OECD Reviews of Risk Management Policies

Boosting Resilience through Innovative Risk Governance

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Foreword

Large scale natural and human-induced disasters generate considerable economic losses. The total damages in OECD and BRIC countries have been estimated at nearly USD 1.5 trillion over the last decade. The Canterbury earthquake in New Zealand in 2011 caused damages of an equivalent of 20% of annual GDP, and the earthquake in 2010 in Chile resulted in losses worth an equivalent of 10% of GDP. The Great East Japan Earthquake exemplifies both the unpredictability and the long range impacts that such events can have. They are also a stark warning to industries dependent on global supply chains, highlighting the vulnerability of modern societies to knock-on effects that can propagate across interconnected systems.

What can governments do to increase economic and social resilience? This report proposes a fundamental shift in risk governance, whereby appropriate incentives are given to risk management actors to contribute to boosting resilience. It highlights the main governance obstacles hampering the effectiveness of risk reduction investments, and presents actions that governments could take to overcome them.

First, governments need to raise awareness of risks to increase stakeholder engagement in policy processes. Inclusiveness is the key to changing the status quo, and the only way to achieve a shared vision of a resilient society.

Second, governments should incentivise individuals and companies to invest in self-protection. In many countries public policies weigh in favour of reliance on government for post-disaster assistance.

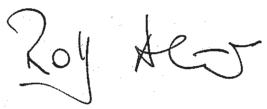
Third, governments need to unleash the potential of the private sector to supply risk reduction solutions, and work with it to agree on business continuity standards.

Finally, governments could achieve better value for money by stimulating collective actions among neighbouring communities. The model of merging allocations for risk prevention and mitigation and prioritising

projects that serve a common functional need is especially important to implement across national borders.

This report was prepared by the OECD High Level Risk Forum with the support of the Public Governance and Territorial Development Directorate. The Forum brings together policy makers from governments, practitioners from the private sector and civil society, and experts from think tanks and academia to identify and share good practices and deepen their understanding of risk management.

The Recommendation of the OECD Council on the Governance of Critical Risks, adopted by the Council of Ministers, is the result of a two-year project of the High Level Risk Forum. It will be of interest to international discussions on resilience in fora such as the G20, the United Nations and the post-2015 sustainable development goals.



Rolf Alter

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The report was co-ordinated and written by Cathérine Désirée Gamper. Stéphane Jacobzone, Deputy Head of the Reform of the Public Sector Division, and Jack Radisch, Risk Management Project Manager, supervised the work. Charles Baubion provided substantive comments. Highly valuable research assistance was provided by Melissa Li and Elena Celada.

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Acronyms and abbreviations

AAL	Average annual loss
ALARP	As low as reasonably practicable
ANIA	*Associazione Nazionale fra le Imprese Assicuratrici* Italian Association of Insurance Companies (Italy)
BMF	*Bundeministerium für Finanzen* Ministry of Finance (Austria)
BP	British Petroleum
BRIC	Brazil, Russia, India and China
Cat DDO	Catastrophe Deferred Drawdown Option (Colombia)
CBA	Cost-benefit analysis
CCCEP	Centre for Climate Change Economics and Policy
CDC	Centers for Disease Control and Prevention
CEM	Comprehensive emergency management (United States)
COAG	Council of Australian Governments (Australia)
CRED	Collaborating Centre for Research on the Epidemiology of Disasters
CSIS	Center for Strategic and International Studies
DALA	Damage, loss and needs assessment
DHS	Department of Homeland Security (United States)
DKKV	*Deutsches Komitee Katastrophenvorsorge* German Committee for Disaster Reduction (Germany)
DRR	Disaster risk reduction
EA	Environment Agency (Great Britain)
EC	European Commission
ECLAC	Economic Commission for Latin America and the Caribbean
EP	Exceedance probability
EQC	Earthquake Commission (New Zealand)
EU	European Union

EUROCONTROL	European Organisation for the Safety of Air Navigation
EUSF	European Union Solidarity Fund
FAO	Food and Agriculture Organization of the United Nations
FEMA	Federal Emergency Management Agency (United States)
FMS	Fiscal Management Strategy (Japan)
GAR	Global Assessment Report
GDP	Gross domestic product
GDV	*Gesamtverband der Deutschen Versicherungswirtschaft* German Insurance Association (Germany)
GEJE	Great East Japan Earthquake
GFDRR	Global Facility for Disaster Reduction and Recovery
GVC	Global value chains
HFA	Hyogo Framework for Action
HSE	Health and Safety Executive (United Kingdom)
IATA	International Air Transport Association
IEA	International Energy Agency
IFRC	International Federation of Red Cross and Red Crescent Societies
IPCC	Intergovernmental Panel for Climate Change
IMF	International Monetary Fund
MBIE	Ministry of Business, Innovation and Employment (New Zealand)
MCA	Multi-criteria analysis
MEI	Main economic indicators
NOU	*Norges offentlige utredninger* Norwegian Official Report (Norway)
NZD	New Zealand Dollar
OFDA	Office of U.S. Foreign Disaster Assistance (United States)
O&M	Operations and maintenance
PLANAT	*Nationale Plattform Naturgefahren* Swiss National Platform for Natural Hazards (Switzerland)

PwC	PricewaterhouseCoopers
RMS	Risk Management Solutions
SINAPROC	*Sistema Nacional de Protección Civil* National Civil Protection System (Mexico)
UCL	University College London
UN	United Nations
UN DESA	United Nations Department of Economic and Social Affairs
UN ISDR	United Nations Office for Disaster Risk Reduction
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
USD	United States Dollar
USFWS	U.S. Fish and Wildlife Service (United States)
USFDA	U.S.Food and Drug Administration (United States)
NOAA	National Oceanic and Atmospheric Administration
VAT	Value added tax
WEF	World Economic Forum
WDR	World Development Report
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wildlife Fund

Executive summary

The socio-economic burden of disruptive shocks across OECD countries

In the last 10 years OECD and BRIC countries have experienced an estimated USD 1.5 trillion in economic damages from disruptive shocks stemming from natural risks such as storms or floods as well as man-made risks like industrial accidents or terrorist attacks. Single shocks have caused damages in excess of 20 % of national GDP, such as the recent earthquakes in New Zealand and Chile, affecting disproportionately local economies and populations. However, major shocks are no longer confined to single places, but rather cascade globally, such as demonstrated by the Great East Japan Earthquake and the major floods in Thailand.

Disruptive shocks have occurred more frequently over the past decades but, perhaps more importantly, they have seen a significant increase in intensity and complexity. Among the factors driving the surge in intensity of shocks are the increased concentration of people, especially a growing number of elderly, more vulnerable people, and economic assets in risk prone areas. Urbanisation has reinforced and accelerated this dynamic. Increased global economic integration, facilitated by transport mobility and communication, has acted as a vector for propagating shocks globally. Deteriorating environmental conditions coupled with climatic changes have equally contributed to these trends. Failure of one country to identify and manage a major risk can have tremendous negative impacts on others.

Uncertainty about future shocks is a challenge for good resilience policies, especially in fiscally constrained environments

Past shocks have highlighted how little is known about the potential wider disruptions of future shocks, especially how they propagate from local to national levels and beyond country borders. These have also shown that OECD countries could do more to make themselves resilient against known and unknown "unknowns". However, policy makers are confronted with several obstacles: risks are constantly changing and rewards to investments in resilience are very low, as the costs are obvious at present but the benefits may or may not show in the future. If public and private coffers are

tightened, such investments are even harder to make because of competing demands for resources.

There have been significant achievements in bolstering resilience…

- **Past major disruptive shocks have increased the understanding of risk**, and in turn improved the knowledge on how risk can be prevented and mitigated, and how preparedness, emergency response, rehabilitation and recovery from shocks can be improved to increase resilience.
- **The level of risk awareness and information sharing is high.** These have been fostered through public information campaigns and integration of risk management tenets in the standard curricula of education institutions. The incorporation of resilience in the national science and research agendas in the great majority of OECD countries has fostered a culture of safety and resilience.
- **Central government leadership has been vital.** Most OECD countries have emphasised strong central leadership by either the Prime Minister's office or equivalent, or by central co-ordinating bodies to ensure critical risks are managed, and investments to reduce them, supported at the highest political level.
- **Successful mainstreaming of risk management policies across sectors and administrative levels.** Nearly all OECD countries systematically consider disaster risk in sectoral public investment strategies and planning. The importance attributed to the local level is reflected by the establishment of legal frameworks for local responsibilities, including risk sensitive regulation in land zoning and private real estate development.

… but vulnerabilities to risks persist

Despite progress in boosting resilience, past shocks have made gaps apparent: in protective infrastructure, in particular its maintenance; in regulatory reform that has not kept pace with changing risk environments, or difficulties in enforcing regulations. The private sector, including critical infrastructure providers, has shown a number of vulnerabilities. Individuals and households have consistently underinvested in protecting their own assets, despite being aware of their exposure to risks. International collaboration could be much more emphasised to address shocks that have increasingly global consequences.

Effective risk governance

Ineffective institutions have undermined many of the valuable efforts to boost resilience. The decision of an individual household not to build protection against floods may depend on the expectation of the government in doing so for them. A local government's decision to not invest in a protective dam may be influenced by the knowledge that neighbouring jurisdictions would freeride on this, while at the central government level, actors may be reluctant to invest more in resilience, because ex-ante investments are not visible, and hence levels of rewards are too low. It is therefore crucial to identify such institutional barriers that need to be addressed to boost resilience.

Key policy recommendations

- **Promote forward-looking risk governance that takes into account complex risks.** In evaluating risk exposure, countries may want to not only rely on past disruptive shocks and linear risk modelling, but also consider evolving risk patterns, including demographic, economic, technological, and environmental drivers, as well as their inter-dependencies and potential cascading impacts. Established resilience measures should be adapted to keep pace with the evolving changes in the risk landscape. Monitoring and evaluation systems can help inform such a process and forward-looking methods can support the identification of future, complex risks.
- **Emphasise the role of trust**. Past disruptive shocks have eroded trust in a government's ability to protect citizens from harmful impacts. Costly measures have been employed to restore trust after major shocks. Shocks can be an opportunity for governments to showcase long-term commitments to protect their citizens. Transparency and accountability in managing resilience are key factors to maintaining trust in the long-run.
- **Establish a shared understanding of acceptable levels of risk at all stakeholder levels.** Identify methods that support governments, businesses, and individual stakeholders to determine their optimal or acceptable levels of risks, based on which risk resilience strategies can be adopted.
- **Decide on an optimal and complementary mix of resilience measures.** Countries can consider a mix of hard (ex. infrastructure) and soft (ex. planning) measures that take into account a multi-

hazard perspective and hence complement each other, while fostering economic development through positive spill over effects.

