if the accelerating loss of schools, health facilities, housing and local infrastructure through extensive disasters continues to be ignored and discounted.

Social demand for clean water, waste disposal, security, employment, adequate housing, transport and access, education and health does not need to be promoted because it already exists in forms that reflect the specificity of local contexts. In contexts with high levels of (mainly) extensive risk, this social demand often includes protection from loss and damage. As such, the satisfaction of basic needs and the creation of opportunities for local social and economic development can become a vehicle and an opportunity to address disaster risks at their source.



If awareness extends from extensive risk to the underlying risk drivers, then the link to transforming local development becomes explicit and obvious. The conservation of a local watershed may improve the quality and availability of drinking water *and* reduce flood risk. Developing systems to collect and recycle household waste may

improve the quality of the environment, generate employment and income, *and* reduce the risk of flooding due to garbage-choked drainage channels. Regenerating mangroves may also help regenerate fish stocks, enhance local fishing activities *and* protect coasts from erosion and storm surges. Providing well-sited land for new housing may reduce the cost of providing infrastructure and services *as well as* reducing disaster risk. Terracing hillsides may increase agricultural production *and* reduce landslide hazard.

This approach is very powerful because it leverages the underlying risk drivers themselves as instruments of sustainability. The energy present in floods, landslides and other local disasters can be transformed and used constructively as energy for sustainable development.

## 13.8 Strengthening accountability for risk management

**As societies become more sensitive to the causes and consequences of disaster risk, responsibility for disaster losses and impacts can be subjected to social discourse and negotiation. Standards and transparent monitoring frameworks for risk accumulation and reduction can play an important role in this context.**

### Accountability for risk generation

It will only be possible to encode the full costs and benefits of disaster risk management into investment decisions, the financial sector, risk financing, social protection and local development if those responsible can be held to account for their decisions. If societies become more sensitive to both the causes and consequences of disaster risk, responsibility for the subsequent losses and impacts will become a societal issue that can be subjected to social discourse and negotiation. This can lead to strengthened accountability not only for realized disaster loss and impacts, but also for the generation and accumulation of future risks.

Accountability mechanisms of any kind depend on agreement regarding who should be accountable for what. Currently, the fact that disasters are still seen as exogenous shocks rather than unresolved development problems means that losses and impacts are attributed to the physical hazards or forces of nature rather than those who generate and accumulate risks. At the same time, accountability is rarely a straightforward issue. Responsibilities for risk generation may be complex or diffuse, involving actions by both public and private stakeholders over a number of years and including non-decisions and non-actions.

### Due diligence

At the core of the issue of accountability is the question “Accountable for what?” Should accountability for disaster risks and losses be measured according to what was known and acted on, or should the corresponding responsibilities rather be judged on the basis of what could and should have been known? The latter is an understanding of accountability based on the principle of due diligence, and it has important implications for the use of risk metrics in public and private investment planning.

If the due diligence principle is applied, risk metrics not only become a tool for evaluating the costs and benefits of managing disaster risks, but can also serve as a form of indemnity in the case of disasters. This principle may have the potential to support a new framework for the rights of citizens and businesses with respect to disaster loss and risk.

However, it is necessary to ensure better access to the risk information used by those who make investment decisions, as this information can enable others, including citizens and local authorities, to make sense of the decisions taken.<sup>8</sup> Currently, severe asymmetries in the generation and availability of risk information are associated with a lack of accountability at all levels. However, social media as well as other new



and disruptive technologies and communication tools have the potential to break down barriers and drive social demand for accountability in risk generation and accumulation.

Globally, due diligence is a sensitive topic because it touches on issues of national sovereignty. The problem of ownership of accountability mechanisms for disaster risk at the global scale has not been tackled to date. Implicitly, each state is responsible for the security of its citizens, but responsibility for the creation of risks that affect other countries (e.g. through climate change or risk-generating investments) is not spelled out.

### **Accountability and social demand**

Social demand and accountability go hand in hand: without bottom-up demand, even high levels of political support for disaster risk reduction will fail to create the type of accountability mechanisms required to effectively address factors such as corruption and the preference for short-term profit over long-term sustainability. However, experience shows that social demand is unlikely to be a response to national policies, laws or new administrative mechanisms, but rather to experience with disasters themselves.

As social media continues to develop rapidly, it becomes more difficult to hide or dissimulate the causality of risk generation and accumulation. Social demand for accountability can become a critical transformer, as it in itself represents a key reputational risk for politicians and business leaders alike. Online petition platforms such as Avaaz.org now regularly “name and shame” governments, companies and business leaders.<sup>9</sup> For example, when a garment factory in Bangladesh collapsed in April 2013, burying numerous underpaid workers under the rubble, public outrage spread rapidly via websites, blog posts and online communities. Within days, a number of high-profile online campaigns had been launched against popular clothing brands, and within a matter of weeks those campaigns succeeded in getting

more than 75 large companies to sign the Accord on Fire and Building Safety in Bangladesh in support of an enforceable worker safety plan.<sup>10</sup>

### **Normative frameworks for accountability**

To date, the normative frameworks that could provide the basis for accountability mechanisms are mostly limited to disaster management (IFRC and UNDP, 2014). Developing accountability mechanisms for risk generation is more challenging, especially with regard to setting targets and determining roles and responsibility. However, this approach has begun to emerge in recent laws, such as those passed in Colombia (Government of Colombia, 2012) and in India (IFRC and UNDP, 2014). For example, a public interest lawsuit was filed with the Supreme Court of India in 2013 against the governments of six states, claiming that the national Disaster Management Act of 2005 had not been implemented properly (ibid.). More recently, and as highlighted in Chapter 6, local authorities in France have been indicted for permitting the urbanization of flood-prone areas.

The different powers within a state will have different roles to play: while the executive branch may have the ability to set goals and targets, several countries are currently experimenting with oversight bodies in the form of parliamentary committees, entire parliaments or ombudsmen. However, the strengthening or adoption of accountability mechanisms ultimately needs to be appropriate to different local and national contexts. These mechanisms may include actions by national control or audit offices to ensure that disaster risk management policies are being applied by sectors or local governments; actions by the judicial branch of government to investigate cases of negligent or malicious risk generation; assessments by the legislative branch of government, for example through parliamentary committees, regarding the implementation of disaster risk management policies and strategies; and potentially new functions such as a risk

ombudsman to assist in resolving conflicts.

### **Voluntary standards**

Voluntary standards have the potential to become a transformational force in strengthening accountability. They can help raise awareness and engagement in risk management by offering simple and agreed metrics put forward in a language and formats familiar to businesses, local governments and communities (UNECE, 2014). The consistency and interoperability of risk and loss information are particularly critical to adopting and applying disaster risk metrics, but they require voluntary standards to achieve those ends.

Currently risk management standards use tools, indicators and language that can enable diverse stakeholders to pool expertise and resources and effectively ground both business strategies and policy-making objectives. But promoting and widening the reach of the transformative energy of voluntary standards requires investment by both governments and the private sector (UNECE, 2014), for example in the quality infrastructure required to monitor and provide credible evidence of compliance as well as quality, reliability and dependability.

These investments will allow a meaningful comparison across geographies and time frames on the basis of agreed and clear metrics. Even without a formal certification process, their successful implementation can generate not just a sense of shared responsibility but also real shared value (UNECE, 2014). In this way, national and international standards can contribute to transforming concrete practice in communities, businesses and governments, as well as promoting a change in the culture of accountability from a business-savvy one of cutting costs by circumventing regulation to one where compliance with voluntary standards is seen as an investment with a potentially high rate of return.

In order to harness the power of voluntary standards, governments can play a crucial role in promoting and widening their reach by making them available to and encouraging their application in small and medium enterprises, universities and vocational institutions, and by convening the standardization community for disaster risk-related consultations and decision-making processes (UNECE, 2014). The infrastructure that would be required to successfully support the spread and further development of standards requires investment in skilled professionals who can audit infrastructure and industrial plants on the basis of cross-sector and sector-specific standards.

### **Setting targets and monitoring progress**

Accountability also depends on some form of monitoring, evaluation and reporting as well as benchmarking and target-setting. Another critical means of transformation, therefore, would be to strengthen the monitoring of progress in a way that increases transparency and accountability. There are a number of ways in which this could happen.

The first is to set global and national targets for the reduction of disaster risks, together with understandable and measurable indicators. As disaster losses are only indicators of development failures, monitoring trends in those losses can be a powerful tool for measuring the transformation of development. Measuring whether disaster losses and impacts are trending up or down can provide insight not only into the progress of disaster risk reduction, but also into the implementation of the Sustainable Development Goals (SDGs) and the United Nations Framework Convention on Climate Change (UNFCCC).

Secondly, in order to capture the full scope of progress, it is necessary to monitor risk management outputs not just across the disaster risk reduction sector but across all development sectors with respect to whether the different



underlying risk drivers are being addressed or not.

In order to ensure that monitoring supports national planning and decision-making, the indicators themselves need to be appropriate, tied to specific public policies and assigned clear ownership among different ministries or departments. Ideally, key performance indicators for key management and government positions should include risk management deliverables, which would promote a better understanding of the risk-related consequences of everyday decision-making.

Monitoring must explicitly embrace actions at the local government level, where most disaster risk management implementation actually takes place, and it needs to be flexible enough to adapt to national planning cycles and maximize the use of nationally generated data as well as locally relevant information from communities at risk.

Finally, the monitoring process needs to be tied to an explicit accountability mechanism, be it a parliamentary review or a national audit body. Otherwise it would have no incisive power and may serve to legitimize symbolic actions to manage and reduce disaster risks rather than becoming a critical mechanism to transform development and address the underlying risk drivers.

## 13.9 A different future?

**If managing disaster risks can enable societies to learn from the past in order to change the future, it may hold the key to sustainable development.**

Currently, surveys indicate waning confidence in the political classes and business leaders, as the benefits of economic growth are becoming more concentrated and less evenly distributed.<sup>11</sup> While direct disaster losses of up to US\$300 billion do

not seem to have been sufficient to change the way risk is valued and priced, the threat of a collapse of the planet's systems, particularly through climate change, does now seem to be catalysing a growing social demand for approaching development in a different way.

There is evidence of increasing momentum to transform development practices from the private sector, citizens and cities in some sectors, such as renewable energy, water and waste management, natural resource management, green building and infrastructure, and sustainable agriculture. This is being driven by a combination of citizens' concern for the planet, particularly among the young, the opportunity for businesses to improve their competitiveness and value proposition by reducing their energy consumption and other costs, and the rapid roll-out of new technologies in these areas, which in turn is spurring the emergence of dynamic new business sectors.

Importantly, this kind of transformation is no longer restricted to Europe or North America. For example, China, India and other rapidly growing economies are now taking the lead in both the development and adoption of the technologies required to transform the energy economy.

While citizens, communities or businesses may stimulate new development practices, change ultimately needs to be encoded in law and regulation: a complex process mediated by a range of politically and socially contentious issues, such as land rights or corruption.

However, at least these new development practices may now be starting to receive political and financial support from governments, businesses and the financial sector at the global level. The UN Climate Summit held in New York in September 2014 highlighted a long series of pledges and commitments (Box 13.2) which, if fulfilled, may catalyse further change.


**Box 13.2** Principal commitments from the UN Climate Summit

In September 2014, 120 Heads of State and thousands of representatives from the private sector, academia, multilateral development organizations and NGOs convened in New York and made a number of high-visibility statements and commitments in support of climate change mitigation and adaptation.



For example, the investment and asset management community made commitments to increase climate-smart investment to US\$500 billion by 2020 and to report on progress in the context of the post-2015 framework for disaster risk reduction, while the finance industry committed to integrating disaster and climate risk into financial regulation beyond insurance and across public and private accounting through 1-in-100-year stress tests.

These commitments were made jointly and were fully endorsed by groups of governments, development banks, insurers, investors, regulators and relevant science institutions. The ambition of these pledges is significant because a number of them address critical nodes in the global financial and economic system that have the potential to become game changers.

(Source: United Nations.<sup>12</sup>)

What is less clear is how much of this change will really address inequality, which, as discussed in Part III, permeates the underlying drivers of disaster risk. For example, globally it will be politically challenging to agree on equitable and sustainable levels of consumption. However, without such a consensus the risks of worsening inequality, disasters and conflict can only increase (Rockström et al., 2013).

Does this mean that sustainable development is unlikely to be achieved or even prove useful as a concept? Not necessarily. It may depend on a number of factors, including scale.

Risk is an integral part of human action and development, and it represents a potential threat as well as an opportunity. The social processes involved in its construction are directly related to past and existing development paradigms. Collective and individual perceptions and reactions to hazard and risk contexts as well as the values attached to disaster risk are constructed in these paradigms. To a large extent, values also determine the direction of future pathways that countries and societies take. These values and the associated assumptions shift constantly, sometimes overtly and abruptly, but mostly slowly,

usually remaining implicit rather than explicit and immediately visible.

**A different future?**


At the global scale, change can be accelerated by massive shocks to the system that ripple across a significant number of countries and interest groups. The 2008 financial crisis and its fallout in the years since may be such a shock, even though some of the longer-term effects are yet to be seen. At the local scale, change may be more incremental but ultimately meaningful (Pelling, 2014).

From that perspective, disasters themselves are powerful agents of change given that they liberate huge quantities of accumulated risk and energy. They have extraordinary power to reveal the multiple dimensions of past development malpractice and the underlying drivers of risk as well as potential levels of future loss and damage.

The existential importance of disasters, therefore, may be their ability to help people learn from the past to change the future. They can point to transformational principles to be incorporated



in development practice that will include not just quantitative values, but qualitative indicators of fundamental changes in ethics, morality, equity, efficiency, participation and accountability. From that perspective, disaster risk reduction has the potential to become a truly transformational force.

The reduction of poverty, the improvement of health and education for all, the achievement of sustainable and equitable economic growth and the protection of the health of the planet now depend on the management of disaster risks in the day-to-day development decisions of governments, companies, investors, civil society organizations, households and individuals. Strengthened disaster risk reduction, therefore, is essential to make development sustainable.

## Notes

---

- 1** <http://www.socialprogressimperative.org/data/spi>.
- 2** For more information on the limitations of CBA and BCRs as well as an analysis of recent studies, see Shreve and Kelman, 2014; Mechler et al., 2014.
- 3** There is little information available on how to reasonably estimate the costs of disaster risk reduction activities that span structural and non-structural approaches and include direct and indirect costs as well as those arising from integrating risk considerations in development practice (Vorhies, 2012). However, based on similar estimates for climate change adaptation (IPCC, 2014; IBRD and World Bank, 2011), this estimate can be considered to be conservative.
- 4** If the discount rate were changed to 10 per cent, total savings by 2030 would still be US\$2.4 trillion. While it is common to use a discount rate of 3-5 per cent when assessing the BCRs of social development investments (see <http://cbkb.org/toolkit/discounting/>), the majority of CBAs for disaster risk reduction projects use a single discount rate of 10-12 per cent or a range of rates between 0 and 10 or 0 and 20 per cent (Shreve and Kelman, 2014).
- 5** <http://www.socialprogressimperative.org/data/spi>.
- 6** <http://www.emergencymgmt.com/disaster/Chief-Resilience-Officers.html> (accessed 11 January 2015).
- 7** <http://www.un.org/climatechange/summit/wp-content/uploads/sites/2/2014/09/RESILIENCE-1-in-100-initiative.pdf> (accessed 11 January 2015).
- 8** Chris Lavell, commentary during UNISDR-UNDP-FLACSO meeting in San José, GAR15 meeting series on the Future of Disaster Risk Management, March 2014.
- 9** [www.avaaz.org](http://www.avaaz.org).
- 10** <http://bangladeshaccord.org>.
- 11** For example, see the results of recent surveys such as the Edelman Trust Barometer 2014, which states that “Overall, trust in leadership has plateaued. [...] CEOs and government leaders remain at the bottom of the list for both Informed and General Publics, with extremely low trust levels on key metrics” (<http://www.edelman.com/insights/intellectual-property/2014-edelman-trust-barometer>).
- 12** <http://www.un.org/climatechange/summit>.



# Glossary

GAR15 uses a set of terms and definitions that build on those included in the previous three GAR.

**Disaster risk** is considered to be a function of **hazard**, **exposure** and **vulnerability**. Disaster risk is normally expressed as the probability of loss of life, injury or destroyed or damaged capital stock in a given period of time. Generic definitions of these and other terms are available in the UNISDR Glossary.<sup>i</sup> The way these terms are used in GAR15 is explained below.

GAR15 uses the term **physical** (rather than **natural**) **hazard** to refer to hazardous phenomena such as floods, storms, droughts and earthquakes. Processes such as urbanization, environmental degradation and climate change shape and configure hazards; therefore, it is becoming increasingly difficult to disentangle their natural and human attributes. **Exposure** is used to refer to the location of people, production, infrastructure, housing and other tangible human assets in hazard-prone areas. **Vulnerability** is used to refer to the susceptibility of these assets to suffer damage and loss due to socially constructed factors that result in unsafe and insecure conditions in the built and human environments. **Resilience** is used to refer to the capacity of systems (ranging from national, local or household economies to businesses and their supply chains) to anticipate, absorb or buffer losses, and to recover.

**Extensive risk** is used to describe the risk of low-severity, high-frequency disasters, mainly but not exclusively associated with highly localized hazards. **Intensive risk** is used to describe the risk of high-severity, mid to low-frequency disasters, mainly associated with major hazards. **Emerging risk** is used to describe the risk

of extremely low-probability disasters associated with new patterns of hazard and vulnerability. Geomagnetic storms, for example, have always occurred, but the associated risks are now magnified by the growing dependence of modern societies on vulnerable energy and telecommunications networks. **Underlying risk drivers** are processes such as badly planned and managed urban and regional development, environmental degradation, poverty, climate change and weak governance, which directly shape risk patterns and trends. **Risk inequality** is used to describe the uneven social, economic and territorial distribution of disaster risk.

**Direct disaster losses** refer to damage to human lives, buildings, infrastructure and natural resources. Economic direct losses are calculated using proxies for replacement costs. **Indirect disaster losses** are declines in output or revenue, as a consequence of direct losses or owing to impacts on a supply chain. **Wider impacts** include longer-terms social and economic effects, for example in education, health, productivity or in the macro economy.

The Global Risk Assessment uses a **probabilistic** approach. **Probability** is defined as the likelihood of a loss occurring compared to all the possible losses that might occur. The **exceedance probability** is the likelihood of a loss of a given magnitude occurring or being exceeded within a defined time span. **Frequency** is the expected number of times that a particular loss occurs in a defined time span. **Return period** is the average frequency with which a particular loss is expected to occur. It is usually expressed in years, such as 1 in X number of years. This does not mean that a loss will occur once every X numbers of years, but rather that it will occur once on average every

X number of years. It is another way of expressing the **exceedance probability**: a 1 in 200 years loss has a chance of 0.5 percent to occur or be exceeded every year. **Annual average loss (AAL)** is the estimated average loss annualised over a long time period considering the full range of loss scenarios relating to different return periods. The **probable maximum loss (PML)** is the maximum loss that could be expected for a given return period, for example of 250 years.










**Capital stock** as referred to in GAR15, and in particular in its risk assessments, is the total value of commercial and residential buildings, schools and hospitals in each country. This excludes infrastructure such as roads, telecommunications and water supply. **Capital investment** is measured as the total investment by the private and public sectors in a given year, using the metric of **gross fixed capital formation (GFCF)**. **Social expenditure** relates to government spending on education, health and social protection. In GAR15, **relative disaster risk** is estimated by comparing the AAL or PML with capital stock, capital investment, social expenditure or other economic metrics, such as savings or reserves.

**Bio-capacity** stands for biological capacity both to produce useful biological materials as well as to absorb waste, such as carbon dioxide. It is related to the concept of **ecological footprint**, which is calculated by considering all of the biological materials consumed and all of the carbon dioxide emissions generated by a person in a given year. Together the two concepts provide a common basis on which to compare the biological capability of the environment with the demand placed by human populations on this capacity. **Planetary boundaries** refer to the limits to critical planetary systems which if crossed could lead to dangerous or irreversible change in the Earth system.

**Disaster risk reduction (DRR)** describes the policy objective of anticipating future disaster risk,

reducing existing exposure, vulnerability or hazard, and strengthening resilience. **Disaster risk management (DRM)** describes the actions that aim to achieve this objective including **prospective risk management**, such as better planning, designed to avoid the construction of new risks; **corrective risk management**, designed to address pre-existing risks; and **compensatory risk management**, such as insurance that shares and spreads risks. **Disaster (or emergency) management** is used to refer to the cluster of measures, including preparedness and contingency planning, business continuity planning, early warning, response and immediate recovery to deal with disasters once they are imminent or have occurred.

**Governance** refers to the different ways in which governments, the private sector and in general all individuals and institutions in a society organize themselves to manage their common affairs. Within this broader governance concept, **disaster risk governance** refers to the specific arrangements that societies put in place to manage their disaster risk.

-  **Earthquake**
-  **Tropical cyclone**
-  **Tsunami**
-  **Flood**
-  **Volcano**
-  **Drought**
-  **Rain**
-  **Capital investment**
-  **Capital stock**
-  **Social expenditure**

---

i See UNISDR, 2009. Terminology on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.

# Acronyms

<b>AAL</b>	Average Annual Loss
<b>BCR</b>	Benefit-Cost Ratio
<b>CBA</b>	Cost-Benefit Analysis
<b>CBDRM</b>	Community-Based Disaster Risk Management
<b>CBDRR</b>	Community-Based Disaster Risk Reduction
<b>CCA</b>	Climate Change Adaptation
<b>CEPAL</b>	Economic Commission for Latin America and the Caribbean
<b>CO2</b>	Carbon Dioxide
<b>DALY</b>	Disability Adjusted Life Year
<b>DRM</b>	Disaster Risk Management
<b>DRR</b>	Disaster Risk Reduction
<b>EIA</b>	Environmental Impact Assessment
<b>ENSO</b>	El Niño Southern Oscillation
<b>FAO</b>	United Nations Food and Agriculture Organisation
<b>FDI</b>	Foreign Direct Investment
<b>GAR</b>	Global Assessment Report
<b>GAR09</b>	2009 Global Assessment Report
<b>GAR11</b>	2011 Global Assessment Report
<b>GAR13</b>	2013 Global Assessment Report
<b>GAR15</b>	2015 Global Assessment Report
<b>GDP</b>	Gross Domestic Product
<b>GFCF</b>	Gross Fixed Capital Formation
<b>GFDRR</b>	Global Facility for Disaster Risk Reduction
<b>GfT</b>	GAR for Tangible Earth
<b>GIS</b>	Geographic Information System
<b>GNI</b>	Gross National Income
<b>HDI</b>	Human Development Index
<b>HFA</b>	Hyogo Framework for Action
<b>IDNDR</b>	International Decade for Natural Disaster Reduction
<b>IFRC</b>	International Federation of Red Cross and Red Crescent Societies
<b>ILO</b>	International Labour Organisation
<b>IMF</b>	International Monetary Fund
<b>IOM</b>	International Organisation for Migration
<b>IPCC</b>	Intergovernmental Panel on Climate Change

<b>IRDR</b>	Integrated Research on Disaster Reduction
<b>IRP</b>	International Recovery Platform
<b>ISDR</b>	International Strategy for Disaster Reduction
<b>JICA</b>	Japanese International Cooperation Agency
<b>LAC</b>	Latin America and the Caribbean
<b>LDCs</b>	Least Developed Countries
<b>MDGs</b>	Millennium Development Goals
<b>NASA</b>	National Aeronautics and Space Administration
<b>NGO</b>	Non-Governmental Organisation
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>PML</b>	Probable Maximum Loss
<b>ppm</b>	Parts Per Million
<b>ppp</b>	Purchasing Power Parity
<b>SDGs</b>	Sustainable Development Goals
<b>SIDS</b>	Small Island Developing States
<b>UN</b>	United Nations
<b>UNAIDS</b>	Joint United Nations Programme on HIV/AIDS
<b>UNCTAD</b>	United Nations Conference on Trade and Development
<b>UNDAC</b>	United Nations Disaster Assessment and Coordination
<b>UNDESA</b>	United Nations Department of Economic and Social Affairs
<b>UNDHA</b>	United Nations Department of Humanitarian Affairs
<b>UNDMTP</b>	United Nations Disaster Management Training Programme
<b>UNDP</b>	United Nations Development Programme
<b>UNDRO</b>	United Nations Disaster Relief Coordinator
<b>UNECE</b>	United Nations Economic Commission for Europe
<b>UNEP</b>	United Nations Environment Programme
<b>UNEP-GRID</b>	United Nations Environment Programme - Global Resource Information Database
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organisation
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>UNICEF</b>	United Nations Children's Fund
<b>UNISDR</b>	United Nations Office for Disaster Risk Reduction
<b>UNOCHA</b>	United Nations Office for the Coordination of Humanitarian Affairs
<b>USD</b>	United States Dollars
<b>WFP</b>	World Food Programme
<b>WHO</b>	World Health Organisation
<b>WMO</b>	World Meteorological Organisation

# Acknowledgements

## Advisory Board

### Chair

**Margareta Wahlstrom**, Special Representative of the Secretary-General for Disaster Risk Reduction

### Members

**Laura Alfaro**, Professor, Harvard Business School, Harvard University, Cambridge, MA; **Wadid Erian**, Head of Land Resource Studies, The Arab Center for the Study of Arid Zones and Dry Lands, Damascus; **Priyanthi Fernando**, Executive Director, Centre for Poverty Analysis, Colombo; **Virginia Garcia Acosta**, Director, Centre for Research and Advanced Studies in Social Anthropology, CIESAS, Mexico DF; **Michelle Gyles-McDonnough**, United Nations Resident Coordinator for Malaysia, Kuala Lumpur; **Michel Jarraud**, Secretary General, World Meteorological Organization, Geneva; **Randolph Kent**, Director, Planning from the Future Programme, King's College, London; **Allan Lavell**, Coordinator, Programme for Environmental and Disaster Risk, Latin America Social Science Faculty (FLACSO), San José; **Anthony Oliver-Smith**, Professor, University of Florida, Gainesville, FL; **Ibrahim Osman**, Former Deputy Secretary-General, International Federation of Red Cross and Red Crescent Societies, Geneva; **Aromar Revi**, Director, Indian Institute for Human Settlements, New Delhi; **Johan Schaar**, Head of Development Cooperation, Consulate General of Sweden, Jerusalem; **Cecilia Ugaz**, United Nations Resident Coordinator for Paraguay, Asunción; **Dennis Wenger**, Programme Director, Element 1638, National Science Foundation, Arlington, TX; **Sandra Wu**, Chief Executive Officer, Kokusai Kogyo Corporation, Tokyo.

## Coordinating Lead Authors

**Bina Desai** and **Andrew Maskrey**, United Nations Office for Disaster Risk Reduction (UNISDR), Geneva.

## UNISDR team

**Marc Gordon** and **Rhea Katsanakis**, coordination of HFA Thematic Review; **Julio Serje**, **Sylvain Ponserre** and **Vicente Anzellini**, national disaster loss data and analysis, online tools, graphs and maps; **Sahar Safaie** and **Mabel Marulanda Fraume**, global risk assessment; **Kazuko Ishigaki**, economic analysis and research; **Vicente Anzellini** and **Lucy Foggin**, research, references and case studies; **Mathieu Meerpoel** and **Julian Templeton**, research assistance; **Frederic Delpech**, production coordination and administrative support.

## Collaborators

### Global Risk Assessment

**CIMNE and associates** and **INGENIAR** (Alex Barbat, Omar Dario Cardona, Gabriel Bernal, Diana Gonzalez, Miguel Mora, Mario Salgado, Liliana Carreno, Mabel Marulanda Fraume, Cesar Velasquez, Claudia Villegas, Daniela Zuloaga); **The Arab Center for the Study of Arid Zones and Dry Lands – ACSAD** (Wadid Erian, Sanaa Ibrahim, Bassem Kataln, Naji Assad); **Beijing Normal University** (Penjung Shi, Saini Yaing); **CIMA Foundation** (Roberto Rudari, Lorenzo Campo, Francesco Silvestro, Giorgio Boni); **FEWS NET** (Harikishan Jayanthi, Greg Husak, Chris Funk, James Verdin); **Geoscience Australia** (Adele Bear-Crozier, Ken Dale, Gareth Davis, Mark Edwards, Jonathan Griffin, Nick Horspool, Andrew Jones, Tariq Maqsood, Steve Newey, Victoria Miller, Hyeuk Ryu, John Schneider, R. Weber, Martin Wehner); **Joint Research Centre – JRC** (Tom De Groeve, Sergio Freire, Daniele Erlich, Martino

Pesaresi); **Kokusai Kogyo** (Noritoshi Kamagata, Junko Tomita); **Norwegian Geotechnical Institute – NGI** (Farrokh Nadim, Carl Harbist, Finn Løvholt, Sylfest Glimsdal, Helge Smebye, Jose Cepeda); **UNAM** (Mario Ordaz and Krishna Singh); **UNEP-GRID** (Pascal Peduzzi, Andrea de Bono, Christian Herold, Bruno Chatenoux); **WAPMERR** (Max Wyss, Philippe Rosset, Stavros Tolis). **Other contributors:** Maria Ana Baptista (IPMA Lisbon); Eric Geist (U.S. Geological Survey); Stefano Lorito and Roberto Basili (INGV Roma); Rui Pinho and Helen Crowley (GEM Foundation); Hong Kie Thio (URS Corporation).

### Scientific peer reviewers:

**WMO coordinated:** James Douris (WMO); Bob Stefanski (WMO); Michael J. Hayes (University of Nebraska-Lincoln); Fumin Ren (Chinese Academy of Meteorological Sciences – CAMS). **UNESCO coordinated:** Pauline Galea (University of Malta); Ren Jinwei (Institute of Earthquake Science, China); Christina Magill (Macquarie University); Alexandros Makarigakis (UNESCO); G.A. Papadopoulos (National Observatory of Athens); Kenji Satake (University of Tokyo); Roberto Scarpa (Universita degli Studi dell'Aquila, Italy); Mehdi Zare (International Institute of Earthquake Engineering and Seismology – IIEES). **GNS Science coordinated:** Kelvin Berryman (GNS Natural Hazards Research Platform) with experts from Arup, Cankaya University, FM Global, Hannover Re, ETH Zurich, NORSAR, and Schneider Geohazards. **Other contributors:** Robert Muir-Wood (Risk Management Solutions - RMS).

### Global volcano hazard and risk:

**GVM and IAVCEI** (Susan C. Loughlin, British Geological Survey; Sarah K. Brown, Steve Sparks, and Susanna Jenkins, University of Bristol; Charlotte Vye-Brown, British Geological Survey; Thomas Wilson, University of Canterbury; Christina Magill, Macquarie University; Victoria Miller, Geoscience Australia; C. Stewart, Joint Center for Disaster Research, GNS Science, Massey University).

**Reviewers:** Jenni Barclay (University of East Anglia); Russle Blong (Aon Benfield); Costanza Bonadonna (Université de Genève); Antonio Costa (Istituto Nazionale di Geofisica e Vulcanologia); Charlie Mandeville (U.S. Geological Survey); Christopher Newhall (Earth Observatory of Singapore); Jose Palma (University of Concepcion); Sally Potter (GNS Science); Greg Valentine (University at Buffalo).

**Content, country data, and case study contributors:** S. Andreastuti (Geological Agency of Indonesia); W. Aspinall (University of Bristol; Aspinall & Associates); G. Atici (General Directorate of Mineral Research and Exploration); M. Auken (University of Bristol); B. Baptie (British Geological Survey); S. Barsotti (Icelandic Meteorological Office); R. Basili (National Institute of Geophysics and Volcanology, Italy – INGV); P. Baxter (University of Cambridge); M. Boulton (University of Bristol); M. Camejo (Seismic Research Center); E. Calder (University of Edinburgh); G. Chigna (INSIVIMEH); V. Cloud (Smithsonian Institution); A. Costa (Istituto Nazionale di Geofisica e Vulcanologia, Italy); E. Cottrell (Smithsonian University); S. Croweller (University of Bristol); C. Dessert (Observatoire Volcanologique et Sismologique de Guadeloupe); S. Daud (Civil Contingencies Secretariat, Cabinet Office, UK); H. Delgado-Granados (Universidad Nacional Autónoma de México); N. Deligne (GNS Science, New Zealand); C.D. Escobar (Ministerio de Medio Ambiente y Recursos Naturales); J. Ewert (U.S. Geological Survey); B. Faria (National Institute for Meteorology and Geophysics, Cape Verde); C. Felton (Civil Contingencies Secretariat, Cabinet Office, UK); A. Garcia (Institute IGEO, CSIC-UCM); J. Gottsman (University of Bristol); E. Gutierrez, (National Institute for Meteorology and Geophysics, Cape Verde); Thea Hincks (University of Bristol); C. Horwell (University of Durham); E. Ilyinskaya (British Geological Survey); R. Iriat, (Universidad Mayor de San Andres); Gill Jolly (GNS Science, New Zealand); R. Kamanyire (Public Health England); K. Karume (Observatoire

Volcanologique de Goma); **M. Kelman** (Natural Resources Canada); **C. Kilburn** (University College London); **J.C. Komorowski**, (Institut de Physique du Globe de Paris, France); **G. Leonard** (GNS Science); **J. Lindsay** (GNS Science); **Kristianto** (Center for Volcanology and Geological Hazard Mitigation); **P. Kyle** (New Mexico Institute of Mining and Technology); **L.E. Lara** (SERNAGEOMIN); **C.-H. Lin** (Taiwan Volcano Observatory at Tatun); **C. Lombana-Criollo** (Universidad Mariana, Colombia); **O. Macedo** (Instituto Geofísico del Peru); **G. Macedonio** (Istituto Nazionale di Geofisica e Vulcanologia, Italy); **C. Magill** (GVM / Risk Frontiers); **C. Mandeville** (U.S. Geological Survey); **J.M. Marrero** (Volcanic consultant); **J. Marti** (Consejo Superior de Investigaciones Científicas, Spain); **W. Marzocchi** (Istituto Nazionale di Geofisica e Vulcanologia, Italy); **K. Mee** (British Geological Survey); **V. Miller** (Geoscience Australia); **P. Mothes** (Instituto Geofísico EPN, Ecuador); **A. Mruma** (Geological Survey of Tanzania); **F. Nadim** (Norwegian Geotechnical Institute); **B. Oddsson** (Department of Civil Protection and Emergency Management, Iceland); **S. Ogburn** (University at Buffalo); **R. Ortiz** (Institute IGEO, CSIC-UCM); **N. Ortiz Guerrero** (Universidad Nacional Autónoma de México; Universidad Mariana, Colombia); **L. Ottemoller** (University of Bergen); **J. Pallister** (Volcano Disaster Assistance Program, U.S. Geological Survey); **M. Poland** (Hawaiian Volcano Observatory, U.S. Geological Survey); **M. Pritchard** (Cornell University); **P. Ramon** (Instituto Geofísico EPN, Ecuador); **R. Robertson** (Seismic Research Centre); **L. Sandri** (Istituto Nazionale di Geofisica e Vulcanologia, Italy); **D. Sayudi** (Geological Agency of Indonesia); **E. Scourse** (University of Bristol); **J. Selva** (Istituto Nazionale di Geofisica e Vulcanologia, Italy); **L. Siebert** (Smithsonian Institution); **H. Smebye** (Norwegian Geotechnical Institute); **R. Solidum** (Philippine Institute of Volcanology and Seismology); **R. Stewart** (Montserrat Volcano Observatory); **R. Stewart** (Massey University); **J. Stone** (University of East Anglia); **Subandriyo** (Geological Agency of Indonesia); **S. Sumarti** (Geological

Agency of Indonesia); **Surono** (Geological Agency of Indonesia); **S. Takarada** (Geological Survey of Japan); **R. Tonini** (Istituto Nazionale di Geofisica e Vulcanologia, Italy); **A. Turkecan** (General Directorate of Mineral Research and Exploration); **G.E. Vougioukalakis** (Institute of Geology and Mineral Exploration); **N. Varley** (Universidad de Colima); **E. Venzke** (Smithsonian Institution); **V. Villeneuve** (Observatoire Volcanologique du Piton de la Fournaise); **G. Wadge** (University of Reading); **K. Wagner** (University at Buffalo); **P. Webley** (Alaska Volcano Observatory, USA); **R.E. Wolf** (INSIVUMEH).

## **HFA Thematic Review**

### **Background Papers**

**GFDRR** (Prashant; Rob Reid; Alanna Simpson; Margaret Arnold; Ayez Parvez; Laura Boudreau; Sergio de Cosmo); **International Recovery Platform** (Sanjaya Bhatia; Gulzar Keyim; Damon P. Coppola); **OECD** (Rachel Scott; Jack Radisch; Cathérine Désiree Gamper); **Save The Children** (Johara Bellali; Briony Towers; Nick Ireland; John Handmer); **Stockholm Environment Institute** (Richard J.T. Klein; Frank Thomalla; E. Lisa F. Schipper; Karlee Johnson; Gregor Vulturius); **UNDP** (Kamal Kishore; Angelika Planitz; Allan Lavell; Yasemin Aysan); **UNECE** (Lorenza Jachia); **UNEP** (Muralee Thummarukudy; Shalini Sharma Kanwar); **UN-Habitat** (Dan Lewis; Patricia Holly Purcell); **UNICEF and UNESCO** (Antony Spalton; Julia Heiss; Aisling Falconer); **UNISDR** (Craig Duncan; Sarah Wade-Apicella; Sophia Scherer); **University of Huddersfield** (Bingunath Ingirige; Dilanthi Amaratunga; Mohan Kumaraswamy; Champika Liyanage; Aslam Perwaiz; Peeranan Towashiraporn; Gayan Wedawatta); **WFP** (Anthony Craig; Randolph Kent; Joanne Burke); **WMO** (Maryam Golnaraghi; Lynn Maximuk; James C. Douris).

### **Input Papers**

**A. Aguiar** (Universidade Vila Velha); **S. Ahn** (Applied Systems Thinking Institute – AsyST); **F. Amelung** (University of Miami); **O. Anikeeva**

(Torrens Resilience Institute); **P. Arbon** (Torrens Resilience Institute); **A. Attolico** (Provincia di Potenza); **F. Atun** (Politecnico di Milano); **S. Baas** (FAO); **H. Baba** (Japan International Cooperation Agency); **C. Bach** (UNU-EHS); **B. Balgos** (Center for Disaster Preparedness Foundation, Inc.); **F. Ballio** (Politecnico di Milano); **J. Barnard** (Independent Consultant); **C. Bartels** (European Centre for Disease Prevention and Control); **M. Batistella** (Center of Environment Studies and Research – NEPAM/UNICAMP; Embrapa Monitoramento por Satélite); **J. Beauté** (European Centre for Disease Prevention and Control); **M. Bengoubou-Valerius** (Bureau de Recherches Géologiques et Minières – BRGM); **N. Berni** (Civil Protection, Italy); **J. Birkmann** (United Nations University – UNU-EHS); **R. Black** (FAO); **E. Brink** (Lund University); **J. Bruce** (FAO); **P. Bubeck** (Adelphi); **J. Burnside-Lawry** (RMIT University); **C. Cabot-Venton** (UNDP); **J. Čalić** (Serbian Academy of Sciences and Arts); **A. Caravani** (Overseas Development Institute); **L. Carvalho** (Civil Protection Municipal Service, Portugal); **A. Cavallo** (University of Adelaide); **P. Chakrabarti** (Independent Consultant); **S. Chang-Rundgren** (Karlstad University); **T. Chelidze** (Ivane Javakishvili Tbilisi State University); **I. Christoplos** (Danish Institute for International Studies); **V. Chub** (Centre of Hydrometeorological Service, Uzbekistan); **M. Ciotti** (European Centre for Disease Prevention and Control); **E. Comba** (Overseas Development Institute); **J. Cools** (Milieu Ltd); **A. Coskun** (Turkish Court of Accounts); **A. Cottrell** (James Cook University); **N. Curosu** (State Enterprise Basin Water Management Authority of Moldova); **L. Cusack** (Torrens Resilience Institute); **S. Cutter** (University of South Carolina); **M. da Penha Smarzaró Siqueira** (Universidade Vila Velha); **T. da Silva Rosa** (Universidade Vila Velha); **B. de Groot** (Natural Resources Canada – Canadian Forest Service); **L. de la Cruz** (Center for Disaster Preparedness Foundation, Inc.); **M. Di Prisco** (Politecnico di Milano); **A. Di Ruocco** (Analisi e Monitoraggio del Rischio Ambientale – AMRA); **N. Dufty** (Molino Stewart Pty Ltd);

(FAO); **C. Emrich** (University of South Carolina); **S. Erbay** (Government of Turkey); **M. Evers** (Bonn University; Karlstad University); **N. Fassina** (World Society for the Protection of Animals); **N. Fernando** (University of Colombo); **L. Ferreira** (Center of Environment Studies and Research – NEPAM/UNICAMP); **F. Ferreira Pedroso** (World Bank); **A. Firdaus** (James Cook University); **C. Fitzgibbon** (UNDP); **K. Fleming** (GFZ); **M. Florin** (International Risk Governance Council); **J. Frittmann** (Applied Systems Thinking Institute – ASyT); **S. Frye** (NASA); **F. Gaetani** (Group on Earth Observations); **J.C. Gaillard** (University of Auckland); **M. Gall** (University of South Carolina); **A. Garcia-Aristizabal** (Analisi e Monitoraggio del Rischio Ambientale – AMRA); **P. Gasparini** (Analisi e Monitoraggio del Rischio Ambientale – AMRA, Italy); **K. Gebbie** (Torrens Resilience Institute); **S. Giovanazzi** (Resilient Organisations); **P. Girot** (CARE International); **Y. Gurtner** (James Cook University); **B. Guru** (Tata Institute of Social Sciences, India); **R. Haigh** (University of Salford); **F. Hamdan** (Disaster Risk Management Centre); **N. Harada** (National Defence Medical College, Japan); **M. Haraguchi** (Columbia University); **C. Harbitz** (Norwegian Geotechnical Institute); **S. Hardjosuwarno** (Government of Indonesia); **S. Harwood** (James Cook University); **K. Hayashi** (Barefoot Doctors Okinawa); **M. Hosseini** (International Institute of Earthquake Engineering and Seismology); **M. Huang** (National Graduate Institute for Policy Studies); **G. Huertas** (World Society for the Protection of Animals); **F. Imamura** (Tohoku University); **D. Innocenti** (University of Antwerp); **V. Ireland** (University of Adelaide); **A. Iwama** (Center of Environment Studies and Research – NEPAM/UNICAMP); **Y. Izadkhah** (International Institute of Earthquake Engineering and Seismology); **P. Jackson** (University of Leicester); **M. Johansson** (Karlstad University); **F. Kagawa** (Sustainability Frontiers); **K. Kalula** (Independent Consultant); **S. Kanwar** (UNEP); **J. Kellett** (Overseas Development Institute); **G. Keyim** (International Recovery Platform); **S. Kim** (Columbia University); **D. King** (James Cook University);

**N. Komendantova** (Institute for Environmental Decisions – ETHZ; International Institute for Applied Systems Analysis – IIASA); **J. Kovačević-Majkić** (Serbian Academy of Sciences and Arts); **H. Kreibich** (GFZ); **S. Kundak** (Istanbul Technical University); **Y. Kurauchi** (UNDP); **K. Kuterdem** (Government of Turkey); **Y. Lee** (Dongguk University); **N. Leitão** (Universidade Nova de Lisboa); **F. Lindsay** (NASA); **M. Liu** (Asian Development Bank Institute); **L. Longoni** (Politecnico di Milano, Italy); **F. Løvholt** (Norwegian Geotechnical Institute); **K. Maripe** (University of Botswana); **S. Marsh** (GeoHazards Community of Practice); **A. Masys** (Centre for Security Science Defence R&D); **S. McGee** (Applied Systems Thinking Institute – ASysT); **Q. Mejri** (Politecnico di Milano); **S. Menoni** (Politecnico di Milano); **D. Miljanović** (Serbian Academy of Sciences and Arts); **M. Milošević** (Serbian Academy of Sciences and Arts); **D. Molinari** (Politecnico di Milano); **D. Montfort** (Bureau de Recherches Géologiques et Minières – BRGM); **E. Morales** (World Society for the Protection of Animals); **R. Mrzyglocki** (German Committee for Disaster Reduction – DKKV); **A. Muhari** (Tohoku University); **S. Murray** (Applied Systems Thinking Institute – ASysT); **F. Nadim** (Norwegian Geotechnical Institute); **N. Ngoy** (WHO); **M. Nurlu** (Government of Turkey); **L. Nyberg** (Karlstad University); **E. Ochoa** (National Secretary for the Management of Risks – SNGR); **J. Odongo** (Independent Consultant); **O. Olu** (WHO); **F. Opiyo** (UNDP); **R. Otoni de Araújo** (Universidade Vila Velha); **C. Pandolfo** (Civil Protection, Italy); **M. Panić** (Serbian Academy of Sciences and Arts); **C. Pathirage** (University of Salford); **A. Patt** (Institute for Environmental Decisions – ETHZ; International Institute for Applied Systems Analysis); **F. Pedroso** (World Bank); **H. Peter-Plag** (GeoHazards Community of Practice); **K. Peters** (Overseas Development Institute); **I. Petiteville** (European Space Agency); **A. Pharris** (European Centre for Disease Prevention and Control); **F. Pichon** (Overseas Development Institute); **M. Pittore** (GFZ); **N. Ray-Bennett** (University of Leicester); **C. Réboli** (Universidade

Vila Velha); **M. Reis** (Universidade Vila Velha); **C. Renschler** (The State University of New York); **E. Roberts** (King’s College London); **T. Rosa** (Universidade Vila Velha); **S. Santha** (Tata Institute of Social Sciences); **A. Scolobig** (Institute for Environmental Decisions – ETHZ; International Institute for Applied Systems Analysis); **G. Seguin** (Independent Consultant); **J. Semenza** (European Centre for Disease Prevention and Control); **K. Seneviratne** (University of Salford); **N. Setiadi** (UNU-EHS); **E. Seville** (Resilient Organisations); **H. Shiroshita** (Kansai University; University of Leicester); **R. Sinkamba** (University of Botswana); **M. Siqueira** (Universidade of Vila Velha); **E. Skelton** (PricewaterhouseCoopers); **K. Soojun** (Georgia Tech); **M. Stal** (Global Risk Forum); **M. Steenkamp** (Torrens Resilience Institute); **J. Suk** (European Centre for Disease Prevention and Control); **B. Sukatja** (Government of Indonesia); **A. Tabacaru** (State Enterprise Basin Water Management Authority of Moldova); **M. Tarande** (WHO); **L. Teixeira** (Center of Environment Studies and Research – NEPAM/UNICAMP; Brazilian Institute of Environment and Renewable Natural Resources – IBAMA); **B. Tekin** (Government of Turkey); **J. Teo** (Kyoto University); **M. Trujillo** (FAO); **S. Tsolova** (European Centre for Disease Prevention and Control); **A. Usman** (WHO); **V. Valenzuela** (Center for Disaster Preparedness Foundation, Inc.); **T. Van Canghai** (European Centre for Disease Prevention and Control); **D. van Niekerk** (UNDP); **J. Vargo** (Resilient Organisations); **C. Vinchon** (Bureau de Recherches Géologiques et Minières – BRGM); **E. Visconti** (Natural Disasters Fund, FONDEN); **C. Walch** (Uppsala University); **C. Wamsler** (Lund University); **M. Wieland** (GFZ); **E. Wilkinson** (Overseas Development Institute); **J. Xu** (International Risk Governance Council); **M. Yasumiishi** (The State University of New York); **T. Yunita** (Government of Indonesia); **D. Zupka** (Centre for Education and Research in Humanitarian Action).