- **Adopt a whole of society approach to engage all actors in strengthening resilience.** Such a strategy is essential to align responsible risk actors and their institutional frameworks.
- **Acknowledge the important role of institutions and institutional gridlock in making risk measures effective in increasing resilience.** Previous shortcomings in the institutional set-up have caused government, market, and collective action failures in risk management that have impeded the achievement of higher levels of resilience. Once such institutional bottlenecks are addressed, they present very cost-effective opportunities for boosting resilience.
- **Employ diagnostic frameworks to identify institutional barriers and realign incentives to boost resilience.** Such frameworks can systematically detect what drives existing institutional shortcomings that impede increased resilience. The framework suggested in this report offers a possible guide for policy makers.

Chapter 1

Boosting resilience to risk and shocks in a time of economic constraints

This chapter explores the rationale for increasing resilience against disaster risks, especially in times when public coffers are tight. After laying out the major concepts underlying this report, including risk, disruptive shocks and resilience, the chapter looks at the exposure of OECD countries to past disruptive shocks, including the sources of risk. It demonstrates that the upwards trend in disruptive shocks, especially in terms of economic impacts, has been largely driven by socio-economic, environmental and technological trends, rather than an increase in the frequency or intensity of shocks per se. Given this significant risk exposure, governments and non-governmental stakeholders may ask how they can invest to reduce their risk exposure. Attaining a zero risk level is neither realistically achievable nor economically feasible, and this chapter offers practical guidelines for policy makers to determine an "optimal risk" level and what measures can be adopted.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Introduction

OECD countries have been and appear to be increasingly exposed to disruptive shocks that have had significant adverse impacts not only on directly affected areas and people, but have also had substantial spill over effects at national and international level. Over the past 30 years, the damages from major disruptive shocks (in absolute terms) have increased across OECD countries. This has led to hundreds of billions of dollars in economic losses. Single shocks have caused losses worth as much as 20 % of annual GDP, such as the earthquakes in New Zealand and Chile in 2011 and 2010 respectively. From a national perspective, storms like Katrina may have led to only 0.1 % of GDP in losses, but the local social and economic disturbances were substantial. The continuously increasing concentration of people and physical assets in risk prone areas, as well as rapid urbanisation and growing economic and social inter-dependencies are expected to drive future expected damage. The real challenge for policy makers has been that shocks are no longer confined to directly affected local areas, but rather lead to disruptions across a whole country, and cascade even globally. Failure of one country to identify and manage a major risk can have tremendous impacts on others.

Considerable uncertainty about future shocks is a challenge to increasing good resilience policy making, especially in fiscally constrained environments, but no less needed. Past shocks are a good starting point for understanding risks and future potential threats. However they have caused impacts and cascading effects that no one had previously expected. Therefore it is necessary for governments and private actors to think beyond what has already gone wrong and articulate future potential threats. Even though these threats are marked by high uncertainty, strategic foresight can help identify existing vulnerabilities, monitor altering risk drivers, and where necessary, decide on investments in measures that increase resilience. However such investments may be difficult to argue for, especially in the fiscally constrained environment that has marked OECD countries since the financial and economic crisis in 2008. Investments in resilience are generally hard to justify for policy makers because the rewards are barely visible and may or may not materialise in the future. If budgets are tight, such investments are even more challenging to negotiate because of other competing demands for resources. Investments in resilience are nonetheless needed more than ever because shocks that occur in already tight budgetary environments may become more costly and challenging to absorb for public treasuries, especially in countries that rely on state budgets for post-disaster loss financing and where insurance coverage remains relatively low.

After some preliminary clarification of terms, this chapter will first give an overview of current and potential future risks affecting OECD countries. The discussion will then turn to demonstrate that despite potentially avoidable adverse impacts, "zero-risk" cannot be feasibly obtained given resource constraints. The chapter will then present instruments that can help governments identify optimal levels of resilience and acceptable residual risks, and outline potential measures to help governments achieve these levels.

Risk, disruptive shocks, and resilience

Defining risk and disruptive shocks

The concept of risk and major disruptive shocks

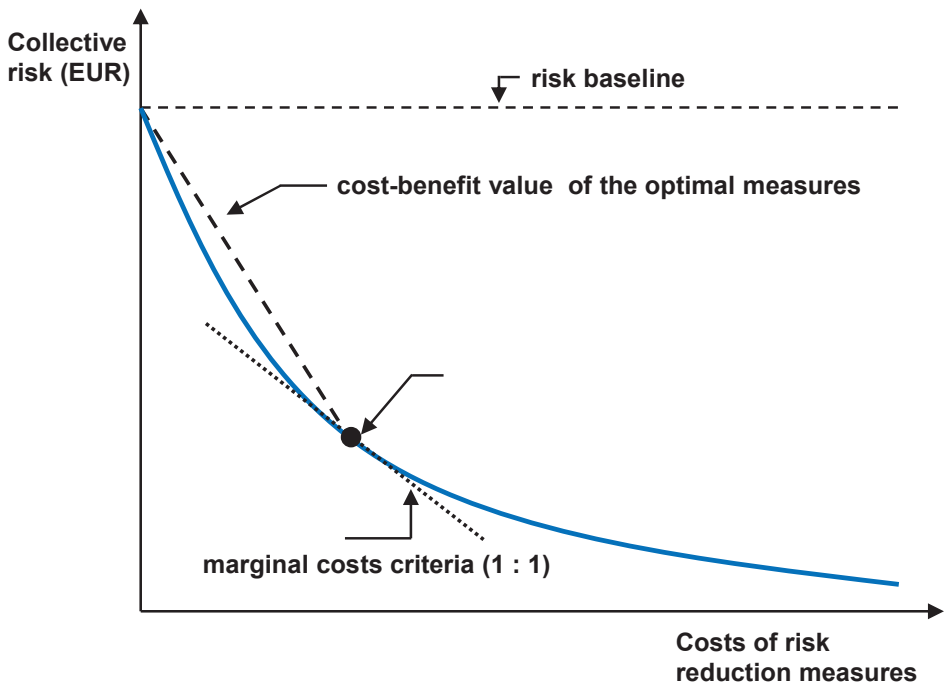
Risks can be defined as the potential damage caused by a single event or a series of events. It is a combination of two factors. The first is the probability of occurrence of a hazard: a potentially harmful event which might itself be influenced by various factors.[1] The second factor, vulnerability, reflects the potential damage inflicted by the occurrence of a hazard in terms of both direct and indirect consequences. Vulnerability is a measure of the exposure of human life, health activities, assets or the environment caused by the hazard occurring (OECD, 2003). A disruptive shock is a situation that causes serious damage to human welfare, the economy, the natural environment or (inter)national security, where serious damage is defined as: loss of human life; human illness or injury; damage to property or infrastructure; homelessness; business interruption; service interruption (including health, transport, water, energy, communication); disruption in the supply of money, food or fuel; contamination or destruction of the natural environment.

Individual, collective and systemic risks

There is an important distinction between individual and societal risks (Jonkman et al., 2011; Liu and Xie, 2008; DVN Software, 2001). Individual risk is calculated for a specific individual and his/her pattern of exposure to the hazards (i.e. annual probability of death of a person). Ammann (2006) exemplifies this by a risk reduction goal that must reflect the maximum acceptable individual risk, defined by the annual probability of death. Collective risk, on the other hand, or societal risk, is calculated for a group of individuals and their pattern of exposure to a risk as a group. The goal of risk reduction may in that case no longer be to define a permissible risk for particular risk situations, but to minimise the number of fatalities all together (Ammann, 2006). For an individual it is more straightforward to determine

his or her accepted level of risk, for a collectively accepted level, this is more complex to determine. Approaches, such as the marginal utility concept used in economic theory and applied to the evaluation of risk reduction measures can be useful to decide on a collectively accepted level of risk. In essence, the concept (Figure 1.1.) allows for a depiction of an optimal risk reduction level under constrained resources and describes the trade-offs of this decision along the marginal cost curve, i.e. indicating the marginal costs of saving a human life through a given risk reduction measure. Most of the decisions governments have to face in risk management deal with the collective risk concept.

Figure 1.1. **Marginal costs of risk reduction measures**



Source: Ammann, W. et al. (2006), "Risk concept, integral risk management and risk governance", in RISK21 – Coping with Risk due to Natural Hazards in the 21st Century, Taylor & Francis Group, London.

Finally, systemic risk is an important concept for understanding complex risks and future uncertainty about risks. The notion of systemic risk describes "the extent to which any risks to human health, the environment, the economy or individual wellbeing is embedded in the larger context of social and cultural aspects that shape our understanding of risks, influence

our attention to causal relationship and trigger our activities for handling these risks" (OECD, 2012c; 2012d; OECD, 2003). What allows for a systemic risk to spread among societies and economies are the interconnections and interdependencies embedded in the networks that characterise the modern global economy. Systemic risks are characterised by: complexity, uncertainty, ambiguity and spill over effects (OECD, 2012c). Complexity refers to the difficulty in identifying and quantifying causal links between a multitude of potential candidates and specific adverse effects. Uncertainty relates to the limitedness or even absence of scientific knowledge (data, information) that makes it difficult to exactly assess the probability and possible outcomes of undesired effects. Ambiguity indicates a situation of ambivalence in which different and sometimes divergent streams of thinking and interpretation about the same risk phenomena and their circumstances are apparent. Spill over effect means that potential damage is not limited to the original risk arena but spreads out to other arenas (OECD, 2012c).

Box 1.1. **Risk, disruptive shock and resilience: definitions**

Risk

Risk can be defined as the potential damage caused by a single event or a series of events. It is a combination of two factors. The first is the probability of occurrence of a hazard: a potentially harmful event which might itself be influenced by various factors. The second, vulnerability, reflects the potential damage inflicted by the occurrence of a hazard in terms of both direct and indirect consequences. Vulnerability is a measure of the exposure of human life, health activities, assets or the environment caused by the hazard.

Disruptive shock

A disruptive shock is a situation that causes serious damage to human welfare, the economy, the natural environment or (inter)national security, where serious damage is defined as: loss of human life; human illness or injury; damage to property or infrastructure; homelessness; business interruption; service interruption (including health, transport, water, energy, communication); disruption in the supply of money, food or fuel; contamination or destruction of the natural environment.

Resilience

Resilience is understood as the capacity of a system to absorb disturbance and reorganise itself while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks.

Sources: OECD (2003), *Emerging Risks in the 21st Century: An Agenda for Action*, OECD Publishing, Paris, *http://dx/doi.org/10.1787/9789264101227-en;* Walker, B. et al. (2004), "Resilience, adaptability and transformability in social-ecological systems", *Ecology and Society*,Vol. 9,No.2:5, *www.ecologyandsociety.org/vol9/iss2/art5/.*

Defining resilience

The term "resilience" can be slightly ambiguous, as it has varying connotations in different disciplines and countries. In environmental studies, for example, it may define the "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change" (IPCC, 2007: 86) In a development studies context, resilience is often used to describe the capacity of individuals and communities to sustain their livelihoods against external shocks (OECD, 2013c). In psychology, one of the disciplines that first coined the term, resilience can refer to the coping with impacts of crises and abrupt changes in family structures or the capacity of poor children to withstand against the traps into which many of their peers fall (Martin-Breen and Anderies, 2011). The World Economic Forum (2013: 37) picks up the notion of system resilience from engineering, which defines it as the capacity for "bouncing back faster after stress, enduring greater stresses, and being disturbed less by a given amount of stress", and emphasises that resilience is not just meant for an object, but more for a system to maintain, restore and adapt its functioning (Table 1.1). Box 1.2 gives an overview of different country definitions across the OECD.

Table 1.1. **Resilience means...**

For an object…	For a system…	For an adaptive system…
…Bouncing back faster after stress, enduring greater stresses, and being disturbed less by a given amount of stress…	…Maintaining system function in the event of a disturbance…	…The ability to withstand, recover from, and reorganise in response to crises…

Source: WEF (2013), "Global Risks 2013", World Economic Forum, Geneva, *www3.weforum.org/docs/WEF_GlobalRisks_Report_2013.pdf.*

Box 1.2. **Approaches to resilience across OECD countries**

The term "resilience" is perceived differently across OECD countries depending on how governments position the meaning of resilience in the overall risk framework, for example:

- Australia's Attorney-General Department, responsible for national security, emergency management and natural disaster relief, refers to resilient communities in its National Strategy for Disaster Resilience as those which "are better able to withstand a crisis event and have enhanced ability to recover from residual impacts" (Australian Government, 2011: 4). Communities can achieve an even stronger position after a disastrous event provided they have previously achieved such resilience characteristics.

- Public Safety Canada, mandated to manage safety against natural disasters, crime and terrorism, defines building resilience against terrorism as "fostering a society in which individuals and communities can withstand violent extremist ideologies and challenge those who espouse them" (Public Safety Canada, 2013: 11). A resilient community is able to alleviate the impacts of a terrorist attack and can ensure fast recovery to ordinary life.

- In the United Kingdom National Security Strategy 2010, which describes how to prepare and react to new and evolving risks to society, resilience determines a quick recovery from potential disasters. It acknowledges that a zero risk level is unattainable and therefore promotes resilience in the context of unpredictable risks. The government of the United Kingdom ensures resilience on the national and local levels by increasing risk awareness in the public. By publishing a National Risk Register which outlines potential risks it ensures that communities are well informed about hazards and can therefore achieve higher resilience.

- The United States Department of Homeland Security, responsible for managing terrorism, border control, immigration laws, cyberspace and natural disasters, defines infrastructure resilience as the capacity to "reduce the magnitude and/or duration of disruptive events. It is the ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event." The concept of resilience entails three elements; robustness which is "the ability to maintain critical operations and functions in the face of crisis", resourcefulness which is "the ability to prepare for, respond to, and manage a crisis or disruption as it unfolds" and rapid recovery which is "the ability to return to and/or reconstitute normal operations as quickly and efficiently as possible after a disruption" (US Department of Homeland Security, 2009: 5).

- The Swedish Civil Contingencies Agency manages societal capacities for preparedness in emergencies and prevention against crises and characterises resilience as "a system that allows a city (or an entity) to withstand, cope with and recover from changes with adverse effects." In the context of a society, this means that the society is able to sustainably govern all disastrous events from political unrest to natural disasters.

Box 1.2. **Approaches to resilience across OECD countries** *(cont.)*

- In 2008, France's Ministry of Defence published a definition of resilience in its White Book, where it is the willingness and capacity of a country, a society and the government to resist the consequences of a catastrophe and then to rapidly restore its organisational functions or at least reach a state which is socially acceptable. Furthermore, resilience does not only concern the government but also the private sector and the civil society as a whole.
- The Swiss National Platform for Natural Hazards (PLANAT), a council on natural risk management, defines resilience as a system's ability to recover from a disturbance and to reach a functioning state again. Therefore resilience is directly related to the speed of recovery and to the degree of vulnerability of a society.

Sources: Australian Government (2011), "National Strategy for Disaster Resilience", *www.ag.gov.au/EmergencyManagement/Documents/NationalStrategyforDisasterResilience.PDF*; Public Safety Canada (2013) "Building Resilience Against Terrorism: Canada's Counter-terrorism Strategy", *www.publicsafety.gc.ca/cnt/rsrcs/pblctns/rslnc-gnst-trrrsm/rslnc-gnst-trrrsm-eng.pdf*; UK Government (2010), "A Strong Britain in an Age of Uncertainty: The National Security Strategy", *www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/documents/digitalasset/dg_191639.pdf;* United States DHS (2009), "The Critical Infrastructure Resilience Study Working Group", United States Department of Homeland Security *www.dhs.gov/xlibrary/assets/niac/niac_critical_infrastructure_resilience_slides_9-8-09.pdf;* Swedish Contingencies Agency (2013), "What is resilience? And how does a city create it?", *www.msb.se/en/Prevention/Natural-Disaster-Risk-Reduction-in-Sweden/National-platform/International-Campaign-Making-Cities-Resilient/What-is-resilience-och-how-does-a-city-create-it/;* French Government (2012), "La résilience des territoires soumis aux risques naturels et technologique", Ministère de l'écologie, du developpement durable et de l'énergie, *http://www.developpement-durable.gouv.fr/IMG/pdf/29_CGDD_resilience_territoires_4p_DEF_WEB.pdf;* PLANAT (2009), "Risikokonzept für Naturgefahren", Swiss National Platform for Natural Hazards, *www.planat.ch/fileadmin/PLANAT/planat_pdf/alle_2012/2006-2010/PLANAT_2009_-_Allgemeine_Darstellung_des_Risikokonzepts.pdf.*

In risk management, resilience has entered the discussion as a determinant factor for defining risk. Risk is therefore defined as a function of threat (T), vulnerability (V), consequences (C), and resilience (R) (Rose, 2009):

$$\textbf{Risk} = \boldsymbol{f}(\boldsymbol{T}, \boldsymbol{V}, \boldsymbol{C}, \boldsymbol{R})$$

The term resilience is therefore adopted in this report to look more broadly at the ability of social and economic systems across the OECD to maintain function when shocked, and the time it takes to recover. The ability itself reflects the notion of so-called static resilience, as defined in economics. It should be complemented by the concept of dynamic resilience, which underlines the notion of speed at which systems get back on track (Rose, 2009). The definition of the Resilience Alliance (Walker, B.

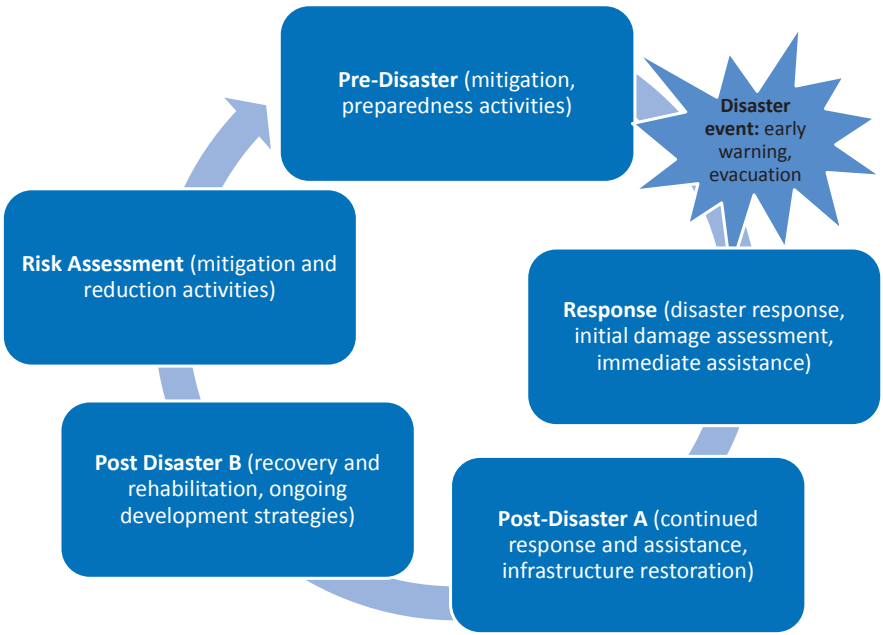
et al., 2004: 2), captures both and is therefore the definition that is adopted in this report:

"Resilience is the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks."

Resilience in the risk management cycle

A general understanding of what constitutes the main activities[2] of risk management systems is depicted in Figure 1.2. These include the identification and assessment of risks; mitigation and prevention of risks; preparedness in the case of a disruptive event; emergency response; recovery and rehabilitation. Resilience is the outcome of measures that have been put in place before, during and following a shock. As stated in Baubion (2013), resilience is an activity that is consistent with prevention and preparedness as well as with enhancing crisis management capacities.