#### *Peer review of background papers*

**Dilanthi Amaratunga** (Global Disaster

Resilience Centre, University of Huddersfield), **Richard Haigh** (Global Disaster Resilience Centre, University of Huddersfield), **Naveed Ahmad** (University of Engineering and Technology), **Sisith Arambepola** (Asian Disaster Preparedness Centre), **Massimo Bianchi** (University of Bologna), **Alice Chang-Richards** (The University of Auckland), **Aguinaldo dos Santos** (Federal University of Parana), **Thayapran Gajendran** (University of Newcastle), **Paolo Gasparini** (AMRA), **Ashantha Goonetilleke** (Queensland University of Technology), **Makarand Hastak** (Purdue University), **Samantha Hettierachichi** (University of Moratuwa), **Siri Hettige** (University of Colombo), **Yamuna Kaluarachchi** (Kingston University), **Arturas Kaklauskas** (Vilnius Gediminas Technical University), **Kaushal Keraminiyage** (University of Huddersfield), **Udaya Kulatunga** (University of Salford), **Bingunath Ingirige** (University of Salford), **Skevi Lees** (Frederick University), **Andrew Lees** (Frederick University), **Irene Lill** (Tallinn University of Technology), **Champika Liyange** (University of Central Lancashire), **Roshani Palliayaguru** (Heriot-Watt University), **Chaminda Pathirage** (University of Salford), **Srinath Perera** (Northumbria University), **Kurt Petersen** (Lund University), **Joachim Post** (DLR), **Harkunti Rahayu** (Institute of Technology Bandung), **James O. B. Rotimi** (AUT University), **Janaka Ruwanpura** (University of Calgary), **Sujeeva Setunge** (RMIT University), **Siti Uzairiah Mohd Tobi** (Technological University Malaysia), **Clive Warren**, (University of Queensland), **Gayan Wedawatta** (Aston University), **Suzanne Wilkinson** (The University of Auckland).

### *The Future of Disaster Risk Management seminar series*

**Osman Alhassan** (University of Ghana); **Naomi Aoki** (Lee Kuan Yew School of Public Policy); **Tarekegn Ayalwe** (Bahir Dar University); **Sophie Baranes** (UNDP); **Roy Barboza** (CEPREDE-NA); **Djillali Benouar** (University of Science and Technology Houari Boumediene); **Gautam Bhan** (Indian Institute for Human Settlements – IIHS);

**Sarah Bradshaw** (Middlesex University); **Caroline Brassard** (Lee Kuan Yew School of Public Policy, National University of Singapore); **Alonso Brenes** (FLACSO); **Ian Burton** (Independent); **Terry Cannon** (Institute of Development Studies); **Gilles Carbonnier** (The Graduate Institute, Geneva – IHEID); **Christo Coetzee** (African Centre for Disaster Studies); **Rui da Maia** (University of Eduardo Mondlane); **Mateugue Diack** (Gaston Berger University); **David Dodman** (IIED); **Mike Douglas** (National University of Singapore); **Jean Christophe Gaillard** (University of Auckland); **Sumetee Pahwa Gajjar** (IIHS); **Rachel Gallagher** (United States Agency for International Development – USAID); **Luis Gamarra** (UNDP); **Christopher Garimpoi Orach** (Makerere University); **Pascal Girot** (Care International); **Michelle Gyles McDonnough** (UNRC, Malaysia); **Kenneth Hewitt** (Wilfried Laurier University); **Gabriela Hoberman** (Florida International University); **Ailsa Holloway** (University of Stellenbosch); **Edwin Iguisi** (Ahmadu Bello University); **Ronald Jackson** (CDEMA); **Garima Jain** (Indian Institute for Human Settlements – IIHS); **Sanny Jegillos** (UNDP); **Benjamin William Jeyaraj** (Singapore Red Cross); **Jyotsna Jha** (Centre for Budget and Policy Studies – CBPS); **Rohit Jigyasu** (Indian Institute for Human Settlements – IIHS); **Ase Johanessen** (Stockholm Environment Institute); **Anup Karanth** (Technical Assistance Response Unit – TARU); **Gabriel Roderick Kassenga** (Ardhi University); **Ilan Kelman** (University College London); **Kamal Kishore** (UNDP); **Shefali Lakhina** (Independent); **Andrea Lampis** (National University of Colombia); **Jonatan Lassa** (Nayang Technological University); **Allan Lavell** (FLACSO); **Chris Lavell** (Independent); **Donald Low** (Lee Kuan Yew School of Public Policy, National University of Singapore); **Tiana Mahefosa Randrianalijaona** (University of Antananarivo); **Roché Mahon** (Lincoln University); **Elisabeth Mansilla** (Universidad Nacional Autonoma de Mexico); **Adolfo Mascarhenas** (University of Dar es Salaam); **Peninah Masibo** (Moi University); **David Matyas** (Save the Children); **Franklin McDonald** (University of the West

Indies); **Imen Meliane** (The Nature Conservancy); **Lilian Mercado Carreon** (ASEAN); **Jessica Mercer** (Secure Futures); **James Morissey** (University of Oxford); **Ilan Noy** (Victoria University of Wellington); **Richard Olson** (Florida International University); **Edmund Penning-Rowell** (University of Oxford); **Robyn Pharoah** (University of Stellenbosch); **Jean Michel Piedagnel** (Woodseer Resources); **Angelika Planitz**, (UNDP); **Aromar Revi** (IIHS); **Dominic Sam** (UNDP); **Neha Sami** (IIHS); **Juan Pablo Sarmiento** (Florida International University); **David Satterthwaite** (IIED); **Jo Scheuer** (UNDP); **Lisa F. Schipper** (Stockholm Environment Institute); **Antony Oliver Smith** (University of Florida); **David Smith Wiltshire** (National University Costa Rica); **Jacob Songso** (University of Ghana); **Marcela Tarazona** (Oxford Policy Management); **Daniel Toole** (UNICEF); **Marco Toscano** (UNISDR); **Emily Wilkinson** (Overseas Development Institute); **Scott Williams** (PricewaterhouseCooper); **Ben Wisner** (University College London).

#### Additional research:

**Felipe Baritto** (Geohidra Consultores); **Amir Bazaz** (IIHS); **Susan Cutter** (University of South Carolina); **Melanie Gall** (University of South Carolina); **Terry Gibson** (GNDR); **Stefan Hochrainer** (IIASA); **Garima Jain** (IIHS); **David Johnston** (Massey University); **Reinhard Mechler** (IIASA); **Junko Mochizuki** (IIASA); **Khai Nguyen** (University of South Carolina); **Ilan Noy** (Victoria University of Wellington); **Mark Pelling** (King's College London); **Ayisha Siddiqi** (King's College London); **Bill Solecki** (City University of New York); **Keith Williges** (IIASA).

#### National disaster loss data

**Albania:** Civil Defense of Albania (Emanuela Toto, Marco Massabo); **Antigua and Barbuda:** NODS (Philmore Mullin); **Argentina:** CENTRO (Alejandra Celis); **Bolivia:** Vice Ministerio de la Defensa Civil – VIDECI (Carlos Mariaca Ceballos, Omar Pedro Velazco); **Cambodia:** National Committee for Disaster Management Cambodia (Sopha Sam);

**Chile:** Universidad de Chile (Alejandro León, Carolina Clerc); **Colombia:** Corporación OSSO (Andrés Velásquez, Natalia Díaz, Nayibe Jiménez, Cristina Rosales, Unidad para la Gestión del Riesgo de Desastres); **Comoros:** Protection Civil Comores (Abdillahi Maoulida Mohamed); **Costa Rica:** Programa Integral de Gestión de Riesgos de Desastres de la Universidad Nacional – PRIGD UNA (Alice Brenes Maykall, David Smith); **Djibouti:** Centre d'Etudes et de Recherches de Djibouti CERD (Samatar Abdi Osman, Ahmed Madar); **Dominica:** Office of Disaster Management, Dominica (Don Corriette); **Ecuador:** Secretaría Nacional de Gestión de Riesgos – SNGR (Dalton Andrade Rodríguez); **El Salvador:** Universidad de El Salvador, Dirección General del Observatorio Nacional DGOA del Ministerio del Medio Ambiente y Recursos Naturales – MARN (Edgar Armando Peña, Ivonne Jaimes); **Ethiopia:** Ministry of Agriculture and World Food Programme – WFP (Animesh Kumar, Workneh Hundessa, Edget Tilahun, Getnet Kebede); **Grenada:** NEMO Grenada (Terence Walters); **Guatemala:** La Red de Estudios Sociales en Prevención de Desastres LA RED (Gisela Gellert); **Guyana:** Civil Defence Commission – CDC (Kester Craig, Sherwin Felicien); **Honduras:** Instituto Hondureño de Ciencias de la Tierra IHCIT de la Universidad Nacional Autónoma de Honduras UNAH (Nabil Kawas, Oscar Elvir); **India:** Tamil Nadu, State Disaster Management Authority (Ganapathy Pattukandan); **Indonesia:** Indonesian National Board for Disaster Management BNPB (Ridwan Yunus); **Islamic Republic of Iran:** Ministry of Interior and UNDP (Amin Shamseddini); **Jamaica:** Office for Disaster Preparedness and Emergency Management – ODPEM (Leiska Powell, Anna Tucker, Rashida Green, Sherese Gentles, Sashekia Powell, Fredene Wilson); **Jordan:** Jordanian Civil Protection (Waleed Al-So'ub); **Kenya:** National Disaster Operations Center (Oliver Madara, Isabel Njihia, Faith Langat); **Laos:** National Disaster Management Organization – NDMO, Laos (Sisomvang Vilayphong, Bouasy Thammasack, Thitiphon Sinsupan, Hang Thi Thanh Pham, Thanongdeth

Insisiengmay, Somvath); **Lebanon:** Office of the Prime Minister and UNDP (Nathalie Zaarour, Lama Tabbara, Bilal El-Ghali); **Madagascar:** Protection Civil Madagascar, (Mamy Nirina Razakanai-vo, Regis Andrianaivo); **Mali:** Protection Civil du Mali (Mamadou Traore, Diawoye Konte, Aboudra Koungoulba, Savane Foulematou SY); **Mauritius:** IOC, Ministry of Environment Mauritius (Venetia Bellers, Bhye Muslim Heetun); **Mexico:** La Red de Estudios Sociales en Prevención de Desastres – LA RED (Elizabeth Mansilla); **Mozambique:** Instituto Nacional de Gestão de Calamidades – INGC and UNDP (Dulce Chilundo, Eunice Mucache, Antonio Queface); **Nepal:** National Society for Earthquake Technology –NSET (Amod Dixit, Gopi Bashal); **Nicaragua:** Sistema Nacional para la Prevención, Mitigación y Atención de Desastres – SINAPRED (Ana Isabel Izaguirre, Mercedes Martínez, Gisela Guevara, Carlos Olivares, Noé Ubau, Ernesto González); **Orissa:** State Disaster Management Authority (Kalika Mohapatra, Ambika Prasad); **Pacific Islands:** SPC/SOPAC (Jutta May, Nicole Daniels, Litea Biukoto); **Pakistan:** NDMA National Disaster Management Authority (Nasir Hussain); **Palestine:** Civil Defense Palestine (Issa Zboun); **Panama:** Sistema Nacional de Protección Civil – SINAPROC (Yira Marisol Campos Barranco); **Perú:** Centro de Estudios de Prevención de Desastres – PREDES (José Sato Onuma, Alfonso Diaz Calero, Julio Meneses Bautista, Yeselín Díaz Toribio, Ingrid Azaña Saldaña); **Saint Kitts and Nevis:** NDMO Saint Christopher and Nevis (Carl Herbert); **Saint Lucia:** NEMO Saint Lucia (Nelda Joseph); **Saint Vincent & the Grenadines:** NEMO Saint Vincent and the Grenadines (Howie Prince); **Senegal:** Protection Civil/UNDP (Sophie Baranes); **Serbia:** Sector for Emergency Management – Serbia (Selena Markovic, Dragana Djokovic Papic, Zoran Jancic); **Seychelles:** Division of Risk and Disaster Management, Ministry of Environment and Energy (Divina Sabino); **Sierra Leone:** Disaster Management Dept, Office of National Security/UNDP (Mary Mye, Mohamed Abchir); **Solomon Islands:** NDMO, Ministry of Environment (Jonathan Tafiariki); **Spain:** Direccion de Protección Civil de

España (Gregorio Pascual Santamaría, Almudena Bustamante Gil); **Sri Lanka:** Ministry of Disaster Management (Anoja Seneviratne, Dinesh Rajapaksha); **Syrian Arab Republic:** Ministry of Local Administration (Kinda Muhanna, Claude Amer); **Timor Leste:** National Disaster Operation Centre – NDOC, Ministry of Social Solidarity (Lourenco Cosme Xavier, Maarten Visser); **Trinidad and Tobago:** Office of Disaster Preparedness and Management ODPM (Candice Ramkissoo, Shelly Bradshaw); **Tunisia:** Ministry of Environment (Hédi Shili, Hazar Belli); **Turkey:** METU (Koray Kuruoğlu, Burcak Basbug Erkan); **Uganda:** Office of the Prime Minister, Department of Disaster Preparedness and Management (Martin Odong, Charles Odok, Samuel Akera); **Uruguay:** Sistema Nacional de Emergencias de la Presidencia de la República – SINAE (Pablo Brugnoli, Virginia Fernandez, Sabrina Pose, Soledad Camacho, Ana Maria Games, Pablo Capurro); **Venezuela:** Dirección Nacional de Protección Civil y Administración de Desastres – DNPCAD (Jesús Riobueno, José Scire); **Viet Nam:** Ministry of Agriculture and Rural Development and UNDP (Miguel Coulier, Oanh Luong Nhu, Nguyen Thi Thu Thuy); **Yemen:** Ministry of Water & Environment (Majed Alrefai).

#### Zero-order draft peer reviewers:

**Jonathan Abrahams** (WHO); **Adele Bear-Crozier** (Geoscience Australia); **Johara Bellali** (Adelphi); **Lee Boscher** (University of Loughborough); **Sarah Brown** (University of Bristol); **Antonella Cavallo** (University of Adelaide); **Jan Cools** (Milieu Ltd); **Luis Rolando Durán Vargas** (Independent Consultant); **Sergio Freire** (Joint Research Centre); **J.C. Gaillard** (University of Auckland); **Terry Gibson** (GNDRR); **Michael Gordy** (Independent Consultant); **Tim Haney** (Mount Royal University); **Ilan Kelman** (University College London); **Susan Loughlin** (British Geological Survey); **Shuaib Lwasa** (Makerere University); **Roché Mahon** (Lincoln University); **David Matyas** (Save The Children); **Jared Mercadente** (GFDRR); **Robert Muir-Wood** (Risk Management

Solutions – RMS); **Kenji Okazaki** (Kyoto University); **Toshio Okazumi** (Government of Japan); **Aris Papadopolous** (Titan America); **Patrick Pigeon** (University of Savoie); **Angelika Planitz** (UNDP); **Nibedita Ray-Bennett** (University of Leicester); **Robert Reid** (World Bank); **John Schneider** (Schneider Geohazards); **Alanna Simpson** (GFDRR); **Xu Tang** (WMO); **Jennifer Trivedi** (University of Iowa); **Jerry Velasquez** (UNISDR); **Christine Wamsler** (Lund University); **Emily Wilkinson** (Overseas Development Institute – ODI); **Scott Williams** (PwC); **Ben Wisner** (University College London & Oberlin College); **Jianping Yan** (UNDP).

### Design Concept

Earth Literacy Program (NPO).

### Design and Production (printed GAR)

**Editing:** Christopher J. Anderson; **Maps and graphs:** Sylvain Ponserre (UNISDR) and Stéphane Kluser (Komplo); **Design concept, cover and style guide:** Mitsuhiro Miyazaki and Masashi Tomura (AXIS), Shin'ichi Takemura (Earth Literacy Programme – ELP), Taku Satoh (Taku Satoh Design Office); **Inverted umbrella symbol:** Taku Satoh and Shin'ichi Takemura, inspired by the work of Makoto Murase and the Institute on Sky Water Harvesting; **Design realization:** Mitsuhiro Miyazaki and Masashi Tomura (AXIS), Shin'ichi Takemura (ELP); **Layout:** Takae Ooka; **Printing:** Imprimerie Gonnet; **Production Coordination:** Frederic Delpech (UNISDR); **Procurement:** UNOPS, Bangkok.

### Online GAR and risk information platforms

Julio Serje, Sylvain Ponserre, Joel Margate and Hugo Jacquet (UNISDR).

### Tangible Earth (TE) and GAR for Tablet (GfT)

**TE platform design and GfT scenario development:** Shin'ichi Takemura; **TE systems architecture:** Takahiro Shinkai; **GfT systems architecture:** Jun Nishimura; **GfT scenario development:** Yoshiyuki Inaba; **Production management:**

Kensuke Arakawa; **Case studies for GfT:** Sylvain Ponserre, Vicente Anzellini and Lucy Foggin (UNISDR); **GfT interface design:** Masashi Tomura (AXIS), Kensuke Arakawa; **Administration:** Shoko Takemura.

### Financial resources

**European Commission** (DGECHO and DG Development), **United Nations Development Programme** (BCPR) and the **Government of the United States of America** (USAID-OFDA).

### In-kind resources and coordination support:

**Florida International University – FIU;** **Geoscience Australia;** **Global Facility for Disaster Risk Reduction – GFDRR;** **Global Volcano Model – GVM;** **IAVCEI: Integrated Institute for Applied Systems Analysis – IIASA;** **Indian Institute for Human Settlements – IIHS;** **Integrated Research on Disaster Risk – IRDR;** **Kokusai Kogyo;** **Latin American Faculty of Social Sciences – FLACSO;** **Lee Kuan School of Public Policy – LKYSPP,** **National University of Singapore;** **United Nations Development Programme – UNDP;** **University of Ghana;** **University of Huddersfield;** **Victoria University of Wellington.**

# References

- Acemoglu, Daron and James Robinson. 2012. *Why Nations Fail: The Origins of Power, Prosperity and Poverty*. New York: Crown Business.
- ACTED (Agency for Technical Cooperation and Development). 2012. *ACTED 2012 Annual Report*. Paris.
- ADPC (Asian Disaster Prevention Center). 2008. *Monitoring and Reporting Progress on Community-Based Disaster Risk Management in Viet Nam*. Partnerships for Disaster Reduction – South East Asia Phase 4. April.
- Agarwal, Siddharth. 2011. The state of urban health in India; comparing the poorest quartile to the rest of the urban population in selected states and cities. *Environment and Urbanization*, Vol. 23, No. 1, pp. 13-28.
- Agrawala, Shardul, Arnaldo Matus Kramer, Guillaume Prudent-Richard and Sainsbury, Marcus. 2010. *Incorporating climate change impacts and adaptation in Environmental Impact Assessments: Opportunities and Challenges*. OECD Environmental Working Paper No. 24. Paris: OECD Publishing.
- AIFDR (Australia-Indonesia Facility for Disaster Reduction). 2013. *Key Disaster Management Successes: January 2012 – February 2013*. Jakarta.
- Airmic Technical. 2013. *Supply Chain Failures: A study of the nature, causes and complexity of supply chain disruptions*. A report by Dr. Alan Punter on behalf of Airmic - Sponsored by Allianz Global Corporate & Specialty & Lockton. London.
- AIS (Asociación Colombiana de Ingeniería Sísmica). 2014. *Historia*. Available from <http://www.asosismica.org.co/?idcategoria=1052>. Accessed 30 September 2014.
- Albala-Bertrand, José Miguel. 1993. *Political Economy of Large Natural Disasters With Special Reference to Developing Countries*. Oxford: Clarendon Press.
- Albala-Bertrand, José Miguel. 2006. *The Unlikelihood of an Economic Catastrophe*. Working Paper No. 576. October 2006. Queen Mary University of London.
- Aldrich, Nancy and William Benson. 2008. Disaster Preparedness and the Chronic Disease Needs of Vulnerable Older Adults. *Preventing Chronic Disease. Public Health Research, Practice and Policy*, Vol. 5, No. 1 (January).
- Alexander, David and Ian Davis. 2012. Disaster risk reduction: An alternative viewpoint. *International Journal of Disaster Risk Reduction*, Vol. 2, pp. 1-5.
- Alvalá, Regina., Nobre, Carlos and Marckezini, Víctor. 2014. *Lições aprendidas com os desastres naturais: a criação de uma estratégia nacional de gestão de riscos no Brasil*.
- Ambraseys, Nicholas and Roger Bilham. 2011. Corruption kills. *Nature*, Vol. 469, 13 January.
- AMDI (Asian Management and Development Institute). 2013. *Final Evaluation Report – Project: Joint partnership to support scale up of the National Community-based Disaster Risk Management Program in vulnerable provinces in Vietnam*. Hanoi.
- Amnesty International. 2010. *Un-Natural Disaster: Human Rights in the Gulf Coast*. Amnesty International Demand Dignity Campaign. Washington, D.C.
- Anderson, Mary. 1994. Disaster Prevention for Sustainable Development. Economic and policy issues. Ch. 3. In *Vulnerability to Disaster and Sustainable Development: A General Framework for Assessing Vulnerability*. Mohan Munasinghe and Caroline Clarke, eds. Washington, D.C.: The International Decade for Natural Disaster Reduction (IDNDR) and The World Bank.
- Aon Benfield. 2013. *Annual Global Climate and Catastrophe Report. Impact forecasting 2013*. Chicago, Illinois.