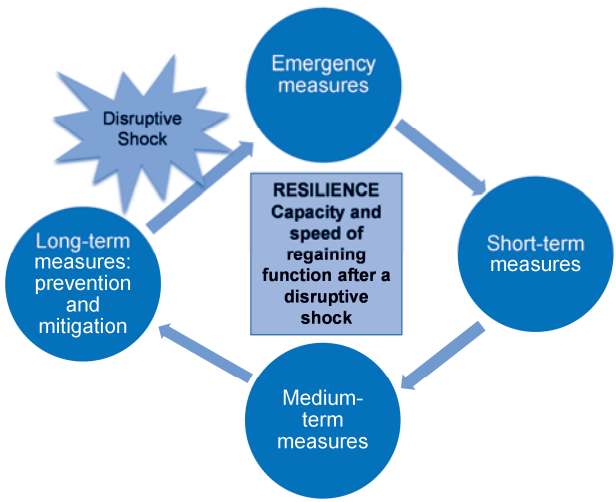
Figure 1.2. **The risk management cycle**



Source: Adapted from Todd, D. and H. Todd, (2011), "Natural Disaster Response, Lessons from Evaluations of the World Bank and Others", Evaluation Brief 16, Independent Evaluation Group World Bank/IFC/MIGA, *http://ieg.worldbank.org/Data/reports/eval_brief_nat_disaster_response.pdf.*

Instead of distinguishing measures that contribute to achieving resilience in one of the phases of the traditional risk management cycle pre- or post-disruptive shock, resilience measures can be categorised according to their time span of implementation, hence establishing a dynamic approach to resilience. To do this, Rose (2009) distinguishes four main phases, namely the (i) immediate response to a disaster (i.e. emergency response), (ii) short-term (e.g. temporary housing), (iii) medium-term (i.e. reconstruction and rehabilitation), and (iv) long-term measures (e.g. prevention and mitigation) (Figure 1.3).

Figure 1.3. **Dynamic resilience strategies**



Source: Adapted from Rose, A. (2009), "Economic Resilience to Disasters", *Published Articles & Papers*, Paper 75, CREATE Research Archive, *http://research.create.usc.edu/published_papers/75*.

Chapter 2 will look at how OECD countries have implemented successful measures that contribute to the resilience of their societies and economies. The measures that will be discussed include activities that avoid exposure to hazards, or reduce vulnerability to their consequences before they occur. It distinguishes measures that aim to put in place protection against specific hazards or at reducing the vulnerability of particular systems, and conditions which encompass the way risk prevention measures are implemented (such as the attitude toward risk and safety at all levels of decision making). The chapter will also look to some extent at knowledge and capacities developed by various stakeholders to anticipate and respond

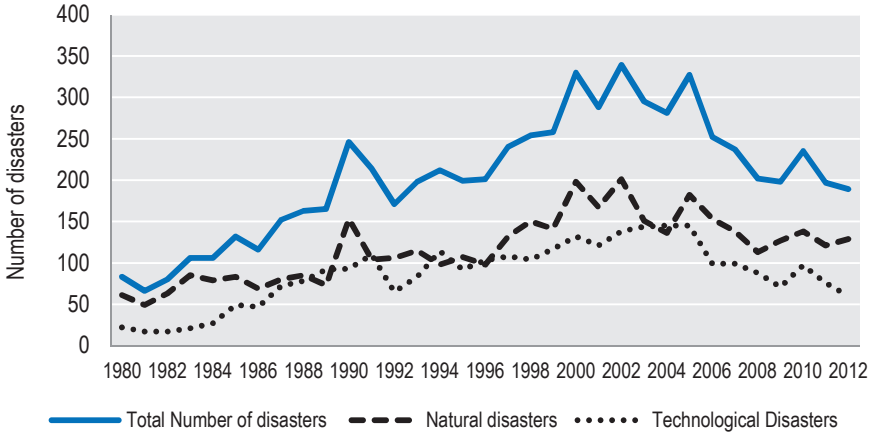
to disruptive events, which complements other work of the OECD that focuses on these activities more in detail.[3] Before moving to a more detailed discussion of the "state of the art" of resilience across OECD countries in Chapter 2, this section will first focus on demonstrating the need for increased resilience given countries' substantial exposure to hazards, as well as instruments that help governments decide which level of resilience they should aim for (e.g. optimal resilience), within a persistently tight fiscal environment.

Risk exposure across OECD countries

Past risk exposure

OECD countries have experienced significant negative impacts from past disruptive shocks, a trend that has been pointing upwards. In the last 30 years disruptive events, including natural and man-made causes, have increased across OECD and BRIC countries, decreasing again in recent years (Figure 1.4). Adverse impacts have led to hundreds of billions of dollars in economic losses[4] (Figure 1.5). Even though early figures need to be interpreted with some caution given previous reporting inconsistencies, a general upwards trend in the severity of impacts can be observed especially in the number of affected people, which increased from an average of around 30 million people in the early 1980s to 140 million people per year during the last ten years. Equally, economic losses associated with disruptive events increased and surpassed a total annual amount of USD 300 billion in 2011. This increasing trend in adverse impacts may not necessarily be associated with more frequent or more intense shocks, as compared to some decades ago, but it points to the fact that human and physical capital is increasingly accumulated in areas affected by disruptive events. Among OECD countries, the United States, Japan and Italy have been the most affected by large-scale disruptive events over the past 40 years. A recent survey conducted by the OECD shows that 32 of the 34 OECD member countries acknowledge that extreme events are a primary concern for policy makers (OECD, 2013d).

Figure 1.4. **Number of annual disasters in OECD and BRIC countries, 1980-2012**



Source: EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013).[5]

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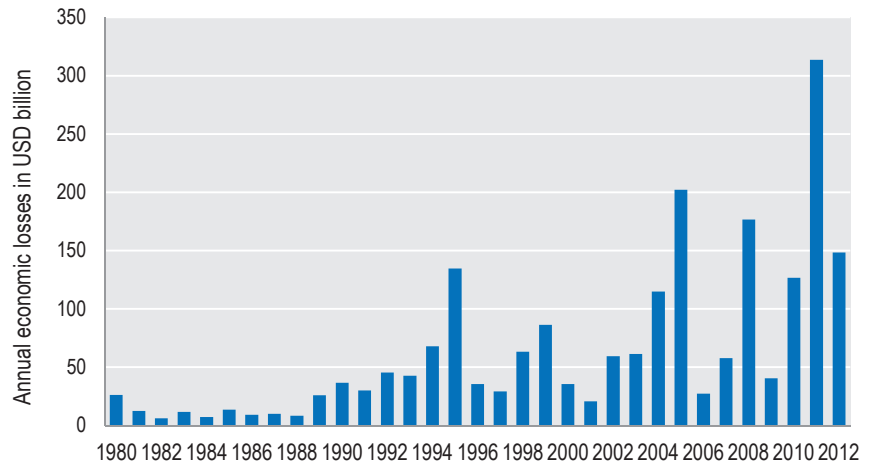
Figure 1.5. **Economic losses due to disasters in OECD and BRIC countries, 1980-2012**



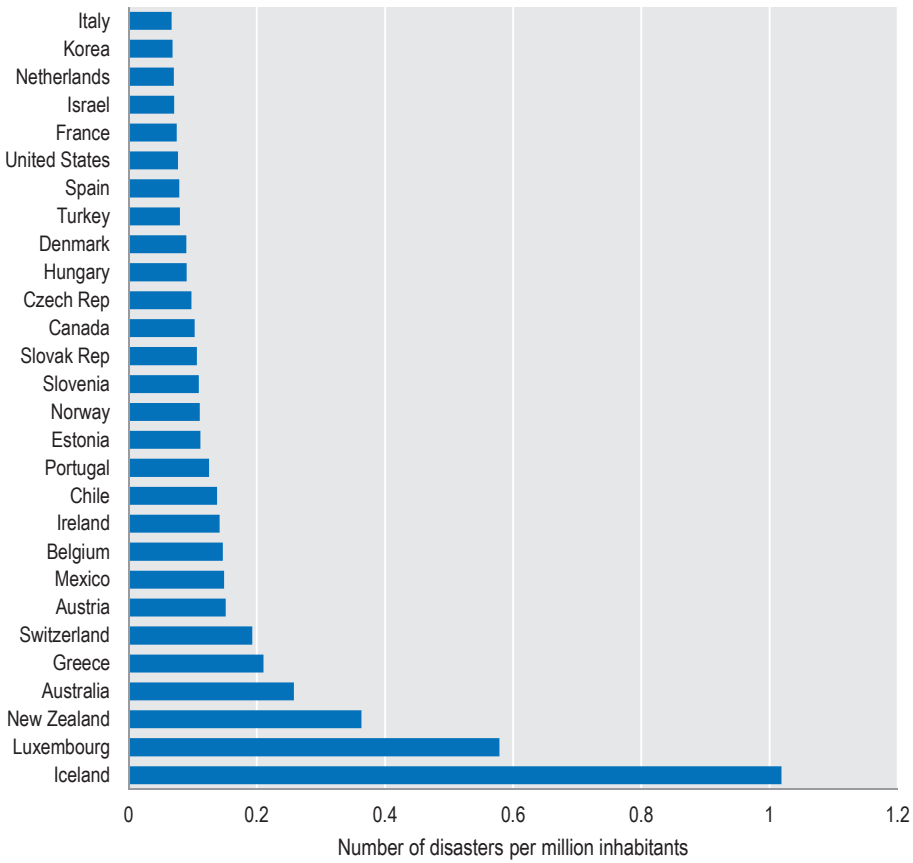
Note: Figures are shown true to the year of the event.

Source: EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013).

StatLink *http://dx.doi.org/10.1787/888933030857*

Within OECD countries, impacts are unevenly distributed. Looking at disasters proportionately to the size of the population, among the countries most affected by disruptive events across the OECD are Iceland, New Zealand and Australia (Figure 1.6). However, impacts are inversely distributed when compared to income. Figure 1.7 shows that OECD countries with a lower GDP per capita experience relatively more fatalities from disasters, whereas countries with a higher GDP per capita see larger economic impacts.

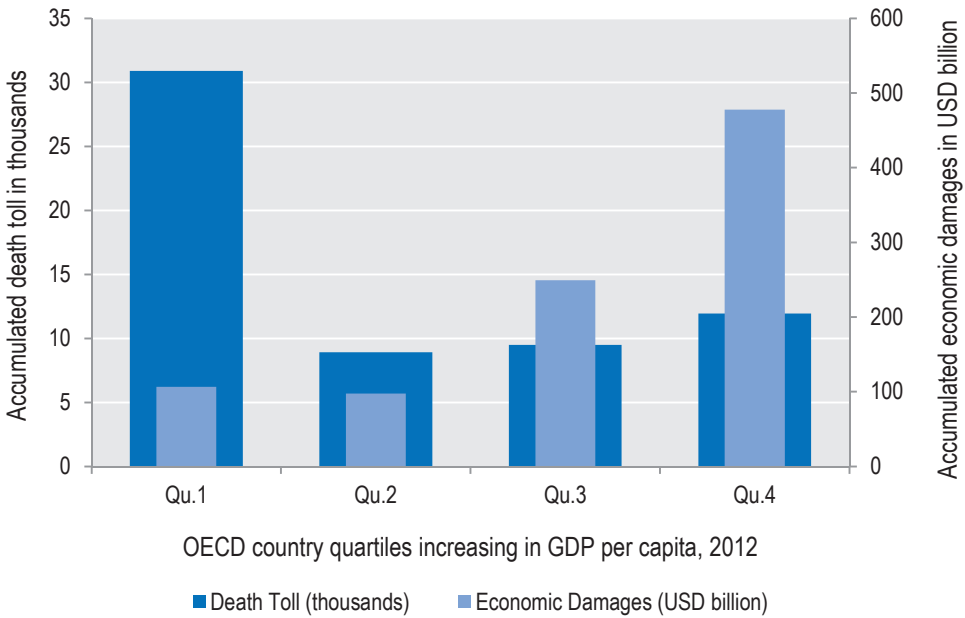
Figure 1.6. **Disaster exposure across OECD countries, 1973-2012**



Sources: EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); OECD (2014), "Population", *OECD demography and population (database)*, *http://dx.doi.org/10.1787/data-00285-en*.

StatLink *http://dx.doi.org/10.1787/888933030876*

Figure 1.7. **Fatality rates and economic damages to OECD countries by income quartile, 1995-2010**



Note: Does not include data on the European heat wave of 2003 due to the difficulty to determine the actual causes of death during this disaster. The figures are shown true to the year of the event.

Sources: EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); OECD (2013e), "Gross domestic product (GDP) MetaData : GDP per capita, USD, constant prices, reference year 2005", *OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en* (accessed 14 November 2013).

StatLink *http://dx.doi.org/10.1787/888933030895*

The frequency of certain types of disasters (such as storms) does not necessarily reflect the overall risk exposure associated with that source of risk. Storms account for almost 30 % of disruptive events across OECD countries over the past 40 years, however, on average, human and economic losses are over four times higher for earthquakes (Table 1.2).

Aggregate, although sometimes considerable, impacts conceal considerable vulnerabilities to citizens and sub-national governments concentrated in specific local economic areas. On average and in absolute numbers, OECD members suffer higher economic losses than lower income countries, but aggregate losses are a much lower percentage of national

GDP, which has until recently made these economies more capable of absorbing losses. Economic losses due to shock events in OECD countries reach an average of 0.2 % of GDP annually compared to an average of 4.8 % (2006-2011) in lower income countries (OECD, 2012a). Recently however, specific major disruptive events have had large-scale economic impacts also in OECD countries. Damages from the Chile earthquake in 2010 and the Christchurch earthquake in New Zealand in 2011 were the equivalent of around 10 % and 20 % of annual GDP. From a national perspective, storms like Katrina may have led to only 0.1 % of national GDP in damages, but the estimated USD 96 billion to USD 108 billion in economic losses were felt disproportionately by the impacted geographic area, its population, and related economic activities (National Hurricane Center, 2005; The White House, 2005). For example, 19 % of American oil production was affected by the destruction of 113 offshore oil and gas platforms and 457 oil and gas pipelines (Amadeo, 2012). One year after the event, approximately 100 000 jobs were lost and USD 2.9 billion in wages (Dolfam, 2007).

Table 1.2. **Human and economic losses across disaster types for OECD countries, 1973-2012**

Type of event	Average economic losses (in USD thousands)	Average people affected[1]	Average people killed	Total number of events
Earthquake	2 571 453	63 836	338	210
Drought	1 278 942	285 000	0	55
Storm	659 870	28 190	17	1 138
Flood	261 554	34 150	13	711
Wildfire	208 949	6 318	5	183
Extreme temperature	166 144	26 301	458	184
Industrial accidents	136 681	3 250	16	261
Insect infestation	60 000	0	0	2
Mass movement wet	36 544	1 580	26	86
Volcano	32 373	10 011	8	33
Miscellaneous accidents	5 943	58	29	212
Transport accidents	49	8	34	679
Epidemic	0	55 674	13	47
Mass movement dry	0	333	94	3

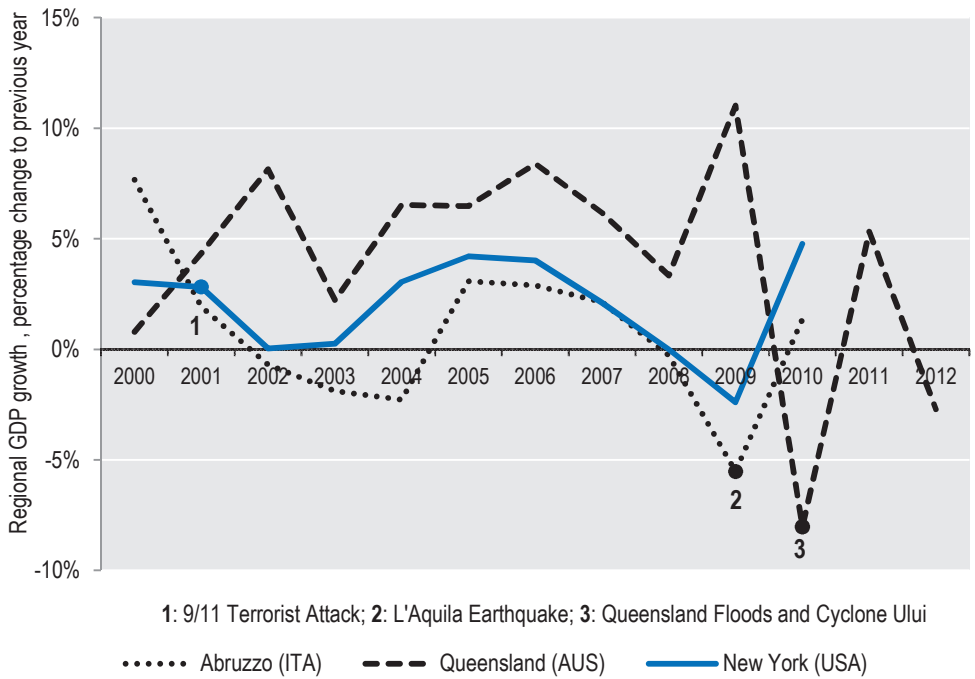
Note: Average values per event, reported true to the year of the event. The number of affected people includes people requiring immediate assistance during a period of emergency; it can also include displaced or evacuated people.

Source: EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013).

StatLink *http://dx.doi.org/10.1787/888933031123*

Figure 1.8 shows the regional economic impact of the attacks of 9/11, the flooding in Queensland in 2010 as well as the earthquake in Italy in 2009 which saw a considerable drop in economic output following the disasters. Such disruptive shocks have equally severe impacts on public finances (Box 1.3), sub-national liquidity needs in the financial sector, sectoral imbalances and consumer and business confidence, with detrimental knock-on effects on the economy (OECD, 2004). For example, the Kobe earthquake in 1995 resulted in a fall of 74 % of sales in department stores in that year. Of the 6 000 small businesses that were destroyed in the Marmara earthquake in 1999 in Turkey, the majority had little or no insurance coverage.

Figure 1.8. **Regional economic growth impact of selected natural disasters**



Source: OECD (2012e), "Large regions, TL2: Demographic statistics", *OECD Regional Statistics*(database), *http://dx.doi.org/10.1787/data-00520-en* (accessed 14 November 2013).

StatLink *http://dx.doi.org/10.1787/888933030914*

Box 1.3. **Impact of disruptive events on public finances**

- To finance reconstruction and recovery after the 2010 earthquake in Chile, the national debt ceiling was raised and taxes were increased. Internal as well as external debt was issued in the amount of USD 1.6 billion. A transitory corporate tax was implemented along with temporary increases to the real estate tax and a permanent increase in the tobacco tax to 62.3 % was introduced.
- To finance the aftermath of the 9/11 terrorist attacks the budget gap of New York City was mostly covered via increased borrowing. The city issued USD 2.1 billion in long-term bonds, called New York City Transitional Finance Authority recovery bonds. To deal with the increased deficit, authorities raised nominal property tax by 18.5 %. Additionally, the city's sales tax was raised by 0.125 percentage points to 8.625 %. Most tax increases were scheduled to end by 2006.
- The Great Eastern Japan Earthquake (GEJE) put even more pressure on Japan's already fiscally constrained budget. In order to finance USD 232.6 billion in expenditures related to the GEJE, the Japanese government was able to quickly liquidate short-term money in exchange for higher debt and taxes in the long-run. Its short-term financing mechanisms included a supplementary budget where within 2 months after the earthquake nearly USD 8 billion was reallocated and nearly USD 30.2 billion was borrowed from the pension fund. In the medium- and long-term, the Japanese government financed its reconstruction costs by issuing around USD 171.5 billion worth of government bonds. To repay the interest expenses, the government increased the income tax for the next 25 years and the annual per capita local tax increased from USD 48.3 to USD 60.4.
- To finance the aftermath of the 1999 Marmara earthquake in Turkey, personal, corporate, income, property and vehicle taxes were increased. The value added tax (VAT), for example, rose from 15 % to 17 %.

Sources: OECD (2004), *Large-scale Disasters: Lessons Learned*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264020207-en*; Fermandois A. (2011), "Chile and its earthquake: Preparedness, response and lessons", Government of Chile, Ambassador's Office, *http://dels.nas.edu/resources/static-assets/materials-based-on-reports/presentations/AmbassadorFermandois.pdf*; Chernick, H. (2005), *Resilient City: The economic Impact of 9/11*, The Russell Sage Foundation, United States; World Bank Institute (2012), "The Financial and Fiscal Impacts", Learning from Megadisasters, Knowledge Note 6-4, Cluster 6: The economics of disaster risk, risk management, and risk financing, The World Bank, Washington D.C., *http://wbi.worldbank.org/wbi/Data/wbi/wbicms/files/drupal-acquia/wbi/drm_kn6-4.pdf*.