- Aragón-Durand, Fernando de Jesús. 2009. *Unpacking the Social Construction of 'Natural' Disaster Through Policy Discourses and Institutional Responses in Mexico: The Case of Chalco Valley's Floods, State of Mexico*. Thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy. Development Planning Unit. The Bartlett, University College London.
- Arnold, Margaret, Robin Mearns, Kaori Oshima and Vivek Prasad. 2014. *Climate and Disaster Resilience: The Role for Community-Driven Development*. Social Development Department. The World Bank and GFDRR. Washington, D.C.
- Arnold, Margaret. 2008. *The Role of Risk Transfer and Insurance in Disaster Risk Reduction and Climate Change Adaption*. Commission on Climate Change and Development. March 2008.
- Aspinall, W., M. Auken, T.K. Hincks, S. Mahony, F. Nadim, J. Pooley, R.S.J. Sparks and E. Syre. 2011. *Volcano hazard and exposure in GFDRR priority countries and risk mitigation measures*. GFDRR Volcano Risk Study. Bristol University Cabot Institute and NGI Norway for the World Bank: NGI Report 20100806, Bristol, 3 May 2011.
- Auken, M.R., R.S.J. Sparks, L. Siebert, H.S. Crossweller and J.A. Ewert. 2013. A statistical analysis of the global historical volcanic fatalities record. *Journal of Applied Volcanology*, 2:2 (February).
- Baez, Javier, Alejandro de la Fuente and Indhira Santos. 2009. *Do Natural Disasters Affect Human Capital? An Assessment Based on Existing Empirical Evidence*. IZA Discussion Paper No. 5164.
- Baez, Javier and Indhira Santos. 2007. *Children's Vulnerability to Weather Shocks: A Natural Disaster as a Natural Experiment*. April 2007.
- Bagstad, Kenneth., Stapleton, Kevin and D'Agostino, John. 2007. Taxes, subsidies, and insurance as drivers of United States coastal development. *Ecological Economics*, Vol. 63: 285-298.
- Baird, A., P. O'Keefe, K. Westgate and B. Wisner. 1975. *Towards an Explanation and Reduction of Disaster Proneness*. University of Bradford Disaster Research Unit. Occasional papers: Number 11, August 1975. Bradford.
- Baker, Judy L. (Ed). 2012. *Climate Change, Disaster Risk and the Urban Poor. Cities Building Resilience for a Changing World*. The World Bank, Washington, D.C.
- Bamidele, Oluwaseun. 2011. Climate Change and Conflicts in Sub-Saharan Africa: Trends, Challenges and Policies Sustainability. *Journal of Sustainable Development in Africa*, Vol. 13, No. 7: 35-45.
- Bartholomew, J.G. 1908. *City of Bombay*. Imperial gazetteer of India. New edition, published under the authority of His Majesty's Secretary of State for India in Council. Oxford: Clarendon Press, 1907-1909. Vol. 8. Available from <http://dsal.uchicago.edu/maps/gazetteer/>.
- Baudrillard, Jean. 1994. *Simulacra & Simulation. The Precession of Simulacra*. University of Michigan Press.
- BEC (Business Environment Council) and CCBF (Climate Change Business Forum). 2014. *2013 Hong Kong Business Survey on Energy Efficiency & Climate Change. Executive Summary*.
- Beck, Ulrich. 2009. Critical Theory of World Risk Society: A Cosmopolitan Vision. *Constellations*, Vol. 16, No. 1, pp. 3-22.
- Benson, Lynne and Jon Bugge. 2007. *Child-Led Disaster Risk Reduction: A Practical Guide*. Save the Children.
- Benson, Charlotte and Edward J. Clay. 2004. Understanding the Economic and Financial Impacts of Natural Disasters. *Disaster Risk Management Series*, No. 4. Washington, D.C.: World Bank.
- Berke, Philip R., Jack Kartez and Dennis Wenger. 1993. Recovery After Disaster: Achieving Sustainable Development, Mitigation and Equity. *Disasters*, Vol. 17, No. 2: 93-109.
- Bertaud, Alain. 2011. *Starving Mumbai from infrastructure investments and new floor space: A critique of Mumbai's Malthusian urban policy over the last 40 years*. Mumbai FAR/FSI Consortium.
- Birdsall, Nancy and Juan Luis Londoño. 1997. As-

- set Inequality Matters: An Assessment of the World Bank's Approach to Poverty Reduction. *The American Economic Review*, Vol. 87, No. 2, Papers and Proceedings of the Hundred and Fourth Annual Meeting of the American Economic Association (May, 1997): 32-37.
- Bishaw, Alemayehu. 2012. *Poverty: 2010-2011*. American Community Survey Briefs. Issued: September 2012. United States Census Bureau.
- Bomlitz, Larisa J. and Mayer Brezis. 2008. Misrepresentation of health risks by mass media. *Journal of Public Health*, Vol. 30, No. 2: 202-204.
- Botha, Doret and Dewald van Niekerk. 2013. Views from the Frontline: A critical assessment of local risk governance in South Africa. *Jàmhá: Journal of Disaster Risk Studies* 5 (2). Art. #82.
- Brillembourg, Alfredo and Hubert Klumpner. 2005. *Informal City*. Prestel Publishing.
- Brookings Institution. 2008. *Protecting Internally Displaced Persons: A Manual for Law and Policymakers*. University of Bern. October 2008.
- Buchanan-Smith, Margaret and Simon Maxwell. 1994. *Linking Relief and Development: An introduction and overview*.
- Bunten, Devin and Matthew Kahn. 2014. *The Impact of Emerging Climate Risks on Urban Real Estate Price Dynamics*. Working Paper 20018. National Bureau of Economic Research Working Paper Series. March 2014. Cambridge, MA.
- Burby, Raymond J., Timothy Beatley, Philip R. Berke, Robert E. Deyle, Steven French, David R. Godschalk, Edward J. Kaiser, Jack D. Kartez, Peter J. May, Robert Olshansky, Robert G. Paterson and Rutherford H. Platt. 1999. Unleashing the Power of Planning to Create Disaster-Resistant Communities. *Journal of the American Planning Association*, Vol. 65, Issue 3: 247-258.
- Burby, Raymond. 2006. Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing About Wise Governmental Decisions for Hazardous Areas. *Annals of the American Academy of Political and Social Science*, Vol. 604, No. 1: 171-191.
- Butchart, S.H.M. et al. 2010. Global Biodiversity: Indicators of Recent Declines. *Science*, Vol. 328, No. 5982, pp. 1164-1168. doi: 10.1126/science.1187512.
- Buzna, L., K. Peters and D. Helbing. 2007. Optimized response to cascading failures in complex networks. In *Risk, Reliability and Societal Safety*, Aven & Vinnem, eds. London.
- Caminos, Horacio and Reinhard Goethert. 1978. *Urbanization Primer: Project assessment, site analysis, design criteria for site and services of similar dwelling environments in developing areas*. Collection of photographs on urbanization. MIT Press.
- Cannon, Terry. 2008. *Reducing People's Vulnerability to Natural Hazards*. Research Paper No. 2008/34. UNU-WIDER.
- Cardona, Omar Darío., Lavell, Allan., Mansilla, Elizabeth and Moreno, Álvaro. 2005. *Avances en las estrategias de desarrollo institucional y sostenibilidad financiera de la gestión del riesgo de desastres en América Latina y el Caribe*. Banco Interamericano de Desarrollo y Diálogo Regional de Política. Mayo de 2005. Washington, D.C.
- Carpenter, Guy. 2006. *Natural Hazards Review 2005*. Instrat Briefing. February 2006.
- Carter, Lynne M., James W. Jones, Leonard Berry, Virginia Burkett, James Murrley, Jayantha Obeysekera, Paul J. Schramm and David Wear. 2014. Southeast and the Caribbean. Chapter 17. In *Climate Change Impacts in the United States: The Third National Climate Assessment*, J.M. Melillo, Terese (T.C.) Richmond and G. W. Yohe, eds., U.S. Global Change Research Program, pp. 396-417. doi:10.7930/JONP22CB.
- Cashman, Adrian. 2007. *Sustainable Flood Risk Management: A Glasgow Case Study – from paralysis to praxis?* Flood Risk Management Research Consortium (FRMRC). June 2007.
- Castells, M., J. Caraça and G. Cardoso. 2012. *Aftermath. The Cultures of the Economic Crisis*. Oxford: Oxford University Press.
- Castillo, Rosa Cordillera A. 2011. *When Fishing is No Longer Viable: Environmental Change, Unfair Market Relations, and Livelihood in a Small Fish-*

- ing Community in the Philippines. Paper presented at the ESF-UniBi-ZiF research conference on 'Environmental Change and Migration: From Vulnerabilities to Capabilities', Bad Salzflun, Germany, December 5-9, 2010. COMCAD Arbeitspapiere - Working Papers No. 105, 2011 Series on Environmental Degradation and Migration. Editors: Jeanette Schade and Thomas Faist.
- Cavallo, Antonella and Vernon Ireland. 2014. *Preparing for Complex Independent Risks: A System of Systems Approach to Building Disaster Resilience*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Cavallo, Eduardo., Galiani, Sebastian., Noy, Ilan and Pantano, Juan. 2009. *Natural Disasters and Economic Growth*. November 10, 2009.
- CDKN (Climate and Development Knowledge Network). 2014. *Risk-informed decision-making: An agenda for improving risk assessments under HFA2*. CDKN Guide, April 2014.
- CDP (Carbon Disclosure Project). 2013. *Reducing Risk and Driving Business Value*. CDP Supply Chain Report 2012-13. London.
- CEO Risk Forum. 2012. *CEO Risk Forum. Spring 2012*.
- CEPAL (Comisión Económica para América Latina y el Caribe). 1973. *Informe sobre los daños y repercusiones del terremoto de la ciudad de Managua en la economía nicaragüense*. Comité Plenario, Séptima Reunión extraordinaria. Nueva York.
- CEPAL (Comisión Económica para América Latina y el Caribe). 1976. *Daños causados por el terremoto de Guatemala y sus repercusiones sobre el desarrollo económico y social del país*. Febrero de 1976.
- CEPAL (Comisión Económica para América Latina y el Caribe). 2010. *Terremoto en Chile: Una primera mirada al 10 de marzo de 2010*.
- Ceres. 2013. *Insurer Climate Risk Disclosure Survey: 2012 Findings & Recommendations*. March 2012. Authored by Sharlene Leurig and Andrew Dlugolecki. Boston.
- Chatenoux, B. and P. Peduzzi. 2013. *Biomass fires: preliminary estimation of ecosystems global economic losses*. Background Paper prepared for the 2013 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Chelidze, T. 2013. *Real Time Telemetric Monitoring/Early Warning System of Large Dams*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Children in a Changing Climate Coalition. 2011. *Children and Disasters: Understanding Impact and Enabling Agency*. Research Report authored by Fran Seballos, Marcela Tarazona, Jose Gallegos and Thomas Tanner. May 2011. Brighton: Institute of Development Studies.
- Chohan, Faisal, Vaughn Hester and Robert Munro. 2011. *Pakreport: Crowdsourcing for Multipurpose and Multicategory Climate-related Disaster Reporting*. Case study: ICTs, Climate Change and Disaster Management. Climate Change, Innovation & ICTs Project: Centre for Development Informatics (CDI), University of Manchester, UK, with the support of the International Development Research Centre (IDRC).
- Christakos, G., R.A. Olea and H.-L. Yu. 2007. Recent results on the spatiotemporal modelling and comparative analysis of Black Death and bubonic plague epidemics. *Public Health*, Vol. 121, pp. 700-720.
- CIMNE-INGENIAR (International Centre for Numerical Methods in Engineering and INGENIAR Ltda.). 2014a. *Update on the Probabilistic Modelling of Natural Risks at Global Level: Global Risk Model. Global earthquake and tropical cyclone hazard assessment. Disaster risk assessment of countries for seismic, cyclonic (wind and storm surge) and flood*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- CIMNE-INGENIAR (International Centre for Numerical Methods in Engineering and INGENIAR Ltda.). 2014b. *Selection of Local Case Studies*

- With Fully Probabilistic Hazard and Risk Assessments*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Coleman, James, Oscar Huh and DeWitt Braud, Jr. 2008. *Wetland Loss in World Deltas*. Coastal Studies Institute, Louisiana State University. Available from [http://www.geol.lsu.edu/WDD/PUBLICATIONS/CH&B04/wetland\\_loss.htm](http://www.geol.lsu.edu/WDD/PUBLICATIONS/CH&B04/wetland_loss.htm) Accessed 08 December 2014.
- Conroy, K., A.R. Goodman and S. Kenward. 2010. *Lessons from the Chars Livelihoods Programme, Bangladesh (2004-2010)*. Paper presented to: Ten Years of 'War Against Poverty': What Have We Learned Since 2000 & What Should We Do 2010-2020? CPRC International Conference, 8-10 September 2010. Government of Bangladesh and UKAID.
- Constanza, R., O. Perez-Maqueo, M.L. Martinez, P. Sutton, S.J. Anderson and K. Mulder. 2008. The value of coastal wetlands for hurricane protection. *Ambio*, Vol. 37, No. 4: 241-248.
- Cools, Jan and Demetrio Innocenti. 2014. *Flood early warning in practice: Lessons learned from a comparative analysis*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Coskun, Arife. 2013. *The expansion of accountability framework and the contribution of supreme audit institutions*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Costa, Luís, Diego Rybski and Jürgen P. Kropp. 2011. *A Human Development Framework for CO2 Reductions*. Potsdam: Potsdam Institute for Climate Impact Research.
- Crawford, A.T. 1908. *The Development of New Bombay: A Pamphlet*. Bombay.
- Credit Suisse. 2013. *Global Wealth Report 2013*. October 2013. Zurich: Credit Suisse Research Institute.
- Credit Suisse. 2014. *Global Wealth Report 2014*. October 2014. Zurich: Credit Suisse Research Institute.
- Cuéllar, Armando, Samuel Maldonado, and J.M. Espinoza Aranda. 2010. Sistema de Alerta Sísmica para la Ciudad de México. *Revista Digital Universitaria*, Vol. 11, No. 1, ISSN: 1067-6079.
- Cummins, J. David and Oliver Mahul. 2009. *Catastrophe Risk Financing in Developing Countries: Principles for Public Intervention*. The World Bank, Washington, D.C.
- Cuny, Frederick C. 1983. *Disasters and Development*. Oxford: Oxford University Press.
- Cutter, Susan. 2014. Building Disaster Resilience: Steps Toward Sustainability. *Challenges in Sustainability*, Vol. 1, Issue 2: 72-79.
- Davies, James, Rodrigo Lluberas and Anthony F. Shorrocks. 2012. *Measuring the Global Distribution of Wealth*. 2012 OECD World Forum New Delhi. 17 October 2012.
- Davis, Ian. 1978. Disasters and Settlements: Towards an Understanding of the Key Issues. *Disasters*, Vol. 2, No. 2/3: 105-117.
- de Sherbinin, Alex, Andrew Schiller and Alex Pulispher. 2007. The vulnerability of global cities to climate hazards. *Environment and Urbanization*, Vol. 19, No. 1: 39-64.
- Degrossi, L.C., J.P. Albuquerque, M.C. Fava, and E.M. Mendiondo. 2014. *Flood Citizen Observatory: a crowdsourcing-based approach for flood risk management in Brazil*. In Proceedings of the 26th International Conference on Software Engineering and Knowledge Engineering (Vancouver, July 1-3, 2014). SEKE '14. Knowledge Systems Inst. Graduate School, 1-6.
- Deloitte and GSMA. 2012. *Sub-Saharan Africa Mobile Observatory 2012*. Available from [http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/SSA\\_FullReport\\_v6.1\\_clean.pdf](http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/SSA_FullReport_v6.1_clean.pdf).
- Deininger, Klaus and Lyn Squire. 1998. New ways of looking at old issues: inequality and growth. *Journal of Development Economics*, Vol. 57 (1998): 259-287.
- DFID (Department for International Development). 2004. *Disaster risk reduction: a development concern. A scoping study on links between disaster risk reduction, poverty and develop-*

- ment. Overseas Development Group, December 2004.
- Dobbs, Richard and Reemes, Jaana. 2012. *Trends. The Shifting Urban Economic Landscape: What Does it Mean for Cities?* McKinsey Global Institute. October 2012.
- Dobbs, Richard, Jaana Reemes, James Manyika, Charles Roxburgh, Sven Smit and Fabian Schaer. 2012. *Urban World: Cities and the rise of the consuming class.* McKinsey Global Institute. June 2012.
- Donner, William and Rodríguez, Avidán. 2008. Population Composition, Migration and Inequality: The Influence of Demographic Changes on Disaster Risk and Vulnerability. *Social Forces*, Vol. 87. No. 2 (Dec. 2008): 1089-1114.
- Dossal, Mariam. 2005. A Master Plan for the City: Looking at the Past. *Economic and Political Weekly*, Vol. 40, No. 36 (Sep. 3-9, 2005): 3897-3900.
- DSWD (Government of the Philippines, Department of Social Welfare and Development), IDMC (Internal Displacement Monitoring Centre), IOM (International Organization for Migration) and SAS. 2014. *The Evolving Picture of Displacement in the Wake of Typhoon Haiyan. An Evidence-Based Overview.* May 2014. Government of the Philippines, Department of Social Welfare and Development (DSWD), International Organization for Migration (IOM).
- Easterly, William. 2002. *Inequality does Cause Underdevelopment: New evidence.* Working Paper No. 1. January 2002 (revised June 2002). Center for Global Development.
- Eco, Umberto. 1986. *Travels in Hyper Reality.* New York: Harcourt Brace Jovanovich.
- European Environment Agency. 2013. *Late lessons from early warnings: science, precaution, innovation.* European Environment Agency Report No. 1. Chapter 15: Floods: Lessons about Early Warning Systems.
- EIU (The Economist Intelligence Unit). 2013. *Global food security index 2013: An annual measure of the state of global food security.* Available from <http://foodsecurityindex.eiu.com/>.
- The Economist Intelligence Unit. 2014. *Global food security index 2014 special report: Food loss and its intersection with food security.* Available from <http://foodsecurityindex.eiu.com/>.
- Engels, Friedrich. 1845. *The Condition of the Working Class in England.* First published in Germany, 1845. English translation first published in 1886; republished with some revisions, and edited by Victor Kiernan. New York, NY: Penguin Books, 1987: 171-184.
- Enia, Jason. 2013. The spotty record of the Hyogo Framework for Action: Understanding the incentives of natural disaster politics and policy making. *The Social Science Journal*, Vol. 50 (2013): 213-224.
- Erian, W., B. Katlan, B. Ouldbedy, H. Awad, E. Zaghity and S. Ibrahim. 2012. *Agriculture Drought in Africa and Mediterranean.* Background paper prepared for the 2013 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Erian, Wadid, Bassem Katlan, Naji Assad and Sanaa Ibrahim. 2014. *Effects of Drought and Land Degradation on Crop Losses in Africa and the Arab Region with Special Case Study on: drought and conflict in Syria.* Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- ERN America Latina (Evaluación de Riesgos Naturales - América Latina). 2010. *Belize.* Central America Probabilistic Risk Assessment. Task IV: Hazard, Risk Maps and Risk Management Applications. Technical Report, Subtask 4.2b - Disaster Risk Assessment for Belize City.
- European Commission and Comunidad Andina. 2006. *Pérdidas por desastres en Perú entre 1970-2006.* . Lima: PREDECAN and Comunidad Andina.
- European Commission. 2007. Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. *Official Journal of the European Union.* L 288/27, 6 November 2007.

- Fajnzylber, Pablo., Lederman, Daniel and Loayza, Norman. 2002. What causes violent crime? *European Economic Review*, Vol. 46: 1323-1357.
- FAO (Food and Agriculture Organization), IFAD (International Fund for Agricultural Development) and WFP (World Food Programme). 2014. *The State of Food Insecurity in the World. Strengthening the enabling environment for food security and nutrition*. Rome.
- FAO (Food and Agriculture Organization). 2007. *The World's Mangroves 1980-2005*. FAO Forestry Paper 153. A thematic study prepared in the framework of the Global Forest Resources Assessment 2005. Rome.
- FAO (Food and Agriculture Organization). 2010. *On Solid Ground: Addressing land tenure issues following natural disasters. Bangladesh: Eroding rivers, eroding livelihoods*. Early Recovery, Global Land Tool Network, UN-HABITAT and FAO.
- FAO (Food and Agriculture Organization). 2012. *World Agriculture Towards 2030/2050. The 2012 Revision*. ESA Working Paper No. 12-03, June 2012. Agricultural Development Economics Division, Food and Agriculture Organization of the United Nations.
- FAO (Food and Agriculture Organization). 2013a. *Drought*. FAO Land & Water.
- FAO (Food and Agriculture Organization). 2013b. *Food wastage footprint: Impact on natural resources*. Summary Report.
- FAO (Food and Agriculture Organization). 2014. *The State of Food and Agriculture: Innovation in family farming*. Rome.
- FEMA (US Federal Emergency Management Agency). 1998. *History and Principles of Seismic Design*. Appendix A: 33-42.
- Ferreira Pedroso, Federico, Joel Teo, Erica Seville, Sonya Giovanazzi and John Vargo. 2013. *Post-Disaster Challenges and Opportunities: Lessons from the 2011 Christchurch Earthquake and Great Eastern Japan Earthquake and Tsunami*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Frost, A.R, C.P. Schofield, S.A. Beulah, T.T. Mottram, J.A. Lines and C.M. Wathes. 1997. A review of livestock monitoring and the need for integrated systems. *Computers and Electronics in Agriculture*, Vol. 17, Issue 2: 139-159.
- Gall, Melanie, Susan Cutter and Khai Nguyen. 2014a. *Governance in Disaster Risk Management*. 2015 Global Assessment Report on Disaster Risk Reduction. Section on the Future of Disaster Risk Management. Hazards and Vulnerability Research Institute, University of South Carolina, July 2014.
- Gall, Melanie, Susan Cutter and Khai Nguyen. 2014b. *Incentives for Disaster Risk Management*. 2015 Global Assessment Report on Disaster Risk Reduction. Section on the Future of Disaster Risk Management. Hazards and Vulnerability Research Institute, University of South Carolina, May 2014.
- Gall, Melanie, Susan Cutter and Khai Nguyen. 2014c. *Transformative Development and Disaster Risk Management*. 2015 Global Assessment Report on Disaster Risk Reduction. Section on the Future of Disaster Risk Management. Hazards and Vulnerability Research Institute, University of South Carolina, May 2014.
- Gandy, Matthew. 2008. Landscapes of disaster: water, modernity, and urban fragmentation in Mumbai. *Environment and Planning A*, 40 (1): 108-130.
- Gharbero, A. and R. Muttarak. 2013. Impacts of the 2010 droughts and floods on the community welfare in rural Thailand: differential effects of village educational attainment. *Ecology and Society*, Vol. 18, No. 4. Available from <http://www.ecologyandsociety.org/vol18/iss4/art27/>.
- Gellert-de Pinto, Gisela-Irene. 2012. El cambio de paradigma: de la atención de desastres a la gestión del riesgo. *Boletín Científico Sapiens Research*, Vol. 2, No. 1 (2012): 13-17. ISSN-e: 2215-9312.
- Gemenne, François. 2010. Climate-induced population displacements in a 4°C+ world. *Philosophical Transactions of the Royal Society A*,