Future and complex risks

Impacts of disruptive events in one location or country may spread much more widely, across territorial borders and economic sectors. For example the financial and economic crisis that started to unfold in the United States in 2008 saw global cascading impacts. By the end of the year

exports declined in most OECD countries, and imports in some OECD countries as well. By 2009 this trend was recorded in all OECD countries (OECD, 2013a; Araújo and Oliveira Martins, 2009). Global value chains have acted as a vector for propagating risks globally (Box 1.4). Failure of one country to identify and manage a major risk can have tremendous impacts on other countries, and this has been observed in recent major shocks.

Box 1.4. **Global value chains as vectors for propagating risks**

An example of how local disruptive shocks can have cascading global effects is demonstrated by global value chains. The Great East Japanese Earthquake, the Thailand Floods, droughts suffered in the United States etc. have recently demonstrated how such shocks can indirectly, but rapidly and significantly have global impacts:

- The Great East Japanese Earthquake in 2011 caused disastrous impacts not only in Japan, it led to slowdowns in the global automotive and electronics industries which rely on Japan for inputs to their value chains. For example, car manufacturers in Detroit were affected when Renesas, a large supplier of microchip controllers in Japan, halted production due to the destruction of its factory. Single sourcing was equally the root cause of a global disruption in the supply of car paint due to a factory that was destroyed in North East Japan. The supplier supplied 100 % of global car paint demand, leading to major disruptions in car supply chains worldwide.

- A relatively small eruption of the Eyjafjallajökull Volcano in 2010 in Iceland led to the development of an ash cloud that grounded 100 000 commercial and cargo airliners across Europe for several days, leaving more than 10 million passengers stranded. The estimated loss for aviation firms was EUR 2.5 billion not including the indirect damages suffered by trade relationships all around the world.

- The floods that affected the Bangkok metropolitan area in Thailand in 2011 hit a particularly indutstrialised part of the city, where more than 1 000 factories were affected. Forty-five % of the world's manufacturing capacity of computer hard disk drives are produced in the affected area. It is estimated that global hard drive supply saw a decrease of 30 % that year.

- The 1999 Chi-Chi earthquake in Taiwan disrupted the global computer manufacturing industry, by halting the production of semiconductors. The Science Industrial Park in Hsinchu, which was located about 110 km from the epicentre, and which housed a significant percentage of the world's semiconductor manufacturing and silicon processing companies, suffered major damages resulting in the closure of the park for two weeks. Subsequently, wholesalers started to hoard memory chips which increased the spot price by four to five times. Taiwan's central government estimated that indirect business interruption costs reached USD 2 billion to USD 3 billion.

Box 1.4. **Global value chains as vectors for propagating risks** *(cont.)*

- The Niigata-Chuetsu Oki earthquake in 2007 brought car production in Japan to a halt by cutting the supply off for an engine piston ring. The Riken production facility is responsible for manufacturing 40 % of all piston rings in the Japanese automobile industry. Riken suffered significant equipment damage due to inadequate anchorage, which led to the closure of the plant for two weeks. At that time Riken was the sole-source supplier of piston rings and transmission seals for major automobile companies such as Toyota and Honda. Toyota alone forewent the production of 120 000 cars in the first weeks after the earthquake. The impact to the automobile industry was attenuated due to the automobile industry assisting Riken to restore its production rates two weeks after the earthquake.

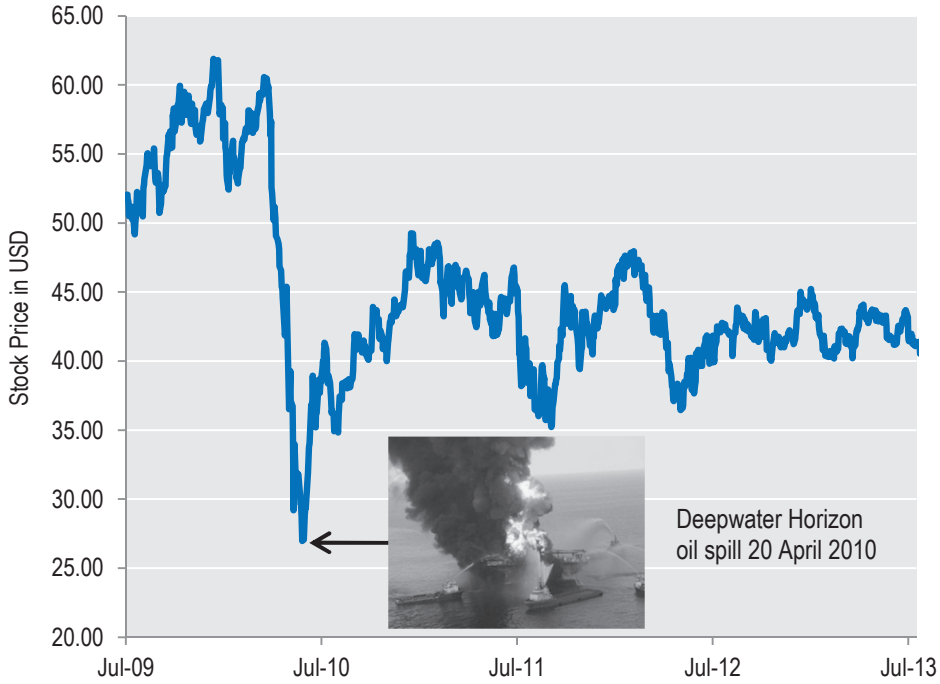
- The severe and prolonged drought in the United States that is estimated to have started in 2012 and that lasted until 2013 has had severe economic impacts. The low water levels in the Mississippi River, for example, where USD 180 billion worth of goods are moved every year, forced barges to reduce the amount of cargo they can carry by two-thirds of their usual load.

Sources: OECD (2013b), *Interconnected Economies: Benefiting from Global Value Chains*, OECD Publis hing, Paris, *http://dx.doi.org/10.1787/9789264189560-en;* WEF (2012a), "Global Risks 2012", World Economic Forum, Geneva, *www3.weforum.org/docs/WEF_GlobalRisks_Report_2012.pdf;* WEF (2012b), "New Models for Addressing Supply Chain and Transport Risk", World Economic Forum, Geneva, *www3 .weforum.org/docs/WEF_SCT_RRN_NewModelsAddressingSupplyChainTransportRisk_IndustryAgenda_ 2012.pdf*; Muench, V. (2013), "Eyjafjallajökull volcanic eruption", in *Allianz Expert Risk Articles*, *http://www.agcs.allianz.com/insights/expert-risk-articles/eyjafjallajokull-volcanic-eruption/* (accessed 14 November 2013); EQE (1999), "An EQE Briefing – 1999 Chichi, Taiwan Earthquake (M7.6)", EQE International, Oakland, *www.absconsulting.com/resources/Catastrophe_Reports/Chichi-Taiwan-1999.pdf;* OECD (2003), *Emerging Risks in the 21st Century: An Agenda for Action*, OECD Publishing, Paris, *http://dx/doi.org/10.1787/9789264101227-en;* RMS (2000), "Event Report Chi-Chi, Taiwan Earthquake", Risk Management Solutions, Menlo Park, *www.rms.com/publications/Taiwan_ Event.pdf;* Global Risk Miyamoto (2007), "2007 Niigata Chuetsu-Oki, Japan Earthquake Reconnaissance Report", Global Risk Miyamoto, Lafayette, *www.grmcat.com/images/Niigata-Chuetsu-Oki-Japan-Report.pdf;* Alfred E. Alquist Seismic Safety Commissioners (2008), "Niigata Chuetsu-oki, Japan Earthquake and Disaster Preparedness in Shizuoka Prefecture: Lessons for California", Alfred E. Alquist Seismic Safety Commissioners, *http://www.seismic.ca.gov/pub/CSSC_08-02_JapanEarthquake2007FINA Lv5.pdf*.

Impacts from disruptive shocks can also be indirect, which are more difficult to quantify, but important to consider. For example, the direct losses incurred by a private company can include the destruction of physical and production assets or the foregone revenues when production is halted. It can however also include less tangible impacts, such as damage to organisational reputation incurred through delays and failures in the delivery of products and services as a result of a disruptive shock (WEF, 2012b). Negligence in the sourcing of suppliers can also cause reputational damage.

For example, global garment producers have had to justify the failure of ensuring safety standards of their garment producers in Bangladesh, when the Rana Plaza commercial building collapsed in the suburbs of the capital Dhaka in 2013, killing over 1 200 and injuring twice as many workers. Finally, impacts of disruptive shocks may have dramatic impacts on the stock market value of a company, as was the case for British Petroleum (BP) during the Deepwater Horizon oil spill in 2010 (Figure 1.9). Its stock price plummeted by two-thirds of its original value and has not fully recovered three years after. A study revealed that many large companies may not be fully aware of the potential reputational and litigational risks to their businesses (Agrawala et al., 2011).

Figure 1.9. **The impact of the Deepwater Horizon Oil Spill on BP stock price values**



Note: Values represent closing prices.

Sources: BP (2014), "BP ADS Share Price History", British Petroleum, *http://ir2.flife.de/data/bp/hpl_us.php* (accessed 8 April 2014); McDermott, M. (15 November 2012), "BP will pay biggest criminal fine in US history for Gulf oil spill", Treehugger, *www.treehugger.com/energy-disasters/bp-will-pay-biggest-criminal-fine-u-s-history-gulf-oil-spill.html*.

StatLink http://dx.doi.org/10.1787/888933030933

Past shocks are a good starting point for understanding risk. However, as demonstrated in the past, large scale shocks have often had impacts and cascading effects that no one had previously expected. For this reason it is necessary for governments and private actors to think beyond what has already gone wrong in the past and articulate future potential threats.

Future risk exposure is marked by uncertainty, but nevertheless needs strategic foresight to increase resilience. The risk landscape across the OECD cannot be assessed in a static backward-looking way based on past disruptive shocks only. Resilience can only be improved once countries identify and address risks that are known to be "unknown". Strategic foresight capacity enables governments to anticipate uncertain events through creative reflection processes, supported by methodologies such as foresight-scenarios, conditional projections, simulations and trend analyses. The emphasis of such reflections is not on forecasting the future, which has rarely worked in the past, but rather in brainstorming about potential consequences and impacts that may or may not trigger investment decisions on resilience measures at present (OECD, 2011c).

For some known "unknowns" foresight has resulted in fairly concrete results that can aid governments in better judging whether resilience measures should be undertaken. A cyber-attack is an example of a known "unknown" risk whose impacts can potentially propagate through sabotage, espionage, or subversion and that can cause potential failures to critical systems, such as financial institutions. In the annual survey launched by the World Economic Forum, experts ranked cyber-attacks among the most important future risks (WEF, 2012a). Preliminary estimates of potential damages have amounted to USD 100 billion for the United States annually, which does not include potential damages through a reduction in national security as a consequence of theft of information or other malicious cyber acts. Global estimates range between USD 300 billion to USD 1 trillion annually (CSIS, 2013). This information serves as a good basis for thinking about future (un)known "unknowns" and possible risk reduction measures more clearly. Other out of the box threats the WEF identified include constant connectivity, epigenetics, financial illiteracy, mega-accidents, mis-education, mis-information, neo-tribalism, resource wars and volcanic winters (WEF, 2012a).

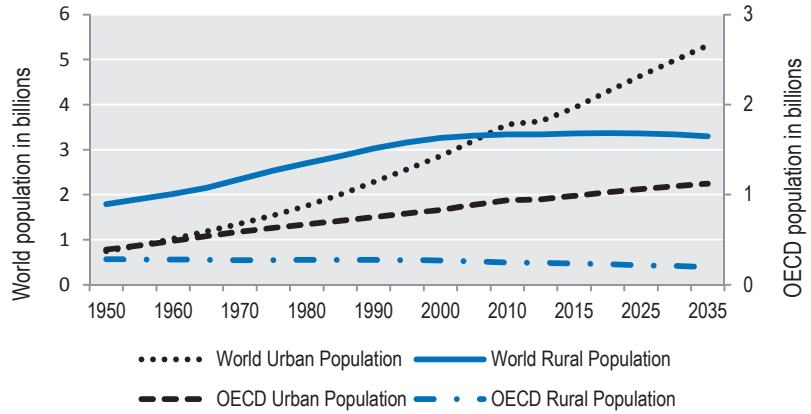
Risk drivers: Increased vulnerability through structural and man-made drivers

The increase in negative consequences of disruptive shocks across OECD countries has not necessarily been caused by an increase in the frequency in occurrence in, for example , natural or man-made risks, but is

also driven by underlying socio-economic (including demographic), technological and environmental drivers that change the way hazard events occur, are spread and generate reactions (OECD, 2004). To address uncertainty in policy making for resilience, understanding such driving forces is indispensable and can inform the strategic foresight capacities of governments and other stakeholders alike. When looking at socio-economic drivers, there are three key important trends that contribute to an increase in risk exposure. These three trends include an increasing population and an increase in the density of people and economic assets in risk-exposed areas, as well as a continuously aging society.

A larger total population and a larger share of the more vulnerable elderly population will continue to contribute to drivers of future risks. The world population of currently 7.2 billion is set to reach nearly 10 billion by 2050 (UN DESA, 2013). Much of this growth will occur in highly vulnerable, less developed countries, and in increasingly dense urban areas (Figure 1.10). These dynamics will affect the food, water and energy supplies, and will have an eroding and harmful impact on the environment, with new health-related risks occurring, for example, through the construction of dams and irrigation systems that facilitate diseases such as malaria and parasitic diseases such as schistosomiasis. Finally, all OECD countries are confronted with an increasing share of elderly people (Figure 1.11), a group that are more vulnerable and have special needs in emergency situations, and which tend to be less well-off and hence more often located in risky areas. For example, 71 % of fatalities during Hurricane Katrina occurred in people above 60 years old; half of the people that died during Hurricane Sandy were above 65 years old (Parry, 2013), and most of the fatalities caused by a heat wave in 2003 in Europe were among the elderly.

Figure 1.10. **Urban and rural population in the world and the OECD, 1950-2030**

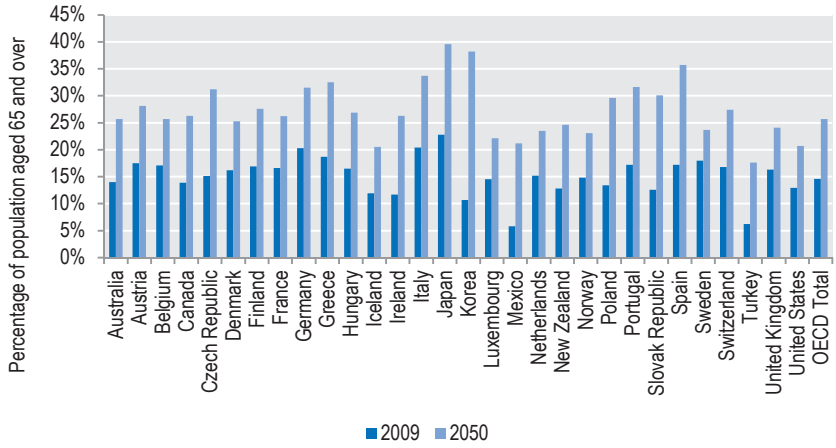


Note: Population data for Korea missing.

Source: Calculations based on data from UN DESA (2013), "World Population Prospects: The 2012 Revision, Highlights and Advance Tables", United Nations Department of Economic and Social Affairs, Population Division Working Paper No. ES A/P/WP.228, *http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2012_HIGHLIGHTS.pdf.*

StatLink *http://dx.doi.org/10.1787/888933030952*

Figure 1.11. **Percentage of population aged 65 and over across OECD countries**



Note: Population data for Estonia, Chile, Israel and Slovenia missing.

Source: OECD (2009), *OECD Factbook 2009: Economic, Environmental and Social Statistics*, OECD Publishing, Paris, *http://dx/doi.org/10.1787/factbook-2009-en.*

StatLink *http://dx.doi.org/10.1787/888933030971*

Economic trends have contributed to increasing risk exposure and vulnerability, including the geographic concentration and the global integration of economic activities. The increased geographic accumulation of economic activities has been motivated by gains in, for example, transport and financial transaction efficiency. Figure 1.12 depicts the resulting economic concentration around Europe's large metropolitan areas in 2005. In addition to density, the global integration of value has amplified the potential propagating impacts of shock events. A major disruptive shock for example in the core economic area of the East Coast in the United States could lead to a disruption in the rest of the country (OECD, 2011a). Port cities, an important economic life artery for global value chains, also demonstrate key driving forces for future risks. Miami in the United States, for example, is expected to see an increase in economic assets from USD 416 billion in 2005 to USD 3.5 trillion in 2070 (UN ISDR, 2013; Nicholls et al., 2008). Global value chains (as depicted in Box 1.4) depend on logistical and transportation nodes such as ports, but also on a global network of suppliers for the production and sale of goods and services, for income and investment flows, and for sharing knowledge through continents. Small economies such as Belgium, Luxembourg and the Slovak Republic are much more reliant on global supply chains than others (Figure 1.13). The increase in global interconnectedness through supply chains has been driven by outsourcing, offshoring, product and network complexity, and single sourcing or buffer stock reduction (WEF, 2012b). Surveys among companies indicate that they may have limited preventive or mitigating capacity regarding supply chain disruptions (OECD, 2013b).

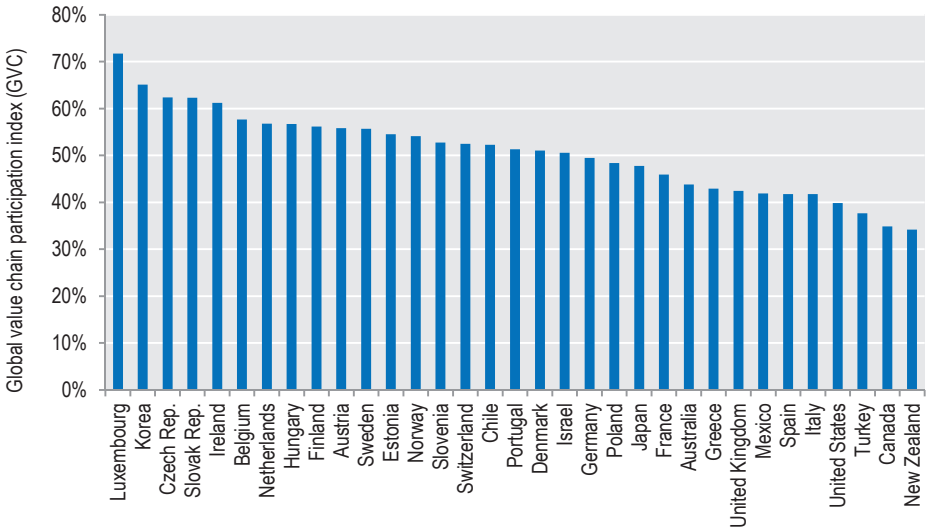
Technological developments in information, communication, space and transport that have facilitated economic development and co-operation on a global scale thereby also act as drivers propagating impacts of shocks. Figure 1.14 shows the rapid expansion of wireless internet access in the past 10 years. In OECD countries a rise of 550 % was observed in internet users from 1997-2007 and as of December 2011 the estimated number of wireless broadband connections was twice as high as the estimated number of fixed broadband subscription (OECD, 2012f; OECD, 2011a). Similar trends can be seen in people having access to global aviation, and mobile technology through the expansion of satellite dishes. On one hand they have increased resilience as technology makes hazard analysis, modelling and mapping, early warning, emergency communication and other tasks more easily manageable, but on the other hand they also act as a channel for propagating risks and diseases, potentially transforming humans and the environment. Cyber risk is a potential significant risk because of low barriers to entry and huge propagating impacts, fears of which may impede the transition of many financial and other transactions to much cheaper online platforms.

Figure 1.12. **Concentration of economic activity in Europe**

Note: Map illustrates GDP per km^2 in 2005.

Source: OECD/China Development Research Foundation (2010), *Trends in Urbanisation and Urban Policies in OECD Countries: What Lessons for China?*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264092259-en*.