- (2011) 369: 182-195.
- Geneva Declaration. No date. *Chapter 5: What's in a Number? Estimating the Economic Costs of Armed Violence*.
- GFDRR (Global Facility for Disaster Reduction and Recovery) and UN-HABITAT (United Nations Human Settlements Programme). 2014. *Improving Building Code Implementation and Compliance for More Resilient Buildings in Developing Countries: Considerations for Policy Makers. Concept Note*. October 2014.
- GFDRR (Global Facility for Disaster Reduction and Recovery), EU (European Union) and UN (United Nations). 2013. *Post-Disaster Needs Assessment. Joint Declaration on Post-Crisis Assessments and Recovery Planning. Volume A: Guidelines*. The World Bank, Washington, D.C.
- GFDRR (Global Facility for Disaster Reduction and Recovery), EU (European Union) and UNDP (United Nations Development Programme). 2014. *Guide to developing disaster recovery frameworks*. World Reconstruction Conference Version. September 2014. The World Bank, Washington, D.C.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2012a. *The Great East Japan Earthquake: Learning From Megadisasters*. Knowledge Notes. Executive Summary. The World Bank, Washington, D.C.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2012b. *Managing Disaster Risks for a Resilient Future: A Strategy for the Global Facility for Disaster Reduction and Recovery 2013 – 2015*. The World Bank, Washington, D.C.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2013a. *Stories of Impact: Big Disaster Planning Pays Off in Odisha, India*. The World Bank, Washington, D.C.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2013b. *Building Resilient Communities in Vietnam*. Project Highlights. GFDRR. The World Bank, Washington, D.C.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2013c. *Bangladesh's Chars Livelihoods Programme (CLP)*. Case Study. June 2013. The World Bank, Washington, D.C.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2014a. *Understanding Risk: The Evolution of Disaster Risk Assessment since 2005*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2014b. *Financial Protection Against Natural Disasters*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2014c. *Resilient Recovery: An Imperative for Resilient Development*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- GFDRR (Global Facility for Disaster Reduction and Recovery). 2014d. *Building Social Resilience of the Poor: Protecting and Empowering Those Most at Risk*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- GFDRR (Global Facility for Disaster Reduction and Recovery). No date. *Disaster Risk Management in Central America: GFDRR Country Notes. Costa Rica*. The World Bank, Washington, D.C.
- GFI (Global Financial Integrity). 2014. *Illicit Financial Flows from Developing Countries: 2003-2012*. Authored by Dev Kar and Joseph Spanjers. December 2014.
- Ghesquiere, Francis and Olivier Mahul. 2010. *Financial Protection of the State against Natural Disasters. A Primer*. Policy Research Working Paper 5429. September 2010. The World Bank, Washington, D.C.
- Gibson, Terry. 2014. *Local level Monitoring: 'Frontline' – building on the experience of Views from the Frontline*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit). 2012. *Disaster risk manage-*

- ment and adaptation to climate change. *Experience from German development cooperation*. Edited by Wolfgang Lutz, Michael Siebert and Eva Wuttge. November 2012. Frankfurt am Main.
- Glantz, Michael. 1999. *Creeping Environmental Problems and Sustainable Development in the Aral Sea Basin*. Cambridge, UK: Cambridge University Press.
- Global Commission on the Economy and Climate. 2014. *Better Growth, Better Climate: The New Climate Economy Report*. Washington, D.C.: World Resources Institute.
- GNDR (Global Network for Disaster Reduction). 2013. *Views from the Frontline: Beyond 2015. Findings from VFL 2013 and recommendations for a post-2015 disaster risk reduction framework to strengthen the resilience of communities to all hazards*.
- GNOCDC (Greater New Orleans Community Data Center). 2013. *The New Orleans Index at Eight: Measuring Greater New Orleans' Progress Toward Prosperity*. August 2013.
- Gonzalez, Maria and Alfred Schipke. 2011. Bankers on the Beach. *Finance & Development*, June 2011: 42-45.
- Goodell, Jeff. 2013. Goodbye Miami. *Rolling Stone*, 20 June 2013.
- Government of Australia. No date. *Natural Disaster Relief and Recovery Arrangements*. Emergency Management Australia.
- Government of Bhutan. 2013. *Disaster Management Act of Bhutan 2013*.
- Government of Burkina Faso. 2014. *Loi No. 012/2014, Portant Loi d'Orientation relative à la prévention et à la gestion des risques, des crises humanitaires et des catastrophes*. Assemblée Nationale.
- Government of Colombia. 1988. *Ley 46 de 1988 (Noviembre 2) Diario Oficial No 38.559, del 2 de noviembre de 1988 Por la cual se crea y organiza el Sistema Nacional para la Prevención y Atención de Desastres, se otorga facultades extraordinarias al Presidente de la República, y se dictan otras disposiciones*. Congreso de Colombia, 1988.
- Government of Colombia. 2010. *Reglamento colombiano de construcción sismo resistente NSR-10*. Ministerio de Ambiente, Vivienda y Desarrollo Territorial. Marzo de 2010, Bogotá.
- Government of Colombia. 2012. *Ley No. 1523 del 24 de Abril de 2012. Por el cual se adopta la política nacional de gestión del riesgo de desastres y se establece el sistema nacional de gestión del riesgo de desastres y se dictan otras disposiciones*.
- Government of France. 1990. *Environnement et prévention des risques technologiques et naturels majeurs. Décret No. 90-918 du 11 octobre 1990*. Journal Officiel de la République Française.
- Government of France. 2004. *Loi n°87-565 du 22 juillet 1987 relative à l'organisation de la sécurité civile, à la protection de la forêt contre l'incendie et à la prévention des risques majeurs*.
- Government of India. 2004. *Disaster Management in India*. Government of India Ministry of Home Affairs.
- Government of Japan. 2011. *Report of the Committee for Technical Investigation on Countermeasures for Earthquakes and Tsunamis Based on the Lessons Learned from the "2011 off the Pacific coast of Tohoku Earthquake"*. 28 September 2011. Central Disaster Management Council.
- Government of Japan. 2012. *Floods in Thailand that caused a significant impact on trade environment, etc. of neighbouring nations/regions, including Japan*. Section 3.
- Government of Myanmar. 2012. *Myanmar Action Plan on Disaster Risk Reduction (MAPDRR)*. The Republic of The Union of Myanmar. Supported by ADPC.
- Government of Nicaragua. 2005. *Informe Nicaragua - CMRD-Japón 2005*. Secretaría Ejecutiva del Sistema Nacional para la Prevención, Mitigación y Atención de Desastres (SE-SINAPRED).
- Government of Odisha. 2013. *Disaster Management Plan*. Government of Odisha Housing & Urban Development Department.

- Government of Paraguay. 2013. *Política Nacional de Gestión y Reducción de Riesgos*. Secretaría de Emergencia Nacional y Gobierno Nacional.
- Government of Scotland. 2009. *National Forum on Drug Related Deaths in Scotland Annual Report 2008-09*. Edinburgh: The Scottish Government.
- Government of the Republic of Haiti. 2010. *Haiti Earthquake PDNA: Assessment of damage, losses, general and sectoral needs*. Annex to the Action Plan for National Recovery and Development of Haiti.
- Government of the Republic of Serbia. 2014. *Serbia Floods 2014*. United Nations Serbia, The World Bank and The European Union. Belgrade.
- Government of the United Kingdom. 2011. *Japanese earthquake and tsunami: Implications for the UK nuclear industry. Final report*. HM Chief Inspector of Nuclear Installations. Office for Nuclear Regulation. September 2011.
- Government of the United Kingdom. 2012. *Reducing Risks of Future Disasters: Priorities for Decision Makers*. Final Project Report. Government Office for Science and Foresight. London.
- Gow, Gordon and Nuwan Waidyanatha. 2011. Mobile Phones and the Challenge of Sustainable Early Warning Systems: Reflections on HazInfo Sri Lanka and opportunities for future research. In *Mobile Communication: Dimensions of Social Policy*, James E. Katz, ed.: 63-74. New Brunswick, New Jersey: Transaction Publishers.
- Green Roofs for Healthy Cities. 2014. *2013 Annual Green Roof Industry Survey*. April 2014.
- Greenstein, Rosalind, Francisco Sabatini and Martim Smolka. 2000. Urban Spatial Segregation: Forces, Consequences, and Policy Responses. *Land Lines*, Vol. 12, No. 6 (November).
- GSMA (Groupe Speciale Mobile Association). 2013. *Mobile Network Public Warning Systems and the Rise of Cell-Broadcast*. January 2013. London.
- Gundecha, Pritam and Huan Liu. 2012. *Mining Social Media: A Brief Introduction*. INFORMS Tutorials in Operation Research.
- GVM (Global Volcano Model). 2014a. *Global Volcanic Hazards and Risk. Summary background paper*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- GVM (Global Volcano Model). 2014b. *Global Volcanic Hazards and Risk. Technical background paper*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Haavisto, Ira, Ruth Banomyong, Gyöngyi Kovács and Karen Spens. 2013. *Supply Chain Co-ordination in Cascading Disasters*. Paper presented at the International Symposium on Marketing, Logistics, and Business (MLB), Nagoya, Japan. September 2013.
- Hagman, G. 1984. *Prevention better than cure: report on human and environmental disasters in the Third World*. Stockholm: Swedish Red Cross.
- Hallegatte, Stéphane, Nicola Ranger, Sumana Bhattacharya, Murthy Bachu, Satya Priya, K. Dhore, Farhat Rafique, P. Mathur, Nicolas Naville, Fanny Henriët, Anand Patwardhan, K. Narayanan, Subimal Ghosh, Subhankar Karmakar, Unmesh Patnaik, Abhijat Abhayankar, Sanjib Pohit, Jan Corfee-Morlot and Celine Herweijer. 2010. *Flood Risks, Climate Change Impacts and Adaptation Benefits in Mumbai: An Initial Assessment of Socio-Economic Consequences of Present and Climate Change-Induced Flood Risks and of Possible Adaptation Options*. OECD Environment Working Papers No. 27. Paris: OECD Publishing.
- Hannigan, John. 2012. *Disasters Without Borders: The International Politics of Natural Disasters*. Cambridge, UK: Polity Press.
- Haraguchi, Masahiko and Kim, Soojun. 2014. *Critical Infrastructure Systems: A case study of the interconnectedness of risks posed by Hurricane Sandy for New York City*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Harbitz, C.B., S. Glimsdal, S. Bazin, N. Zamora, F. Løvholt, H. Bungum, H. Smebye, P. Gauer and O. Kjekstad. 2012. Tsunami hazard in the Ca-

- ribbean: Regional exposure derived from credible worst case scenarios. *Continental Shelf Research*, Vol. 38, 15 April 2012: 1-23.
- Harvey, David. 1985. *The Urbanization of Capital*. First Edition (US), First Printing edition (November 1, 1985). Johns Hopkins University Press.
- Harvey, David. 1989. *The Condition of Postmodernity: An enquiry into the origins of cultural change*. Cambridge and Oxford, UK: Blackwell Publishers.
- Harvey, David. 2010. *The Enigma of Capital and the Crises of Capitalism*. New York: Oxford University Press.
- Hasan, Arif, Asiya Sadiq and Suneela Ahmed. 2010. *Planning for high density in low-income settlements: Four case studies from Karachi*. Human Settlements Working Paper Series. Urbanization and emerging population issues - 3. UNFPA, IIED, March 2010.
- Helliwell, John, Richard Layard and Jeffrey Sachs, eds. 2013. *World Happiness Report 2013*. Available from [http://unsdsn.org/wp-content/uploads/2014/02/WorldHappinessReport2013\\_online.pdf](http://unsdsn.org/wp-content/uploads/2014/02/WorldHappinessReport2013_online.pdf)
- Henderson, J. Vernon, Mark Roberts and Adam Storeygard. 2013. *Is Urbanization in Sub-Saharan Africa Different?* Policy Research Working Paper 6481. The World Bank Development Research Group, Environment and Energy Team. June 2013. The World Bank, Washington, D.C.
- Hewitt, Kenneth, ed. 1983. *Interpretations of Calamity from the Viewpoint of Human Ecology*. The Risks and Hazard Series I. Allan & Unwin.
- Hewitt, Kenneth. 2013. Disasters in 'development' contexts: Contradictions and options for a preventive approach. *Jàmbá: Journal of Disaster Risk Studies* 5(2), Art. #91.
- Hochrainer, Stefan. 2009. *Assessing the Macroeconomic Impacts of Natural Disasters: Are there any?* Policy Research Working Paper 4968. The World Bank, Washington, D.C.
- Hochrainer-Stigler, Stefan, Reinhard Mechler, Georg Pflug and Keith Williges. 2014. Funding public adaptation to climate-related disasters. Estimates for a global fund. *Global Environmental Change* 25 (2014): 87-96.
- Holley, Cameron, Neil Gunningham and Clifford Shearing. 2011. *The New Environmental Governance*. Earthscan, Routledge.
- Holloway, Ailsa. 2014. *Strategic mobilization of higher education institutions in disaster risk reduction capacity-building: Experience of Peripери U*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Hulme, David and Green, Maia. 2005. From Correlates and Characteristics to Causes: Thinking About Poverty from a Chronic Poverty Perspective. *World Development*, Vol. 33, No. 6: 867-879.
- IANSAs (International Action Network on Small Arms), Oxfam International and Safer World. 2007. *Africa's missing billions: International arms flows and the cost of conflict*. Briefing Paper 107.
- IASC (Inter-Agency Standing Committee). 2006. *Women, Girls, Boys and Men: Different Needs, Equal Opportunities*. IASC Gender Handbook in Humanitarian Action. December 2006.
- IASC (Inter-Agency Standing Committee). 2009. *Initial Strategy Paper: Meeting Humanitarian Challenges in Urban Areas*. 11-13 November 2009, Conference Room 10, UN-HABITAT Headquarters. Nairobi.
- IASC-WFP (Inter-Agency Standing Committee and World Food Programme). 2014. *Preparedness action in present and future context, lessons learned and to be learned*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- ICSU-LAC (International Council for Science, Regional Office for Latin America and the Caribbean). 2010. *Understanding and Managing Risk Associated with Natural Hazards: A Comprehensive Approach for Latin America and the Caribbean*. Science for a better life: Developing Regional Scientific Programmes in Priority Areas for Latin America and the Caribbean.
- IDMC (Internal Displacement Monitoring Centre). 2014. *Global Estimates 2014: People displaced*

- by disasters. September 2014.
- IEA (International Energy Agency). 2013. *CO2 Emissions from fuel combustion. Highlights*. IEA Statistics. Paris.
- IFRC (International Federation of Red Cross and Red Crescent Societies) and UNDP (United Nations Development Programme). 2014. *Effective law and regulation for disaster risk reduction: a multi-country report*. New York.
- IFRC (International Federation of Red Cross and Red Crescent Societies). 2011. *International Disaster Response Law (IDRL) in Nepal: A study on strengthening legal preparedness for international disaster response*. Nepal Red Cross and IFRC. Geneva.
- IFRC (International Federation of Red Cross and Red Crescent Societies). 2014. *Emergency appeal operation update Philippines: Typhoon Haiyan*. Emergency appeal n° MDRPH014, GLIDE n° TC-2013-000139-PHL, Operation update n°8, 4 September 2014.
- ILO (International Labour Office). 2013. *Global Wage Report 2012/13: Wages and equitable growth*. Geneva: International Labour Office.
- IMF (International Monetary Fund). 2009. *Global Financial Stability Report: Responding to the Financial Crisis and Measuring Systemic Risks*. World Economic and Financial Surveys. April 2009. Washington, D.C.
- INGENIAR. 2010. *Programa de Reducción de la Vulnerabilidad Fiscal del Estado ante Desastres Naturales. Apoyo al Fortalecimiento de las Políticas e Instrumentos Financieros del Sistema Nacional para la Prevención y Atención de Desastres (SNPAD) de Colombia -DGR-*. Documento con bases de formulación de la política (Documento técnico síntesis de soporte para la propuesta normativa). Diciembre de 2010.
- Ingirige, Bingunath, Dilanthi Amaratunga, Mohan Kumaraswamy, Champika Liyanage, Aslam Perwaiz, Peeranan Towashiraporn and Gayan Wedawatta. 2014. *Private investment in Disaster Risk Management*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Ingram, Jane, Guillermo Franco, Cristina Rumbaitis-del Rio and Bjian Khazai. 2006. Post-disaster recovery dilemmas: challenges in balancing short-term and long-term needs for vulnerability reduction. *Environmental Science and Policy*, Vol. 9, Issues 7-8: 607-613.
- International Law Commission. 2013. *Sixth report on the protection of persons in the event of disasters*. Sixty-fifth session Geneva, 6 May-7 June and 8 July-9 August 2013, by Eduardo Valencia-Ospina, Special Rapporteur. Geneva: United Nations.
- Inter-Parliamentary Union. 2014. *130th Assembly of the Inter-Parliamentary Union*.
- IOM (International Organization for Migration). No date. *Human mobility: shaping vulnerability and resilience to disasters*. Background paper to the HFA2 dialogue.
- IPCC (Intergovernmental Panel on Climate Change). 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Full Report*. (Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor and P.M. Midgley, eds.). A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge and New York: Cambridge University Press.
- IPCC (Intergovernmental Panel on Climate Change). 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Full Report*. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley, eds. Cambridge and New York: Cambridge University Press.
- IPCC (Intergovernmental Panel on Climate Change). 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Working Group II. Cambridge and New York: Cambridge University Press.
- IRDR (Integrated Research on Disaster Risk).

2013. *Strategic Plan 2013-2017*. Beijing.
- IRP (International Recovery Platform). 2014. *The-matic Summary Report*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Ishiwatari, Mikio. 2013. *Disaster Risk Management at the National Level*. ADBI Working Paper Series. No. 448 November 2013. Tokyo: Asian Development Bank Institute.
- International Telecommunications Union. 2013. *The World in 2013: ICT Facts and Figures*. February 2013. Geneva.
- IUCN (International Union for Conservation of Nature). 2012. *Tacaná Watersheds Guatemala & Mexico: Transboundary water governance and implementation of IWRM through local community action*. IUCN Water Programme. Demonstration Case Study No. 5. Water and Nature Initiative.
- Jackson, Tim. 2009. *Prosperity Without Growth: Economics for a Finite Planet*. London, UK and Sterling, VA: Earthscan Publishing.
- Jayanthi, Harikishan. 2014. *Assessing the agricultural drought risks for principal rainfed crops due to changing climate scenarios using satellite estimated rainfall in Africa*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction.
- Jenkins, Alan, Juhu Thukral, Kevin Hsu, Nerissa Kunakemakorn and Megan Haberle. 2012. *Promoting Opportunity through Impact Statements: A Tool for Policymakers to Assess Equity*. American Constitution Society Issue Brief. April 2012. Washington, D.C.
- Johnson, C., I. Adelekan, F. Arefian, L. Boshier, H. Jabeen, S. Kataria, W.A. Marome and B. Zerjav. 2012. *Private Sector Investment Decisions in Building and Construction: Increasing, Managing and Transferring Risks*. Background Paper prepared for the 2013 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Johnson, Cassidy. 2011. *Creating an enabling environment for reducing disaster risk: Recent experience of regulatory frameworks for land, planning and building in low and middle-income countries*. Background Paper prepared for the 2011 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Kahn, Matthew E. 2014. *Sustainable and Smart Cities*. Policy Research Working Paper 6878. The World Bank Sustainable Development Network, Urban and Disaster Management Department. May 2014. Washington, D.C.
- Kawachi, Ichiro, Bruce P. Kennedy, Kimberly Lochner and Deborah Prothrow-Stith. 1997. Social Capital, Income Inequality, and Mortality. *American Journal of Public Health*, Vol. 87, No. 9 (September).
- K.C., Samir. 2013. Community Vulnerability to Floods and Landslides in Nepal. *Ecology and Society*, Vol. 18, No. 1: 8. doi: <http://dx.doi.org/10.5751/ES-05095-180108>.
- Keim, Mark E. and Eric Noji. 2011. Emergent use of social media: a new age of opportunity for disaster resilience. *American Journal of Disaster Medicine*, Vol. 6, No. 1 (January/February): 47-54.
- Kellett, Jan and Alice Caravani. 2013. *Financing Disaster Risk Reduction: A 20 year story of international aid*. Overseas Development Institute and the Global Facility For Disaster Reduction and Recovery. September 2013.
- Kellett, Jan and Dan Sparks. 2012. *Disaster Risk Reduction: Spending where it should count*. Global Humanitarian Assistance Briefing Paper. Development Initiatives, United Kingdom.
- Kelman, Ilan. 1998. *Role of Technology in Managing Vulnerability to Natural Disasters, With Case Studies of Volcanic Disasters on Non-Industrialized Islands*. A thesis submitted in conformity with the requirements for the degree of Master of Applied Science. Graduate Department of Civil Engineering, University of Toronto.
- Kent, Randolph. 2011. *Disaster risk reduction and changing dimensions and dynamics of future drivers*. Background Paper prepared for the 2011 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.

- Khan, Himayatullah, Laura Giurca Vasilescu and Asmatullah Khan. 2008. *Disaster Management Cycle: A Theoretical Approach*. Available from <http://www.mnmk.ro/documents/2008/2008-6.pdf> (last accessed 11 December 2014).
- Kim, Chul Kyu. 2010. *The Effects of Natural Disasters on Long-Run Economic Growth*. University of Michigan.
- Kopytko, Natalie and John Perkins. 2011. Climate change, nuclear power, and the adaptation-mitigation dilemma. *Energy Policy* 39 (2011): 318-333.
- Kunreuther, H. and E. Michel-Kerjan. 2012. *Policy Options for Reducing Losses from Natural Disasters: Allocating \$75 billion*. Challenge Paper: Natural Disasters. Copenhagen Consensus 2012.
- Kunreuther, H. and Pauly, M. 2006. Rules rather than discretion: Lessons from Hurricane Katrina. *Journal of Risk and Uncertainty*, Vol. 33, Issue 1-2: 101-116.
- Lall, Somik and Uwe Deichmann. 2011. *Density and Disasters: Economics of Urban Hazard Risk*. The World Bank Research Observer Advance Access. Published July 7, 2011.
- Lassa, Jonatan A. 2010. *Institutional Vulnerability and Governance of Disaster Risk Reduction: Macro, Meso and Micro Scale Assessment (With Case Studies from Indonesia)*. Dissertation zur Erlangung des Grades Doktor Ingenieur (Dr.Ing.) der Hohen Landwirtschaftlichen Fakultät der Rheinischen Friedrich-Wilhelms-Universität zu Bonn. Vorgelegt am 24 November 2010.
- Lavell, Alan and Eduardo Franco, eds. 1996. *Estado, sociedad, y gestión de los desastres en América Latina: en busca del paradigma perdido*. Red de Estudios Sociales en Prevención de Desastres en América Latina.
- Lavell, Allan and Andrew Maskrey. 2014. The future of disaster risk management. *Environmental Hazards*, Vol. 13, Issue 4, 2014.
- Lavell, Allan. 2003. *Regional Programme for Risk Management in Central America. Ideas and notions relating to concept and practice*. With the collaboration of CEPREDENAC and UNDP.
- Lavell, Allan. 2004. *La red de estudios sociales en prevención de desastres en América Latina, La Red: Antecedentes, formación y contribución al desarrollo de los conceptos, estudios y la práctica en el tema de los riesgos y desastres en América Latina: 1980-2004*.
- Lavell, Allan. 2014. *Disaster Risk Reduction and Public Investment Decisions: The Peruvian Case*. Technical Note. First edition, August 2014. Lima.
- Leeson, Peter T. and Russell S. Sobel. 2008. *Blame the Weather? Natural Disasters, FEMA, and Corruption in America*. Article containing material from: Peter T. Leeson and Russell S. Sobel, 2008. Weathering Corruption, *Journal of Law and Economics*, Vol. 51, No. 4: 667-681.
- Levitt, Jeremy I. and Whitaker, Matthew C. 2009. Truth Crushed to Earth Will Rise Again. Katrina and its Aftermath. Introduction. In *Hurricane Katrina, America's Unnatural Disaster*. Edited and with an introduction by Jeremy I. Levitt and Matthew C. Whitaker. University of Nebraska Press.
- Lewis, James and Ilan Kelman. 2012. *The Good, The Bad and The Ugly: Disaster Risk Reduction (DRR) Versus Disaster Risk Creation (DRC)*. PLOS Currents Disasters. 21 June 2012. Edition 1. doi: 10.1371/4f8d4eac6af8.
- Lewis, Roy R. 2001. *Mangrove Restoration – Costs and Benefits of Successful Ecological Restoration*. In review, Proceedings of the Mangrove Valuation Workshop, Universiti Sains Malaysia, Penang, 4-8 April 2001. Beijer International Institute of Ecological Economics, Stockholm, Sweden.
- Lewis, James. 2011. Corruption: The hidden perpetrator of under-development and vulnerability to natural hazards and disasters. *Jàmbá: Journal of Disaster Risk Studies*, Vol. 3, No. 2, May 2011.
- Lindley, Sarah, John O'Neill, Joseph Kandeh, Nigel Lawson, Richard Christian and Martin O'Neill. 2011. *Climate change, justice and vulnerability*. Joseph Rowntree Foundation. November 2011.

- Lloyd's. 2012. *Lloyd's Global Underinsurance Report*. October 2012.
- Longhurst, Richard. 1994. Conceptual Frameworks for Linking Relief and Development. *IDS Bulletin*, Vol. 25, No. 4: 17-23.
- López, Juanita. 2009. *La construction sociale du risque à Medellín (Colombie): Gouvernance locale et représentations*. Thèse pour l'obtention du grade Docteur en EHESS. Paris.
- Løvholt, Finn, Daniela Kühn, Hilmar Bungum, Carl B. Harbitz and Sylfest Glimsdal. 2012. Historical tsunamis and present tsunami hazard in eastern Indonesia and the southern Philippines. *Journal of Geophysical Research*, Vol. 117, B09310. doi:10.1029/2012JB009425.
- Løvholt, Finn, Carl B. Harbitz, Farrokh Nadim, Joern Birkmann, Neysa Setiadi, Claudia Bach and Fernando Nishara. 2014. *Tsunami Risk Reduction: Are we better prepared today than in 2004?* Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Lucchetti, Leonardo. 2011. *Three Essays on Household Welfare*. Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Graduate College of the University of Illinois at Urbana-Champaign.
- Lutz, W., W.P. Butz and Samir K.C., eds. 2014. *World Population and Human Capital in the Twenty-first Century*. Oxford: Oxford University Press.
- Maplecroft. 2014. *Natural Hazards Risk Atlas 2014*. Available from <http://maplecroft.com/portfolio/new-analysis/2014/02/19/natural-hazards-risk-atlas-2014/>.
- Marino, Elizabeth. 2011. The long history of environmental migration: Assessing vulnerability construction and obstacles to successful relocation in Shishmaref, Alaska. *Global Environmental Change* 22 (2012): 374-381.
- Marulanda, Mabel C., Omar D. Cardona, Miguel G. Mora and Alex H. Barbat. 2014. Design and implementation of a voluntary collective earthquake insurance policy to cover low-income homeowners in a developing country. *Nat Hazards*, Vol. 74, Issue 3. doi: 10.1007/s11069-014-1291-4.
- Maskrey, Andrew. 1989. *Disaster Mitigation: A Community-Based Approach*. Development Guidelines No. 3. Oxfam.
- Maskrey, Andrew. 1996. *Terremotos en el trópico húmedo. La gestión de los desastres del Alto Mayo, Perú (1990 y 1991), Limón, Costa Rica (1991) y Atrato Medio, Colombia (1992)*. LA RED: Red de Estudios Sociales en Prevención de Desastres en América Latina. Colombia.
- Maskrey, Andrew. 1997. *Report on National and Local Capabilities for Early Warning*. International Decade for Natural Disaster Reduction.
- Maskrey, Andrew. 1999. Reducing Global Disasters. In *Natural Disaster Management*, J. Ingleton, ed. Leicester.
- Maskrey, Andrew. 2011. Revisiting community-based disaster risk management. *Environmental Hazards*, Vol. 10, Issue 1: 42-52.
- Masozera, Michel, Melissa Bailey and Charles Kerchner. 2007. Distribution of impacts of natural disasters across income groups: A case study of New Orleans. *Ecological Economics* 63 (2007): 299-306
- McGee, Sibel, Jaime Frittmann, Seongjin "James" Ahn and Susan Murray. 2014. *Risk Relationships and Cascading Effects in Critical Infrastructures: Implications for the Hyogo Framework for Action*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- McGuirk, Justin. 2014. *Radical Cities: Across Latin America in Search of a New Architecture*. Verso Books.
- McIvor, A.L., T. Spencer, I. Möller and M. Spalding. 2013. *The response of mangrove soil surface elevation to sea level rise*. Natural Coastal Protection Series: Report 3. The Nature Conservancy and Wetlands International.
- Meadows, Donella H., Dennis L. Meadows, Jorgen Randers and William W. Behrens III. 1972. *The Limits to Growth*. A report for The Club of Rome's Project on the Predicament of Man-

- kind. New York: Universe Books.
- Mekonnen, M.M. and A.Y. Hoekstra. 2011. National Water Footprint Accounts: The green, blue and gray water footprint of production and consumption. *Value of Water Research Report Series* No. 50. Volume 1: Main Report. Delft, Netherlands: UNESCO-IHE Institute for Water Education.
- Menon-Sen, K. and K. Bhan. 2008. *Swept off the Map: Surviving Eviction and Resettlement in New Delhi*. New Delhi: Yoda Press.
- Merz, Bruno, Florian Elmer, Michael Kunz, Bernhard Mühr, Kai Schröter and Steffi Uhlemann-Elmer. 2014. The extreme flood in June 2013 in Germany. *La Houille Blanche*, No. 1 (2014): 5-10.
- MGSDP (The Metropolitan Glasgow Strategic Drainage Partnership). 2012a. *Successful partnership working: 10 years on*. Briefing Note 10 - Winter 2012/13.
- MGSDP (The Metropolitan Glasgow Strategic Drainage Partnership). 2012b. *White Cart Water Flood Prevention Scheme*. White Cart Water Project.
- Miller, Martin. 1909. *The World's Greatest Disaster: The Complete Story of the Italian Earthquake Horror*. Washington, D.C.: National Geographic Society.
- Mitlin, Diana and David Satterthwaite. 2013. *Urban Poverty in the Global South. Scale and Nature*. USA and Canada: Routledge Publishing.
- Mochizuki, Junko, Stefan Hochrainer, Keith Williges and Reinhard Mechler. 2014. *Fiscal and Economic Risk of Natural Disasters in Comoros, Mauritius, Seychelles and Zanzibar. CATSIM Assessment (Preliminary Result)*. Risk Policy and Vulnerability Program, International Institute for Applied Systems Analysis (IIASA).
- Molinari, Daniela, Francesco Ballio, Nicola Berni and Claudia Pandolfo. 2013. *Towards more effective Early Warning Systems: The Italian Experience*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Molinari, D., S. Menoni, G.T. Aronica, F. Ballio, N. Berni, C. Pandolfo, M. Stelluti and G. Minucci. 2014. Ex post damage assessment: an Italian experience. *Natural Hazards and Earth System Sciences*, Vol. 14: 901-916.
- Morris, I. 2010. *Why the West Rules – For Now: The Patterns of History, and What They Reveal About the Future*. New York: Farrar, Straus and Giroux.
- Moullier, Thomas. 2014. *Improving Building Code Implementation and Compliance for More Resilient Buildings in Developing Countries: Considerations for Policy Makers*. Concept note. October 2014.
- Moynihan, Donald P. 2009. The Response to Hurricane Katrina. In *International Risk Governance Council report “Risk Governance Deficits: An analysis and illustration of the most common deficits in risk governance”*. Geneva.
- MRC (Mekong River Commission). 2010. *Mekong Integrated Water Resources Management Project*. Inception Report. Final Version Prepared by: Mekong Integrated Water Resources Management Project, Mekong River Commission Secretariat. September 2010.
- Muir-Wood, Robert. 2011. *Designing Optimal Risk Mitigation and Risk Transfer Mechanisms to Improve the Management of Earthquake Risk in Chile*. OECD Working Papers on Finance, Insurance and Private Pensions, No. 12. OECD Publishing.
- Munich Re. 2014. *After the floods*. Topics Geo: Natural catastrophes 2013. Analyses, assessments, positions. 2014 Issue. Munich.
- Munich Re. 2013. *2013 Natural Catastrophe Year in Review*. January 2014. Munich.
- Muttarak, Raya and Wolfgang Lutz. 2014. Is Education a Key to Reducing Vulnerability to Natural Disasters and hence Unavoidable Climate Change? *Ecology and Society* 19 (1): 41.
- Myanmar and Japan Consortium for Thilawa Special Economic Zone Development Project. 2013. *Environmental Impact Assessment Report*. September 2013.
- Nair, Ramachandran. 2014. Grand challenges in agroecology and land use systems. *Frontiers in Environmental Science*, Vol. 2 (January).
- National Audit Office. 2014. *Strategic flood risk*

- management. Report by the Comptroller and Auditor General. Department for Environment, Food & Rural Affairs and Environment Agency. 5 November 2014.
- National Hurricane Center. 2013. *Tropical Cyclone Report: Hurricane Sandy*. Authored by Eric S. Blake, Todd B. Kimberlain, Robert J. Berg, John P. Cangialosi and John L. Beven II. 12 February 2013.
- NDRRMC (National Disaster Risk Reduction and Management Council of the Philippines). 2014. *NDRRMC Update on the Effects of Typhoon Yolanda (Haiyan)*. 17 April 2014.
- Neumayer, Eric and Fabian Barthel. 2010. *Normalizing economic loss from natural disasters: a global analysis*. Centre for Climate Change Economics and Policy Working Paper No. 41. Munich Re Programme Technical Paper No. 6. Grantham Research Institute on Climate Change and the Environment Working Paper No. 31. November 2010.
- Neumayer, Eric., Thomas Plümper and Fabian Barthel. 2012. *The Political Economy of Natural Disaster Damage*. February 2012.
- New York City Government. 2013. *A Stronger, More Resilient New York*. 11 June 2013.
- Newsham, Andrew, Mark Davies and Christophe Béné. 2011. *Making Social Protection Work for Pro-Poor Disaster risk Reduction and Climate Change Adaptation*. Addis Ababa, Ethiopia, 14-17 March 2011. Background Paper.
- Nguyen, Thi Puch Hoa. 2011. *Disaster Risk Reduction - A Viet Nam Context*. World Conference on Drowning Prevention 2011.
- NIDM (National Institute of Disaster Management). 2012a. *Village Disaster Management Plan*. Authored by Ajinder Walia and Sushma Guleria. Ministry of Home Affairs, Government of India.
- NIDM (National Institute of Disaster Management). 2012b. *Flood Risk Mitigation and Management: A Training of Trainers (TOT) Module*. Authored by Dev Ashutosh, PhD. Ministry of Home Affairs, Government of India.
- NIDM (National Institute of Disaster Management). 2013. *Annual Report 2012-2013*. Compiled and edited by Anil K. Gupter. Ministry of Home Affairs, Government of India.
- NIDM (National Institute of Disaster Management). 2014. *Training Module on Urban Risk Mitigation*. Authored by Chandrani Bandyopadhyay. Ministry of Home Affairs, Government of India.
- Nilufar, Ahmad. 2012. *Gender and Climate Change in Bangladesh: The Role of Institutions in Reducing Gender Gaps in Adaptation Program*. A summary of ESW Report no. P125705, Paper No. 126/March 2012. Social Development Papers. Social Inclusion.
- NOAA (National Oceanic and Atmospheric Administration). 2005. *Hurricane Katrina*. National Climatic Data Center. Updated 29 December 2005.
- NOAH (Nationwide Operational Assessment of Hazards). 2014. *Devastating Storm Surges of Typhoon Yolanda*, Vol. 3 (2014): 82-95. ISSN: 2362 7409.
- Noy, Ilan. 2009. The macroeconomic consequences of disasters. *Journal of Development Economics* 88 (2009): 221-231.
- Noy, Ilan. 2014. *A New Non-Monetary Global Measure of the Direct Impact of Natural Disasters*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Noy, Ilan. 2015. *A New Non-Monetary Global Measure of the Direct Impact of Natural Disasters: country case studies*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- ODI (Overseas Development Institute). 2013. *Disaster as opportunity? Building back better in Aceh, Myanmar and Haiti*. Lillianne Fan, ed. HPG (Humanitarian Policy Group) Working Paper. November 2013.
- OECD (Organisation for Economic Co-operation and Development) and IEA (International Energy Agency). 2013. *World Energy Outlook 2013*. Executive Summary. Paris.
- OECD (Organisation for Economic Co-operation and Development). 2009. *Privatisation in the*

- 21<sup>st</sup> Century: Recent Experiences of OECD Countries Report on Good Practices*. Paris.
- OECD (Organisation for Economic Co-operation and Development). 2011b. *Divided We Stand: Why inequality keeps rising*. Paris: OECD Publishing.
- OECD (Organisation for Economic Co-operation and Development). 2012. *OECD Environmental Outlook to 2050: The consequences of Inaction*. Paris: OECD Publishing.
- OECD (Organisation for Economic Co-operation and Development). 2014a. *Interconnected, Inter-dependent Risks*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- OECD (Organisation for Economic Co-operation and Development). 2014b. *Disasters Derail Development. So why aren't we doing more about them? How better incentives could help overcome barriers to disaster risk reduction in development programming*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Olson, Richard Stuart, Juan Pablo Sarmiento and Gabriela Hoberman. 2011. Establishing public accountability, speaking truth to power and inducing political will for disaster risk reduction: 'Ocho Rios + 25'. *Environmental Hazards*, Vol. 10, No. 1: 59-68.
- Oteros-Rozas, E., J.A. Gonzales, B. Martin-Lopez, C.A. Lopez, and C. Montes. 2012. Ecosystem services and social-ecological resilience in transhumance cultural landscapes: learning from the past, looking for a future. In *Resilience and the cultural landscape: Understanding and managing change in human-shaped environments*, T. Plieninger and C. Bieling, eds. Cambridge, UK: Cambridge University Press.
- Otoni de Araújo, Raquel, Teresa Da Silva Rosa, Maria da Penha Smarzaró Siqueira, Márcio Reis, Camila Réboli and Arthur Aguilar. 2013. *Communicability between the National, State and Municipal Governments in the Integration of the Principles of the Hyogo Framework for Action to Reduce Risks and Disasters*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Oxfam International. 2006. *Disaster Management Policy & Practice: Lessons for Government, Civil Society, & the Private Sector in Sri Lanka*. Oxfam Humanitarian Field Studies. October 2006.
- Pandey, Bishnu and Kenji Okazaki. 2005. *Community Based Disaster Management: Empowering Communities to Cope with Disaster Risks*. United Nations Centre for Regional Development. Japan.
- Parry, W. 2013. *Why disasters like Sandy hit the elderly hard*. 8 March 2013. Available from <http://www.livescience.com/27752-natural-disasters-hit-elderly-hard.html>.
- Patel, Sheela and Diana Mitlin. 2001. *SPARC, the National Slum Dwellers Federation and Mahila Milan*. IIED Working Paper 5 on Poverty Reduction in Urban Areas.
- Peary, Brett, Rajib Shaw and Yukiko Takeuchi. 2012. *Utilization of Social Media in the East Japan Earthquake and Tsunami and its Effectiveness*. Graduate School of Global Environmental Studies, Kyoto University.
- PEDRR (Partnership for Environment and Disaster Risk Reduction). 2010. *Demonstrating the Role of Ecosystems-based Management for Disaster Risk Reduction*. Background Paper prepared for the 2011 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Pei, Minxin. 2007. *Corruption Threatens China's Future*. Carnegie Endowment for International Peace. Policy Brief 55. October 2007.
- Pelling, Mark (ed.). 2014. *Pathways for Transformation: Disaster risk management to enhance development goals*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Penning-Rowell, Edmund C. 2014. A realistic assessment of fluvial and coastal flood risk in England and Wales. *Transactions of the Institute*

- of *British Geographers*, Vol. 40. Issue 1: 44-61 (published online: March 2014).
- Peri Peri U (Partners Enhancing Resilience, People Exposed to Risks). No date. *An African Partnership: Building Capacity, Reducing Risk*.
- Persson, Torsten and Guido Tabellini. 1991. *Is inequality harmful for growth? Theory and Evidence*. National Bureau of Economic Research Working Paper Series. Cambridge, MA.
- Pichler, Adelheid and Erich Striessnig. 2014. Differential Vulnerability to Hurricanes in Cuba, Haiti, and the Dominican Republic: The Contribution of Education. *Ecology and Society*, Vol. 18, No. 3: 31. doi: <http://dx.doi.org/10.5751/ES-05774-180331>.
- Piketty, Thomas. 2014. *Capital in the Twenty-First Century*. First Edition edition. Belknap Press.
- Porter, M. and M. Kramer. 2011. Creating Shared Value. *Harvard Business Review*, Vol. 89, No. 1/2: 62-77.
- Porter, Michael E., Scott Stern and Michael Green. 2014. *Social Progress Index 2014*. Social Progress Imperative. Washington, D.C.
- Procuraduría General de la Nación. 2005. Veinte años vigentes. *Procurando* No. 37. Octubre de 2005. Gobierno de Colombia.
- Purasinghe, Harsha. 2014. *DEWN - Disaster & Emergency Warning Network. GSM Based Disaster Alerting*. University of Moratuwa.
- Quarantelli, Enrico Louis. 1978. *Disasters: Theory and Research*. Sage.
- Quarantelli, Enrico Louis. 1986. *Disaster Crisis Management*. Preliminary Paper #113. Disaster Research Center, University of Delaware.
- Ragona, M., F. Hannstein and M. Mazzocchi. 2011. The Financial Impact of the Volcanic Ash Crisis on the European Airline Industry. Chapter 3. In *Governing Disasters: The Challenges of Emergency Risk Regulation*, A. Alemanno, ed. Edward Elgar Publishing.
- Ramsar Convention on Wetlands. 1971. *Convention on Wetlands of International Importance especially as Waterfowl Habitat*. Ramsar, Iran, 2 February 1971 as amended by the Protocol of 3 December 1982 and the Amendments of 28 May 1987.
- Randers, Jorgen. 2008. Global collapse—Fact or fiction? *Futures*, Vol. 40, Issue 10: 853-864.
- Ranger, Nicola, Stéphane Hallegatte, Sumana Bhattacharya, Murthy Bachu, Satya Priya, K. Dhore, Farhat Rafique, P. Mathur, Nicolas Naville, Fanny Henriet, Celine Herweijer, Sanjib Pohit and Jan Corfee-Morlot. 2011. An assessment of the potential impact of climate change on flood risk in Mumbai. *Climatic Change*, Vol. 104, Issue 1: 139-167.
- Rathnaweera, T. D., M.P. Palihawadana, H.L.L. Rangana and U.P. Nawagamuwa. 2012. *Effects of climate change on landslide frequencies in landslide prone districts in Sri Lanka; Overview*. Civil Engineering Research Exchange Symposium 2012.
- Ray-Bennett, N.S., A.J. Masys, H. Shiroshita and P. Jackson. 2014. *Hyper-risks in a hyper connected world: A call for critical 'reflective response' to develop organisational resilience*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Reeves, Andrew. 2010. Political Disaster: Unilateral Powers, Electoral Incentives, and Presidential Disaster Declarations. *The Journal of Politics*, Vol. 73. No. 4 (October): 1142-1151.
- Renn, Ortwin. 2008. *Risk Governance: Coping with Uncertainty in a Complex World*. UK and USA: Earthscan.
- Rentschler, Jun E. 2013. *Why Resilience Matters: The Poverty Impacts of Disasters*. Policy Research Working Paper 6699. November 2013. The World Bank GFDRR, Washington, D.C.
- Revi, Aromar. 2005. Lessons from the Deluge Priorities for Multi-Hazard Risk Mitigation. *Economic and Political Weekly* (September 3, 2005): 3911-3916.
- Reyes, Lilian and Allan Lavell. 2012. Extensive and every day risk in the Bolivian Chaco: Sources of crisis and disaster. *Journal of Alpine Research*, 100-1 (2012): Montagne, marginalité et catastrophe.

- RMS (Risk Management Solutions). 2013. *The 2012 UK Floods*. RMS White Paper.
- Rockström, Johan, Jeffrey D. Sachs, Marcus C. Öhman and Guido Schmidt-Traub. 2013. *Sustainable Development and Planetary Boundaries*. Background Paper submitted to the High Level Panel on the Post-2015 Development Agenda. May 2013.
- Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart Chapin III, Eric F. Lambin, Timothy M. Lenton, Marten Scheffer, Carl Folke, Hans Joachim Schellnhuber, Björn Nykvist, Cynthia A. de Wit, Terry Hughes, Sander van der Leeuw, Henning Rodhe, Sverker Sörlin, Peter K. Snyder, Robert Costanza, Uno Svedin, Malin Falkenmark, Louise Karlberg, Robert W. Corell, Victoria J. Fabry, James Hansen, Brian Walker, Diana Liverman, Katherine Richardson, Paul Crutzen and Jonathan A. Foley. 2009. A safe operating space for humanity. *Nature*, Vol. 461 (September): 472-475.
- Rodriguez-Oreggia, Eduardo, Alejandro De La Fuente, Rodolfo De La Torre and Hector A. Moreno. 2012. Natural Disasters, Human Development and Poverty at the Municipal Level in Mexico. *The Journal of Development Studies*, Vol. 49, No. 3: 442-455.
- Safir, Abla, Sharon Faye Piza and Emmanuel Skoufias. 2013. *Disquiet on the Weather Front: The Welfare Impacts of Climatic Variability in the Rural Philippines*. Policy Research Working Paper 6579. World Bank, Washington, D.C.
- Salgado, Mario A., Daniela Zuloaga, Gabriel A. Bernal, Miguel G. Mora and Omar-Darío Cardona. 2014a. Fully probabilistic seismic risk assessment considering local site effects for the portfolio of buildings in Medellín, Colombia. *Bulletin of Earthquake Engineering*, Vol. 12. Issue 2 (April): 671-695. doi: 10.1007/s10518-013-9550-4.
- Salgado, Mario A., Daniela Zuloaga, Cesar A. Velásquez, Martha. L. Carreño, Omar-Darío Cardona and Alex Barbat. 2014b. *Urban Seismic Risk for Medellín, Colombia: A Probabilistic and Holistic Approach*. Second European Conference on Earthquake Engineering and Seismology, Istanbul, 25-29 August 2014.
- Sarmiento Prieto, Juan Pablo, Gabriela Hoberman and Richard Stuart Olson. 2014. *Urban Development and Disaster Risk: Formality and Informality*. Working Paper. Disaster Risk Reduction in the Americas Project. Latin American and Caribbean Center, Florida International University, Miami. November 2010.
- Sassen, Saskia. 2012. *Cities in a World Economy*. Thousand Oaks, CL: Sage Publications.
- Satapathy, Sujata and Bhadra Subhasis. 2009. Disaster Psychosocial and Mental Health Support in South & South-East Asian Countries: A Synthesis. *Journal of South Asia Disaster Studies*, Vol. 2, No.1 (June).
- Satterthwaite, David and David Dodman. 2013. Towards resilience and transformation for cities within a finite planet. *Environment and Urbanization*, Vol. 25, No. 2: 291-298.
- Satterthwaite, David and Diana Mitlin. 2014. *Reducing Urban Poverty in the Global South*. USA and Canada: Routledge Publishing.
- Satterthwaite, David. 2007. *The transition to a predominantly urban world and its underpinnings*. IIEE Human Settlements Discussion Paper Series. Theme: Urban Change –4.
- Schensul, D. and D. Dodman. 2013. Populating Adaptation: Incorporating population dynamics in climate change adaptation policy and practice. In *The demography of adaptation to climate change*, G. Martine and D. Schensul, eds. New York, London and Mexico City: United Nations Population Fund, International Institute for Environment and Development and El Colegio de Mexico.
- Schumacher, Ingmar and Eric Strobl. 2008. *Economic Development and Losses due to Natural Disasters: The Role of Risk*. Ecole Polytechnique, Cahier No. 2008-32, December 2008.
- SCI (Save the Children International). 2014. *The cultural dimension of Disaster Risk Reduction*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.

- SCOR. 2013. *Supply Chain and Contingent Business Interruption (CBI). A perspective on Property and Casualty*. Focus December 2013. SCOR Global P&C.
- Scott, Zoë and Marcela Tarazona. 2011. *Study on Disaster Risk Reduction, Decentralization and Political Economy*. Background Paper prepared for the 2011 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- SEI (Stockholm Environment Institute). 2014. *Climate Change and Disaster Risk Reduction*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Sendai City. 2014. *Sendai Reconstruction (Fukkou) Report*, Vol. 21.
- Shaw, Rajib, ed. 2013. *Community-Based Disaster Risk Reduction*. Community, Environment and Disaster Risk Management Series, Volume 10. Emerald Group Publishing Limited.
- Shaxson, Nicholas. 2012. *Treasure Islands: Tax Havens and The Men Who Stole The World*. Vintage Publisher.
- Shepherd, Andrew, Tom Mitchell, Kirsty Lewis, Amanda Lenhardt, Lindsey Jones, Lucy Scott and Robert Muir-Wood. 2013. *The geography of poverty, disasters and climate extremes in 2030*. Overseas Development Institute, MetOffice and RMS. October 2013.
- Shimizu, M. and A. Clark. 2014. *Interconnected Risks, Cascading Disasters and Disaster Management Policy: A Gap Analysis*. Input Paper for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Shreve, C.M. and I. Kelman. 2014. Does mitigation save? Reviewing cost-benefit analyses of disaster risk reduction. *International Journal of Disaster Risk Reduction*, Vol. 10, Part A (December): 213-235.
- Singh, Shri Karishna and Xyoli Pérez-Campos. No date. *Una iniciativa para alerta temprana de tsunami en México*. Departamento de Sismología, Instituto de Geofísica, Universidad Nacional Autónoma de México.
- Sisk, Blake and Carl L. Bankston. 2014. Hurricane Katrina, a Construction Boom, and a New Labor Force: Latino Immigrants and the New Orleans Construction Industry, 2000 and 2006–2010. *Population Research and Policy Review*, Vol. 33, Issue 3: 309-334.
- Skidmore, Mark and Hideki Toya. 2002. Do Natural Disasters Promote Long-Run Growth? *Economic Inquiry*, Vol. 40, Issue 4 (October): 664-687.
- Slim, Hugo. 2012. *IASC Real-Time Evaluation of the Humanitarian Response to the Horn of Africa Drought Crisis in Somalia, Ethiopia and Kenya*. Inter-Agency Standing Committee Synthesis Report. June 2012.
- Smythe, Tiffany C. 2013. *Assessing the Impacts of Hurricane Sandy on the Port of New York and New Jersey's Maritime Responders and Response Infrastructure*. Quick Response Report No. 238: Final Report to the University of Colorado Natural Hazards Center Quick Response Grant Program (National Science Foundation grant CMMI1030670), 31 May 2013.
- Stehr, Steven. 2006. The Political Economy of Urban Disaster Assistance. *Urban Affairs Review*, Vol. 41, No. 4 (March): 492-500.
- Striessnig, E., W. Lutz and A.G. Patt. 2013. Effects of educational attainment on climate risk vulnerability. *Ecology and Society* 18(1), p. 16. doi: <http://dx.doi.org/10.5751/ES-05252-180116>.
- Subbaraman, Ramnath, Jennifer O'Brien, Tejal Shitole, Shrutika Shitole, Kiran Sawant, David E. Bloom and Anita Patil-Deshmukh. 2012. Off the map: the health and social implications of being a non-notified slum in India. *Environment and Urbanization*, Vol. 24, No. 2 (October): 642-643.
- Surono, Philippe Jousset, John Pallister, Marie Boichu, M. Fabrizia Buongiorno, Agus Budisantoso, Fidel Costa, Supriyati Andreastuti, Fred Prata, David Schneider, Lieven Clarisse, Hanik Humaida, Sri Sumarti, Christian Bignami, Julie Griswold, Simon Carn, Clive Oppenheimer and Franck Lavigne. 2012. The 2010 explosive eruption of Java's Merapi volcano—A '100-year'

- event. *Journal of Volcanology and Geothermal Research*, Vols. 241-242 (October): 121-135.
- Swiss Re. 2012. *Flood – an underestimated risk: In-spect, inform, insure*. Zurich.
- Swiss Re. 2014a. *Natural catastrophes and man-made disasters in 2013: large losses from floods and hail; Haiyan hits the Philippines*. No 1/2014. Zurich.
- Swiss Re. 2014b. *Mind the risk: A global ranking of cities under threat from natural disasters*. Zurich.
- Talberth, John, Clifford Cobb and Noah Slattery. 2007. *The Genuine Progress Indicator 2006: A Tool for Sustainable Development*. Redefining Progress. February 2007.
- TEC (Tsunami Evaluation Coalition). 2006. *Joint Evaluation of the international response to the Indian Ocean tsunami: Synthesis Report*. J. Telford, J. Cosgrave and R. Houghton, eds. July 2006. London.
- TEC (Tsunami Evaluation Coalition). 2007. *Joint Evaluation of the international response to the Indian Ocean tsunami: Synthesis Report. Expanded Summary*. John Cosgrave, ed. January 2007. London.
- TEEB (The Economics of Ecosystems and Biodiversity). 2013. *The Economics of Ecosystems and Biodiversity for Water and Wetlands*.
- The Geneva Association. 2013. *Warming of the Oceans and Implications for the (Re)insurance Industry. A Geneva Association Report*. The Geneva Association (The International Association for the Study of Insurance Economics).
- Thieken, Annegret H. 2009. *Floods, flood losses and flood risk management in Germany*. Habilitationsschrift zur Erlangung des akademischen Grades doctor rerum naturalium habilitatus (Dr. rer. nat. habil.) venia legendi: Geoökologie vorgelegt der Mathematisch - Naturwissenschaftlichen Fakultät der Universität Potsdam.
- Tierney, Kathleen. 2006. Social Inequality, Hazards and Disasters. Ch. 8. In *On Risk and Disaster: Lessons from Hurricane Katrina*, Ronald J. Daniels, Donald F. Kettl and Howard Kunreuther, eds. University of Pennsylvania Press.
- Tierney, Kathleen. 2008. Hurricane Katrina: Catastrophic Impacts and Alarming Lessons. Ch. 7. In *Risking House and Home: Disasters, Cities, Public Policy*, John M. Quigley, and Larry A. Rosenthal, eds. Berkeley, California: Berkeley Public Policy Press. Institute of Governmental Studies Publications.
- Transparency International. 2005. *Global Corruption Report 2005: Special focus - Corruption in Construction and Post-Conflict Reconstruction*. Foreword by Francis Fukuyama. London: Pluto Press.
- Trawinski, L. 2013. *Assets and debt across generations: the middle-class balance sheet 1989-2010*. Washington, DC: AARP Public Policy Institute.
- Tufail, Sadia, Gaye McKissock and Harry Adshhead. 2004. *Urban Watercourses in Glasgow's East End: study to end flooding, improve environment & amenities*. Case Study. Wastewater Treatment & Sewerage.
- Turnbull, Shann and Michael Pirson. 2011. Corporate Governance, Risk Management, and the Financial Crisis: An Information Processing View. *Corporate Governance: An International Review*, Vol. 19, Issue 5 (September): 459-470.
- Turner, John. 1972. *Freedom to Build: Dweller Control of the Housing Process*. New York: Macmillan.
- Turner, Graham M. 2008. A comparison of *The Limits to Growth* with 30 years of reality. *Global Environmental Change*, Vol. 18, Issue 3 (August): 397-411.
- UNAIDS. 2014. *Financing the Response to HIV in Low- and Middle-Income Countries: International Assistance from Donor Governments in 2013*. July 2014. Prepared by Jennifer Kates & Adam Wexler (Kaiser Family Foundation) and Eric Lief (Consultant).
- UNCTAD (United Nations Conference on Trade and Development). 2014. *World Investment Report 2014 - Investing in the SDG's: An Action Plan*. Printed in Switzerland.
- UNDESA (United Nations Department of Economic and Social Affairs). 2013. *World Population Prospects: The 2012 Revision*. Volume I: Com-

- prehensive Tables. United Nations, New York.
- UNDESA (United Nations Department of Economic and Social Affairs). 2014a. *Partnerships Briefs for Small Island Developing States. Climate Change & Disaster Risk Management*. UN Conference on Small Island Developing States. UNDESA Division for Sustainable Development.
- UNDESA (United Nations Department of Economic and Social Affairs). 2014b. *World Urbanization Prospects. 2014 Revision. Highlights*. United Nations, New York.
- UNDP (United Nations Development Programme), UNEP (United Nations Environment Programme), UN-ESCAP (United Nations Economic and Social Commission for Asia and Pacific), UNFCCC (United Nations Framework Convention on Climate Change), UNISDR (United Nations Office for Disaster Risk Reduction) and WMO (World Meteorological Organization). 2013. *TST Issues Brief: Climate Change and Disaster Risk Reduction*. Prepared by UNDP, UNEP, UN-ESCAP, UNFCCC, UNISDR and WMO with contributions from FAO, IFAD, ITU, OCHA, PBSO, UNCCD, UNDESA, UN-ESCWA, UNFF, UNFPA, UN-HABITAT, UNIDO, UNOOSA, UN-Women, WFP, WHO, and the World Bank.
- UNDP (United Nations Development Programme). 2004. *Reducing Disaster Risk: A Challenge for Development*. A Global Report. UNDP Bureau for Crisis Prevention and Recovery.
- UNDP (United Nations Development Programme). 2010. *A guide to UNDP Democratic Governance Practice*. Bureau for Development Policy, Democratic Governance Group. New York.
- UNDP (United Nations Development Programme). 2013a. *Issue Brief: Disaster Risk Governance*.
- UNDP (United Nations Development Programme). 2013b. *Integrated Community-based Early Recovery Framework. Disaster Risk Reduction*. UNDP Myanmar.
- UNDP (United Nations Development Programme). 2014a. *Disaster Risk Governance During the HFA Implementation Period*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- UNDP (United Nations Development Programme). 2014b. *Human Development Report. Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience*. New York.
- UNDRO (Office of the United Nations Disaster Relief Co-ordinator). 1980. *Natural Disasters and Vulnerability Analysis*. Report of Expert Group Meeting, 9-12 July 1979. United Nations, Geneva.
- UNECE (United Nations Economic Commission for Europe). 2014. *Standards and Normative Mechanisms for Disaster Risk Management*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- UNEP (United Nations Environment Programme) and Global Footprint Network. 2012. *A New Angle on Sovereign Credit Risk E-RISC: Environmental Risk Integration in Sovereign Credit Analysis*. Geneva.
- UNEP (United Nations Environment Programme) and PSI (Principles for Sustainable Insurance). 2014. *The PSI Global Resilience Project: Building disaster-resilient communities and economies*. Part one of a research series by the UNEP FI Principles for Sustainable Insurance Initiative. UNEP Finance Initiative and PSI Global Resilience Project (led by Insurance Australia Group). Geneva.
- UNEP (United Nations Environment Programme). 2012. *The Emissions Gap Report 2012. A UNEP Synthesis Report*. UNEP, Nairobi.
- UNEP (United Nations Environment Programme). 2013. *Cyclone Phailin in India: Early Warning and Timely Actions Save Lives*. UNEP, Global Environmental Alert Service. November 2013.
- UNEP (United Nations Environment Programme). 2014. *Disaster risk reduction is an integral objective of environment related policies and plans, including for land use natural resource management and adaptation to climate change*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.

- UN-HABITAT (United Nations Human Settlements Programme). 2009. *Shelter Situation in Ratnapura Municipal Council Area. An Overview*. Compiled by Management Resources for Good Governance (MaRGG) for The Ratnapura Municipal Council. November 2009.
- UN-HABITAT (United Nations Human Settlements Programme). 2010. *State of the World's Cities Report 2010-2011: Bridging the Urban Divide*. Overview and Key Findings. United Nations.
- UN-HABITAT (United Nations Human Settlements Programme). 2013. *State of the World's Cities Report 2012-2013: Prosperity of Cities*. United Nations, Nairobi.
- UN-HABITAT (United Nations Human Settlements Programme). 2014a. *From Disaster Risk Reduction to Resilience. A New Urban Agenda for the 21<sup>st</sup> Century*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- UN-HABITAT (United Nations Human Settlements Programme). 2014b. *Urban Equity in Development - Cities for Life*. Concept Paper. World Urban Forum 7. 5-11 April 2014. Medellin, Colombia.
- UNICEF (United Nations Children Fund) and UNESCO (United Nations Educational, Scientific and Cultural Organization). 2014. *Advances and continuing challenges towards HFA2 AND Post-2015: Background chapter*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- UNISDR (United Nations Office for Disaster Risk Reduction) and Government of Germany. 2006. *Developing Early Warning Systems: A Checklist. EWC III: Third International Conference on Early Warning. From concept to action. 27-29 March 2006, Bonn*.
- UNISDR, The German Committee for Disaster Reduction and EUROPA Major Hazards Agreement. 2009. *Implementing the Hyogo Framework for Action in Europe: Advances and Challenges. Report for the period 2007-2009*. Geneva.
- UNISDR, ITC-ILO (International Training Center - International Labour Organization), UNDP (United Nations Development Programme). 2010. *Local Governments and Disaster Risk Reduction, Good practices and Lessons Learned: A contribution to the "Making Cities Resilient" Campaign*. Contribution to the "Making Cities Resilient" Campaign 2010-2011. Geneva.
- UNISDR. 2005. *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. Extract from the final report of the World Conference on Disaster Reduction (A/CONF.206/6). Geneva, Switzerland: UNISDR.
- UNISDR. 2007. *Disaster Risk Reduction: Global Review*. Geneva, Switzerland: UNISDR.
- UNISDR. 2009a. *Global Assessment Report on Disaster Risk Reduction: Risk and Poverty in a Changing Climate*. Geneva, Switzerland: UNISDR.
- UNISDR. 2009b. *UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland: UNISDR.
- UNISDR. 2011a. *Global Assessment Report on Disaster Risk Reduction: Revealing Risk, Redefining Development*. Geneva, Switzerland: UNISDR.
- UNISDR. 2011b. *Hyogo Framework for Action 2005-2015 Building the Resilience of Nations and Communities to Disasters: Mid-Term Review 2010-2011*. Geneva, Switzerland: UNISDR.
- UNISDR. 2011c. *HFA Progress in Asia Pacific Regional Synthesis Report 2009-2011*. Geneva, Switzerland: UNISDR.
- UNISDR. 2013a. *Global Assessment Report on Disaster Risk Reduction: From Shared Risk to Shared Value: the Business Case for Disaster Risk Reduction*. Geneva, Switzerland: UNISDR.
- UNISDR. 2013b. *Implementation of the Hyogo Framework for Action. Summary of Reports 2007-2013*. Geneva, Switzerland: UNISDR.
- UNISDR. 2013c. *Findings of the Review of National Platforms for Disaster Risk Reduction 2012-2013*. Final Report. Including comments, feedback and recommendations from National Platforms Consultation on a Post-2015 Framework for Disaster Risk Reduction held at the Fourth

- Session of the Global Platform for Disaster Risk Reduction (19-23 May 2013, Geneva). September 2013.
- UNISDR. 2014. *Progress and Challenges in Disaster Risk Reduction: A contribution towards the development of policy indicators for the Post-2015 Framework on Disaster Risk Reduction*. Geneva, Switzerland: UNISDR.
- UNISDR. 2014b. *Annual Report 2013*. Final Report on 2012-2013 Biennium Work Programme. Geneva, Switzerland: UNISDR.
- UNISDR. 2014c. *HFA Thematic Review: Research Area 2. Priority for Action 3 - Core Indicator 1: Relevant information on disasters is available and accessible at all levels, to all stakeholders (through networks, development of information sharing systems etc.)*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- United Nations and World Bank. 2007. *Stolen Asset Recovery (StAR) Initiative: Challenges, Opportunities, and Action Plan*. June 2007. Washington, D.C.
- United Nations. 2012. *Resolution adopted by the General Assembly on 27 July 2012. 66/288: The Future we want*. UN General Assembly, Sixty-Sixth Session, Agenda Item 19. A/RES/66/288\* 11 September 2012.
- United Nations. 2014a. *The Millennium Development Goals Report 2014*. New York.
- United Nations. 2014b. *Resilience: Integrating Risks into the Financial System: The 1-in-100 Initiative Action Statement*. Climate Summit 2014. New York.
- University of South Carolina. 2014. *Who needs loss data?* Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- UNOCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2013. *Myanmar: A Country Prone to a Range of Natural Disasters*. Infographic from OCHA September 2013.
- UNOCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2014a. *An Overview of Global Humanitarian Response 2014*. UNOCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2014b. *Humanitarian Bulletin Philippines. Issue 27. 01 – 31 August 2014*.
- UNU (United Nations University). 2013. *The Role of Ecosystems in Disaster Risk Reduction*. Edited by Fabrice G. Renaud, Karen Sudmeier-Rieux and Marisol Estrella. Tokyo.
- US Nuclear Regulatory Commission. 1994. *Information Notice No. 93-53, Supplement 1: Effect of Hurricane Andrew on Turkey Point Nuclear Generating Station and Lessons Learned*.
- US Nuclear Regulatory Commission. 1994. *Effect of Hurricane Andrew on Turkey Point Nuclear Generating Station*. NRC Information Notice 93-53, Supplement 1.
- USGAO (United States Government Accountability Office). 2009. *Alaska Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion*. USGAO Report to Congressional Requesters. June 2009.
- van Hooijdonk, Ruben, Jeffrey Allen Maynard, Derek Manzello and Serge Planes. 2014. Opposite latitudinal gradients in projected ocean acidification and bleaching impacts on coral reefs. *Global Change Biology*, Vol. 20, Issue 1: 103-112.
- van Niekerk, Dewald. 2014. *Retrospective Assessment of Progress in Disaster Risk Governance against the HFA*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Vermeulen, Sonja J., Bruce M. Campbell and John S.I. Ingram. 2012. Climate Change and Food Systems. *Annual Review of Environment and Resources*, Vol. 37: 195-222.
- Virginia Polytechnic Institute. 1985. *Proceedings of the International Conference on Disaster Mitigation Program Implementation*. Ocho Rios, Jamaica, November 12-16, 1984.
- von Hauff, Michael and Amitabh Kundu. 2002. *Energy Strategy for Sustainable Development Use of Renewable Resources and its Implications in India*.

- Vorhies, Francis. 2012. *The economics of investing in disaster risk reduction*. Working paper based on a review of the current literature commissioned by the Secretariat to the UN International Strategy for Disaster Reduction (UNISDR). Geneva.
- Walden, Daniel, Nick Hall and Kelly Hawrylyshyn. 2009. *Participation and Protection: Children's Involvement in Climate Change Debates*. IDS In Focus Policy Briefing 13.4. November 2009. Institute of Development Studies.
- Wamsler, Christine and Ebba Brink. 2014. *The Urban Domino Effect: A Conceptualization of Cities' Interconnectedness of Risk*. Input Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Wamsler, Christine. 2006. Mainstreaming Risk Reduction in Urban Planning and Housing: A Challenge for International Aid Organisations. *Disasters*, Vol. 30, No. 2: 151-177.
- Wamsler, Christine. 2014. Urban focus in climate change adaptation and risk reduction. *Klimat Fokus*, No. 12 (2014). Lund University.
- Ward, Christopher, Claudia Ringler, Raphael Torquebiau and Tom Watson. 2014. *Improving resilience in SSA drylands: the contribution of agricultural water management*.
- Warner, Koko, Tamar Afifi, Kevin Henry, Tonya Rawe, Christopher Smith and Alex de Shebinin. 2012. *Where the rain falls: climate change, livelihood security, and migration*. Paris and Bonn: CARE France and UNU.
- Watson, Vanessa. 2014. African urban fantasies: dreams or nightmares? *Environment and Urbanization*, Vol. 26, No. 1: 215-231.
- Watts, Michael. 1983. On the poverty of theory: natural hazards research in context. In *Interpretations of Calamity from the Viewpoint of Human Ecology*, Hewitt, Kenneth, ed. The Risks and Hazard Series I. Allan & Unwin.
- Weber, Elke. 2006. Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change*, Vol. 77, Issue 1-2 (July): 103-120.
- WEF (World Economic Forum). 2013. *The Global Competitiveness Report 2013-2014*. Full Data Edition.
- WEF (World Economic Forum). 2014. *Global Risks 2014. Ninth Edition*. Insight Report. Geneva, Switzerland.
- Werritty, Alan, Donald Houston, Tom Ball, Amy Tavendale and Andrew Black. 2007. *Exploring the Social Impacts of Flood Risk and Flooding in Scotland*. Social Research Environment Group. Research Findings No.32/2007.
- Wilkinson, Richard and Michael Marmot. 2003. *Social determinant of health: The solid facts*. Second Edition. The World Health Organization. Copenhagen, Denmark.
- Wilkinson, E., E. Comba and K. Peters. 2014. *Disaster Risk Governance: Unlocking Progress and Reducing Risk*. UNDP, BCPR and ODI.
- Wilkinson, Richard. 2005. *The Impact of Inequality: How to Make Sick Societies Healthier*. 1 edition (9 Jun 2005). Routledge.
- Williges, Keith, Stefan Hochrainer-Stigler, Junko Mochizuki and Reinhard Mechler. 2014. *Modeling the indirect and fiscal risks from natural disasters: Emphasizing resilience and "building back better"*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- Winterwerp J.C., William G. Borst and M.B. de Vries. 2005. Pilot study on the erosion and rehabilitation of a mangrove mud coast. *Journal of Coastal Research*, Vol. 21, Issue 2: 223-231.
- Winterwerp, Han, Bregje van Wesenbeeck, Jan van Dalfsen, Femke Tonneijck, Apri Astra, Stefan Verschure and Pieter van Eijk. 2014. *A sustainable solution for massive coastal erosion in Central Java - Towards Regional Scale Application of Hybrid Engineering*. Discussion paper. Deltares and Wetlands International.
- Wirtz, A., W. Kron, P. Löw and M. Steuer. 2014. The Need For Data. Natural Disasters and The Challenges of Database Management. *Natural Hazards*, Vol. 70, Issue 1: 135-157.
- Wisner, Ben, Piers Blaikie, Terry Cannon and Ian Davis. 2003. *At Risk: Natural Hazards, People's*

- vulnerability and disasters. 2nd Edition.
- WMO (World Meteorological Organization). 2005. *Climate and Land Degradation*. Geneva.
- WMO (World Meteorological Organization). 2011. *Institutional Partnerships in Multi-Hazard Early Warning Systems. A Compilation of Seven National Good Practices and Guiding Principles*. Golnaraghi, Maryam, ed. Springer.
- WMO (World Meteorological Organization). 2014a. *Synthesis of the Status and Trends With the Development of Early Warning Systems*. Background Paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: UNISDR.
- WMO (World Meteorological Organization). 2014b. *WMO Greenhouse Bulletin. The State of Greenhouse Gases in the Atmosphere Based on Global Observations through 2013*. No. 10, 9 September 2014.
- World Bank and Australian Aid. 2013. *Socialist Republic of Vietnam Performance of the Wastewater Sector in Urban Areas: A Review and Recommendations for Improvement. Vietnam Urban Wastewater Review*. The World Bank, Washington, D.C.
- World Bank and ESMAP (Energy Sector Management Assistance Program). 2011. *Improving Energy Access to the Urban Poor in Developing Countries*. The World Bank, Washington, D.C.
- World Bank, RMSI, IFPRI and GFDRR. No date. *Economic Vulnerability and Disaster Risk Assessment in Malawi and Mozambique: Measuring Economic Risks of Droughts and Floods*.
- World Bank. 2004. *Inequality and Economic Development in Brazil*. A World Bank Country Study. The World Bank, Washington, D.C.
- World Bank. 2006. *Hazards of Nature, Risks to Development. An IEG Evaluation of World Bank Assistance for Natural Disasters*. Independent Evaluation Group. The World Bank, Washington, D.C.
- World Bank. 2010. *World Development Report 2010: Development and Climate Change*. The World Bank, Washington, D.C.
- World Bank. 2011. *Dar es Salaam Case Study Overview. Climate Change, Disaster Risk and the Urban Poor: Cities Building Resilience for a Changing World*. The World Bank, Washington, D.C.
- World Bank. 2012. *Analysis of Disaster Risk Management in Colombia: A Contribution to the Creation of Public Policies*. Coordinators and Editors: Ana Campos G., Niels Holm-Nielsen, Carolina Díaz G., Diana M. Rubiano V., Carlos R. Costa P., Fernando Ramírez C. and Eric Dickson. The World Bank and GFDRR, Washington, D.C.
- World Bank. 2013. *Building Resilience: Integrating Climate and Disaster Risk into Development. The World Bank Group Experience*. The World Bank, Washington, D.C.
- WRI (World Resources Institute). 2014. *Sea-Level rise and its impact on Miami Dade County*. Fact sheet. By Forbes Tompkins and Christina Decocini.
- WWF (World Wildlife Fund for Nature). 2002. *Turning the tide on flooding. A WWF Scotland report*. WWF Scotland, November 2002.
- Yodmani, Suvit. 2001. *Disaster Risk Management and Vulnerability Reduction: Protecting the Poor*. Paper Presented at The Asia and Pacific Forum on Poverty Organized by the Asian Development Bank.
- Zeiderman, Austin and Laura Astrid Ramírez Elizalde. 2010. "Apocalipsis anunciado": un viraje en la política de riesgo en Colombia a partir de 1985. # 31 Revista de Ingeniería: 119-131. Universidad de Los Andes. Bogotá.
- Zobler, Leonard. 1976. Review of *Natural Hazards: Local, National, Global* by Gilbert F. White. *Geographical Review*, Vol. 66, No. 2, pp. 247-249.
- Zurich Insurance. 2014. *Risk Nexus: Central European floods 2013: a retrospective*. Flood resilience review 05.14.

# Index

## UN list of country names and territories

### A

Afghanistan	64, 66
Albania	92, cclxxvi
Algeria	iv, 10265, 76, 107
American Samoa	77, 81
Angola	84
Anguilla	vi, 75, 77, 79
Antigua and Barbuda	75, 76, 77, 78, cclxxvi
Argentina	152, 206, 221, 234, cclxxvi
Armenia	66, 81
Aruba	75, 78
Australia	67, 68, 70, 71, 82, 88, 140, 148, 155, 170, 171, 237, cclxx, cclxxi, cclxxii, cclxxvii, cclxxviii
Austria	ii, 50
Azores	81

### B

Bahamas	75, 76, 77, 78
Bangladesh	29, 35, 46, 47, 48, 64, 65, 68, 72, 73, 74, 155, 161, 191, 192, 206, 262
Barbados	75, 78, 92, 154
Belgium	158
Belize	68, 69, 75, 76, 104, 105, 238, cclxxxvi
Benin	84
Bermuda	75, 78
Bhutan	64, 72, 73, 74, 120
Bolivia	102, 152, 159, cclxxv
Bolivia (Plurinational State of)	cclxxv
Brazil	71, 152, 171, 222, 223, 224, 228, 234, 239, 242
British Virgin Islands	75, 77, 78
Burkina Faso	120
Burundi	84, 185

### C

Cambodia	62, 64, 66, 72, 73, 74, 92, 103, 140, cclxxviii
Canada	102, 237, cclxxiv, cclxxv, ccxcvi, ccc
Canary Islands	81
Cape Verde	cclxxiii
Cayman Islands	76, 77, 78, 104, 105
Central African Republic	74
Chad	84

Chile	iv, 65, 66, 70, 102, 152, 155, 157, 168, 169, 174, 218, 221, cclxxviii
China	41, 49, 55, 65, 70, 71, 72, 104, 105, 127, 166, 196, 225, 231, 232, 239, 241, 242, 244, 264, cclxxiii, ccxcviii
Colombia	28, 29, 33, 34, 66, 70, 71, 80, 88, 118, 123, 146, 148, 152, 226, 256, 262, cclxxiv, cclxxvii, cclxxviii
Comoros	81, 92, 103, cclxxviii, ccxcvi
Congo, Democratic Republic of	73, 74, 84, 184, 234
Costa Rica	81, 206, 249, 256, cclxxviii
Cuba	46, 78, 139, 161, ccxcix
Czech Republic	50

### D

Djibouti	234, cclxxviii
Dominica	75, 76, 77, 81, cclxxviii
Dominican Republic	65, 78, 139, ccxcix

### E

Ecuador	64, 66, 152, 161, 169, cclxxii, cclxxvi
Egypt	70, 158
El Salvador	65, 66, 81, 97, 106, cclxxii
Eritrea	73, 74, 84
Ethiopia	80, 83, 84, 159, cclxxvi, ccxcvi, ccc

### F

Fiji	75, 76, 77, 230
France	ii, 102, 126, 140, 148, 204, 262, cclxxiv
French Guiana	73
French Polynesia	77

### G

Gabon	64, 74
Georgia	66, 157, cclxxvi
Germany	50, 102, 154, 155, 174, 204, 207
Ghana	214, cclxxvii, cclxxviii, cclxxx
Greece	v, 65, 66, 100, 101
Grenada	75, 81, 92, 127, 128, cclxxviii
Guadeloupe	75, 77, 78, cclxxiii

<b>Guatemala</b>	29, 62, 64, 65, 66, 79, 80, 81, 206, 238, cclxxviii
<b>Guinea</b>	74, 84
<b>H</b>	
<b>Haiti</b>	47, 48, 58, 75, 78, 100, 127, 128, 139, 143, 157, 168, 169
<b>Honduras</b>	58, 62, 64, 65, 66, 68, 78, 100, 104, 164, cclxxviii
<b>Hong Kong</b>	68, 70, 71, 135
<b>Hungary</b>	73
<b>I</b>	
<b>Iceland</b>	79, 80, cclxxii
<b>India</b>	23, 32, 44, 55, 68, 70, 71, 72, 92, 98, 124, 151, 155, 161, 164, 172, 221, 225, 226, 232, 239, 241, 242, 244, 262, 264, cclxxv, cclxxviii
<b>Indonesia</b>	iv, 23, 32, 41, 70, 71, 79, 80, 81, 82, 88, 91, 102, 147, 148, 164, 165, 172, 239, 242, cclxxiii-cclxxvi, cclxxviii
<b>Iran, Islamic Republic of</b>	65, 66, 102, cclxxviii, ccxcix
<b>Iraq</b>	73, 184, 255
<b>Ireland</b>	233, 255, cclxxiv, cclxxv
<b>Italy</b>	65, 80, 157, 228, 249, cclxxiii, cclxxiv, cclxxv, cclxxvi
<b>J</b>	
<b>Jamaica</b>	v, 31, 75, 78, 100, 114, 195, 238, cclxxviii, ccv
<b>Japan</b>	ii, iii, xiii, xvi, 27, 31, 58, 65, 66, 67, 68, 70, 71, 79, 80, 81, 82, 88, 110, 122, 125, 127, 128, 129, 132, 134, 156, 167, 171, 193, 205, 206, 208, 209, 210, 211, 231, 244, cclxxiv, cclxxv, cclxxx
<b>Jordan</b>	cclxxviii
<b>K</b>	
<b>Kenya</b>	vi, 85, 86, 87, 159, 218, 238, cclxxviii
<b>Kiribati</b>	71, 77
<b>Korea, Republic of</b>	231
<b>Korea (DPR)</b>	68
<b>Kyrgyzstan</b>	66
<b>L</b>	
<b>Lao People's Democratic Republic</b>	64, 72, 73, 74
<b>Lebanon</b>	238, cclxxvii
<b>Lesotho</b>	66, 73, 234
<b>Liberia</b>	84

<b>M</b>	
<b>Macao (Special Administrative Region of China)</b>	70, 71
<b>Madagascar</b>	iv, 64, 68, 74, 76, 84, 92, 97, 100, 102, 103, cclxxix
<b>Malawi</b>	vi, 64, 66, 73, 74, 83, 85, 86, ccvii
<b>Maldives</b>	105
<b>Mali</b>	84, 158, 185, 238, cclxxix
<b>Marshall Islands</b>	77
<b>Martinique</b>	75, 78, 81, 88
<b>Mauritius</b>	92, 103, 104, 144, 154, 255, cclxxix, ccxcvi
<b>Mexico</b>	vi, 52, 68, 78, 79, 80, 104, 105, 122, 156, 157, 165, 186, 193, 207, 212, 238, 256, cclxxii, cclxxiv, cclxxvii, cclxxix
<b>Micronesia, Federated States of</b>	71, 77
<b>Moldova, Republic of</b>	73
<b>Mongolia</b>	193
<b>Montserrat</b>	75, 77, 81
<b>Morocco</b>	92, 195
<b>Mozambique</b>	46, 68, 84, 102, 161, 172, cclxxix, ccvii
<b>Myanmar</b>	45, 48, 62, 64, 68, 72, 73, 74, 163, 164, 210, 211
<b>N</b>	
<b>Nepal</b>	65, 73, 74, 138, 206, 238, cclxxix, ccxcii, ccxciii
<b>Netherlands</b>	71, 237, ccxcvi
<b>New Caledonia</b>	77
<b>New Zealand</b>	41, 55, 67, 68, 70, 71, 82, 171, 238, cclxxiii
<b>Nicaragua</b>	29, 32, 66, 81, cclxxix
<b>Niger</b>	vi, 55, 85, 86, 92
<b>Nigeria</b>	94, 234
<b>P</b>	
<b>Pakistan</b>	iv, 74, 92, 102, 143, 157, 169, 172, 219, cclxxix
<b>Palau</b>	71, 76, 77
<b>Palestine</b>	92, cclxxix
<b>Panama</b>	90, 206, 233, 256, cclxxix
<b>Papua New Guinea</b>	68, 71, 77, 81, 82
<b>Peru</b>	iv, 23, 29, 30, 64, 65, 66, 67, 70, 123, 148, 152, 187, 206, 234, 256, cclxxiv
<b>Philippines</b>	v, 31, 62, 64, 65, 68, 70, 71, 76, 79, 80, 82, 100, 101, 122, 130, 155, 165, 166, 187, 237
<b>Puerto Rico</b>	75, 76, 77, 78
<b>R</b>	
<b>Russian Federation</b>	82, 182, 244
<b>Rwanda</b>	195

**S**

Saint Kitts and Nevis	75, 76, 78, 81, 92, cclxxix
Saint Lucia	75, 76, 77, 81, 92, cclxxix
Saint Vincent and the Grenadines	75, 76, 77, 81
Samoa	81
Sao Tome and Principe	81
Senegal	84, 92, cclxxvix
Serbia	58, 73, 92, cclxxvix
Sierra Leone	84, 92, 184, 185, 234, cclxxvix
Slovenia	66
Solomon Islands	71, 76, 77, 82, cclxxvix
Somalia	73
South Africa	123, 218, 234, 239, 242
Spain	92, cclxxiv, cclxxix
Sri Lanka	23, 32, 132, 155, 156, 237, cclxxix
State of Palestine	66, 92
Sudan	84
Swaziland	73, 234
Sweden	cclxxii, ccxciv
Switzerland	ii, 232, 248, cclxx
Syrian Arab Republic	66, 234, 235, cclxxix

**T**

Taiwan (Province of China)	68, 70, 82, 166, cclxxiv
Tajikistan	65, 66, 73
Tanzania	84, 92, 98, 219, cclxxiv
Togo	92
Tonga	71, 75, 76, 77
Trinidad and Tobago	vi, 67, 75, 78, 79, 92, cclxxix
Tristan da Cunha, Nightingale Island and Ascension	81
Tunisia	92, cclxxix
Turkey	41, 47, 92, 188, 193, 202, 212, cclxxv, cclxxvi, cclxxix, cccv
Turks and Caicos Islands	77
Tuvalu	41

**U**

Uganda	84, 148, cclxxix
Ukraine	73
United Arab Emirates	64
United Kingdom	29, 30, 71, 72, 143, 200, 210, 252, ccxc, ccxciii
United States of America	24, 29, 31, 55, 58, 65, 68, 70, 72, 155, 193, 197, 231, 244, 248, cclxxx

United States Virgin Islands	77, 78
Uruguay	152, cclxxix
U.S.A.	24, 29, 31, 55, 58, 65, 68, 72, 155, 193, 197, 231, 244, 248, cclxxix
Uzbekistan	cclxxv

**V**

Vanuatu	71, 75, 76, 77, 81, 82, 97, 104, 105
Venezuela, Bolivarian Republic of	78, 152, 164, cclxxix
Viet Nam	73, 74, 163, 166, 226, 237, 238, cclxxix, cclxxxi, ccxcvii

**Y**

Yemen	cclxxix
-------	---------

**Z**

Zambia	234
Zimbabwe	222, 234

average annual loss (AAL)	ix, xiv, 54-70, 72-79, 81-82, 85, 87-88, 100-101, 127, 144, 146, 149, 211, 251, 252, 255, 259, cclxxix
agriculture	vi, xvi, 40, 58, 70, 79, 83-84, 169, 190, 232, 242
biocapacity	iv, xv-xvi, 181, 204, 229-244
business continuity	129, 135, 145, cclxxix
capital stock	iv, xviii, 56, 58, 59, 60-61, 65-67, 70-77, 100-101, 104, 202, 211, 252, cclxviii, cclxxix
climate change	iii, vi, xiii-xiv, xvi-xvii, xix, 33, 56, 69, 71, 78-79, 83-87, 106-107, 115-116, 124, 129, 135-136, 140, 143-144, 179, 181-182, 188, 191, 202, 211, 217, 220-221, 230-233, 236-237, 241, 247-253, 256, 262, 264-266, cclxviii
corrective risk management	ix, xviii, 60, 121, 251, cclxxix
cyclone	iv, vi, xiv, xix, 29, 32, 35, 44-46, 48-49, 54-56, 58, 64, 67-69, 71, 76-79, 88, 90, 103-104, 110, 143-144, 148, 156, 163-165, 170, 178, 186, 190, 202, 211, 215
direct losses	58, 104, 205, 208, cclxviii
drought	vi, xix, 54, 56, 83, 84, 86, 88, 148, 159, 172, 178, 190, 233, 234, 235

<b>earthquake</b>	23, 27, 30-32, 34, 36, 41, 47-49, 52, 56, 58, 65-67, 70, 75, 88, 90, 103-104, 118, 124, 127-128, 135-136, 143, 146-149, 156-157, 163, 169, 171-172, 178, 187-188, 208, 215	<b>resilience</b>	iii-iv, vi, ix, xi, xiv-xv, xviii, xx, 26, 28, 30, 35, 58, 83, 86, 96, 100, 101, 103-104, 108, 131, 133, 138, 145, 147, 150-151, 160, 163, 169, 172, 181, 186, 189, 190-193, 195, 212, 218, 220, 222, 232-233, 247, 251, 255-256, 260, cclxix
<b>economic resilience</b>	58, 100, 103, 192	<b>return period</b>	48, 50, 57, 84, 86, 90, 102-103, 108-109, 144, 169-170, cclxviii-cclxix
<b>extensive risk</b>	iv, xiv, xviii, xix, xx, 26, 58, 90, 91, 93, 94, 95, 96, 97, 98, 125, 132, 159, 160, 170, 184, 188, 214, 257, 258, 260	<b>risk financing</b>	xviii, 25, 34, 55, 58, 103, 129, 137, 144, 169, 193, 194, 195, 256, 259, 260, 261
<b>financing gap</b>	iv, 102, 167, 169, 170	<b>risk governance</b>	xi, xvii, 29, 33, 117, 118, 119, 121, 124, 126, 128, 129, 130, 134, 195, 253, 254, 256, cclxix
<b>fire</b>	47, 83, 90, 151, 219, 238, 241	<b>risk transfer</b>	34, 150
<b>flood</b>	xiv, 24-25, 41, 44, 49, 56, 58, 70-74, 110, 121, 124-126, 128, 132, 143, 145, 147, 157-158, 160, 172, 185, 190-191, 197, 201, 207, 215-217, 219, 236, 238-240, 247, 249, 260, 262	<b>river flood</b>	xiv, 41, 56, 70-74, 2011, 215, 238
<b>food security</b>	xvi, 158, 159, 190, 191, 232, 249	<b>small and medium enterprise (SME)</b>	151, 200, 203
<b>GFCF</b>	60, 88, 98, cclxix	<b>small island developing states (SIDS)</b>	iv, xiv, xvi, 58, 74-77, 80, 100, 102, 104, 203
<b>global risk assessment</b>	xix, xx, 55-57, 70, 88, cclxxii	<b>tsunami</b>	23-24, 32, 36, 52, 56, 58, 65, 68-70, 76, 110, 143, 147, 148
<b>gross fixed capital formation (GFCF)</b>	60, 88, cclxix	<b>underlying risk drivers</b>	xiii, 33, 35, 90, 97, 116, 121, 162, 179, 224, 249, 254, 260, 261, 264
<b>Hyogo Framework for Action (HFA)</b>	viii, xiii, xv-xvi, xx, 26, 27-29, 32, 35-36, 40, 44-45, 47, 90, 97, 100, 104, 114-116, 118-121, 123-124, 126, 130, 133-134, 137, 139-145, 147-148, 154-155, 160-169, 171, 173, 179, 190, 192-193, 205-207, 210, 214, 220-222, 230, 233, 236-237, cclxxiv	<b>urban development</b>	vii, viii, xiii, 33, 35, 47, 90, 125, 128, 133, 137, 180, 214, 215, 216, 218, 220, 221, 223, 224, 225, 248, 249, 254, 259
<b>inequality</b>	vii, xi, xiii, xv-xvi, xviii, 25, 33, 36, 90, 96, 178, 180-181, 183-185, 187-190, 192, 195-198, 214, 216, 218, 226-227, 230, 235, 247-248, 254, 258-259, 265, cclxxviii	<b>vulnerability</b>	xviii, 25, 26, 27, 33, 44, 45, 47, 49, 56, 57, 58, 64, 65, 67, 78, 88, 90, 96, 106, 108, 126, 127, 138, 141, 147, 148, 150, 158, 159, 164, 172, 181, 185, 189, 190, 191, 192, 195, 197, 205, 211, 219, 232, 233, 239, 257, 258, cclxxviii, cclxix
<b>intensive risk</b>	xv, 26, 49, 90, 151, 186, 209, 214		
<b>International Decade for Natural Disaster Reduction (IDNDR)</b>	xix, 27, 29, 31, 32, 40, 44, 45, 114, 120, 134, 137, 161		
<b>land degradation</b>	83, 84, 191, 232, 234		
<b>landslides</b>	70, 132, 178, 233, 261, ccxcviii		
<b>Millennium Development Goals (MDGs)</b>	xvi, 45, 46, 191, 219, cccv		
<b>natural capital</b>	vi, vii, xv, xvi, 180, 231, 234, 235, 239, 248		
<b>probability</b>	57, 66-67, 70, 75, 81, 84, 87, 133, 156, 167, 187, 202, 209, cclxxviii, cclxix		
<b>probable maximum loss (PML)</b>	56-57, 66-67, 70-71, 75, 77, 84, 86, 144, 146, 149, cclxix		
<b>prospective (disaster) risk management</b>	ix, xviii, 34, 61, 65, 68, 71-72, 120-121, 128, 163, 168, 173, 191-192, 251, cclxix		
<b>public-private partnership (PPP)</b>	206, 210		



# GAR15 products

---

- The Pocket GAR summarizes the main evidence and messages of the report in a concise, easy-to-read format.
- The main report contains further enhanced content links which provide access to dynamic maps, videos, photos, and case studies for users with smartphones and tablets.
- Tablet computer and smartphone users can also enjoy the free GAR for Tangible Earth (GfT) application. The GfT (or “gift”) is a fully interactive stand-alone application which features a 3D globe interface with decades of dynamic earth science data sets, including disaster events from all GARs. These data sets are illustrated with interactive risk scenarios, maps and photos, and can be searched by time (including real-time), place, risk driver, hazard, disaster event, and more.
- GAR15 is also available as a web version, with much of the functionality available in products such as:

Interactive main report in English

Main report (PDF) in Arabic, Chinese, French, Russian and Spanish

The Pocket GAR in Arabic, Chinese, French, Japanese, Russian and Spanish

Appendices

Background papers

Interim national progress reports on the implementation of the Hyogo Framework for Action

Access to disaster loss and risk databases

All GAR15 products can be accessed via:

[www.preventionweb.net/gar/](http://www.preventionweb.net/gar/)





ISBN 978-92-1-132042-8



9 789211 320428