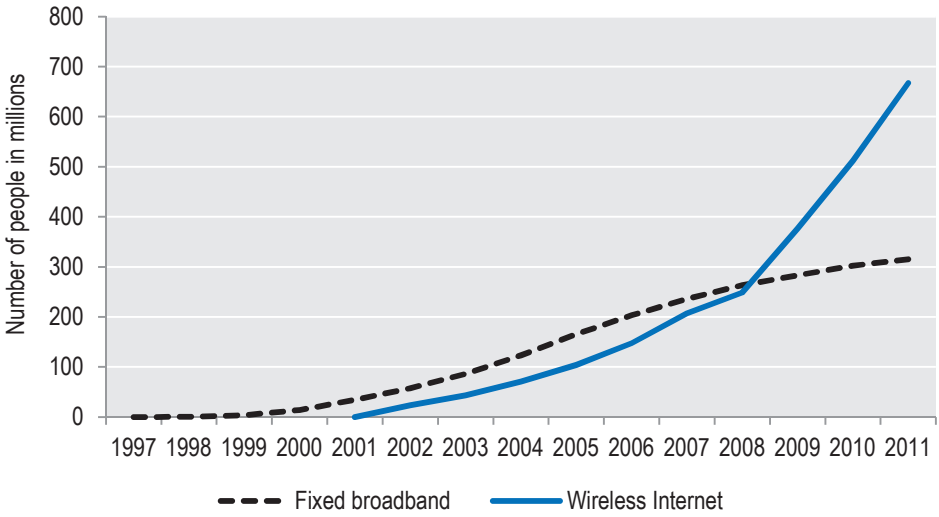
Figure 1.13. **Global value chain participation index in OECD countries, 2009**



Source: Mirdoudot, S. and K. De Backer (2012), "Mapping Global Value Chains", OECD, *www.oecd.org/dac/aft/MappingGlobalValueChains_web_usb.pdf.*

StatLink *http://dx.doi.org/10.1787/888933030990*

Figure 1.14. **Internet connectivity of OECD population, 1997 - 2011**

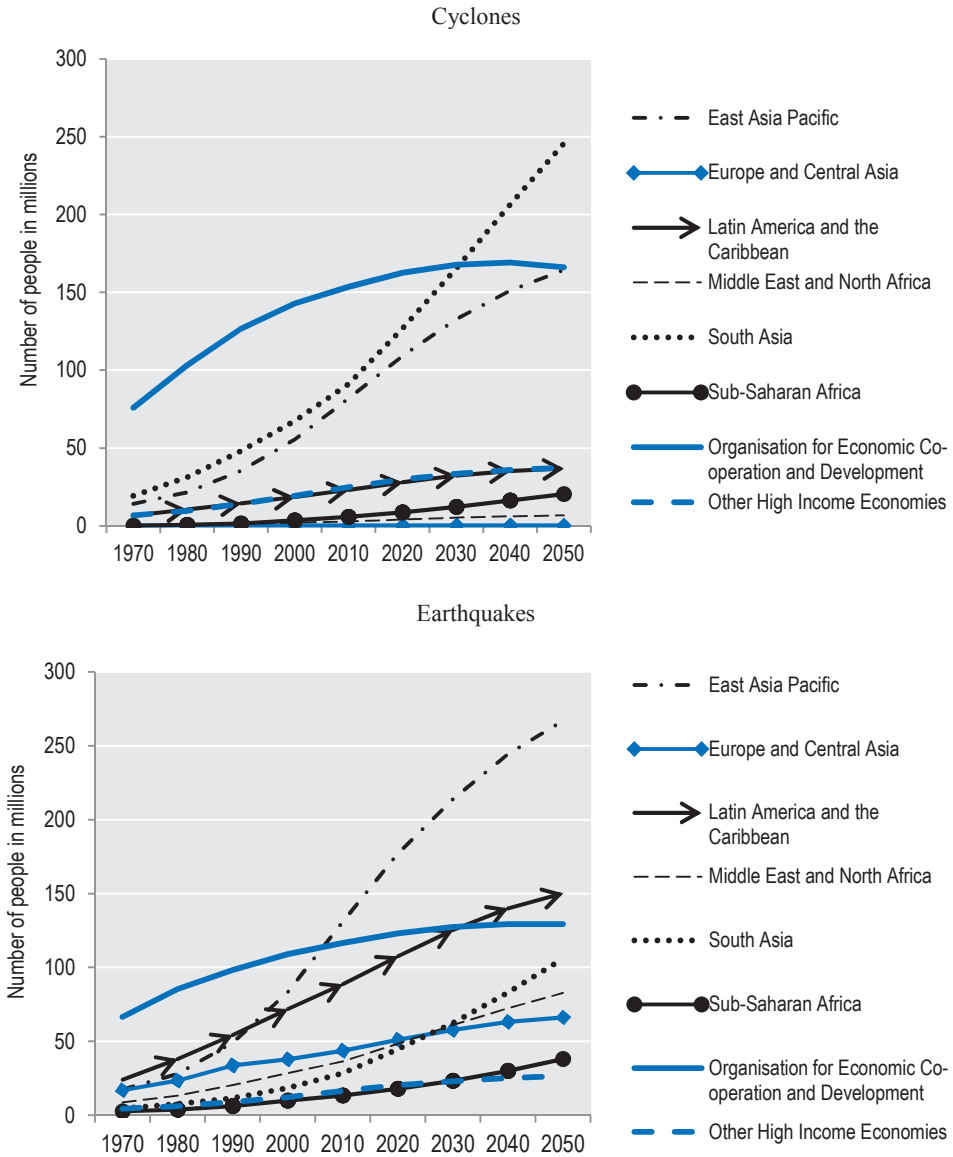


Source: OECD (2012f), *OECD Internet Economy Outlook 2012, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264086463-en.*

StatLink *http://dx.doi.org/10.1787/888933031009*

Expected climatic changes may be an environmental factor driving an increased frequency and intensity of some risks. Experts expect that climatic change may result in an increase in heavy rainfall, and hence floods and maximum wind speeds, triggering cyclones; and increasing the length, frequency and intensity of warm spells, leading to heat waves and droughts. An associated mean sea level rise, glacial retreat and permafrost degradation may increase coastal flooding, slope instabilities, mass movements, glacial lake outburst floods and so on (IPCC, 2007). According to Swiss Re (2013) flood risk threatens more people than any other natural catastrophe, since most major cities developed along the sea or waterways. Without any adaption measures, mean annual losses are predicted to reach more than USD 1 trillion by 2050[6] (Hallegate et al., 2013). For example, according to the Greater London Authority (2009), 15 % of Greater London has some extent of known tidal and/or fluvial flood risk. Figure 1.15 depicts the projected exposure of urban population to cyclone and earthquake risks until 2050.

Figure 1.15. **Expected urban population exposed to cyclones and earthquakes, 1970-2050**



Source: Lall S. and U. Deichmann (2009), "Density and Disasters, Economics of Urban Hazard Risk", World Bank, *https://gfdrr.org/docs/WPS5161.pdf*.

StatLink *http://dx.doi.org/10.1787/888933031028*

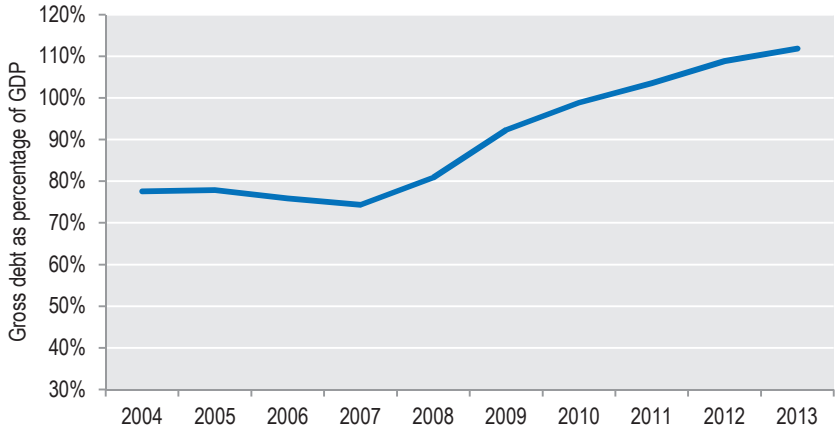
Given past risks and exposure trends and future uncertain shocks, OECD countries need to address existing vulnerabilities, while at the same time adapt to changing risk drivers and continuously monitor, and where necessary invest in measures that increase resilience. However, the current fiscal reality makes it difficult for countries to justify additional investments. The next sections will look at this challenge and will also discuss approaches that can help OECD countries decide on an "optimal" level of risk.

Boosting resilience in a tight fiscal environment

The financial and economic crisis that unfolded in 2008, and which affected all OECD economies, has had a detrimental impact on public budgets, as economic activities slowed down and tax revenue decreased substantially, while demand for public safety net compensations increased. Gross debt[7], has increased from an average 80 % in 2004 to an estimated 112 % across OECD countries in 2013 (Figure 1.16). The fiscal balance[8] was down at nearly 9 % in 2009 (Figure 1.17), whereby the GDP growth average was negative from 2008 until 2010. Economic growth will reduce countries' deficits and debt to GDP ratio in the short and medium term, but will not be sufficient in many countries to overcome current debt dynamics. Further fiscal consolidation[9] may still be needed for some time. It is estimated that OECD countries require an overall consolidation of 3.9 % of GDP to stabilise debt by 2030 (OECD, 2013a).

In such tight fiscal environments disruptive shocks can become more challenging to absorb for public treasuries, especially in countries that rely on state budgets for post-disaster loss financing and where insurance coverage remains relatively low. Since June 2010, Japan has intended to reduce its primary budget deficit of central and local governments. The Fiscal Management Strategy (FMS) aimed to create a surplus by 2020 at latest. However, the programme was severely disrupted by the Great East Japan Earthquake in March 2011, the most expensive natural disaster in Japan's post-war history. The damages from this disaster have been estimated at 3.5 % of the national GDP which do not include the costs of the accident at the Fukushima nuclear plant. The Japanese economy contracted by 0.7 % in real GDP and its fiscal deficit increased to 9.5 % in 2011. As a result of 18 consecutive years of budget deficits and recent disastrous events, gross public debt in Japan rose to 200 % of GDP (OECD, 2012b). The Japanese case highlights that countries that already face economic and public financial difficulties may have to implement measures that could disproportionately affect the economy and a country's welfare in case of a coincidental disruptive event.

Figure 1.16. **Average government gross debt in OECD countries, 2004-2013**

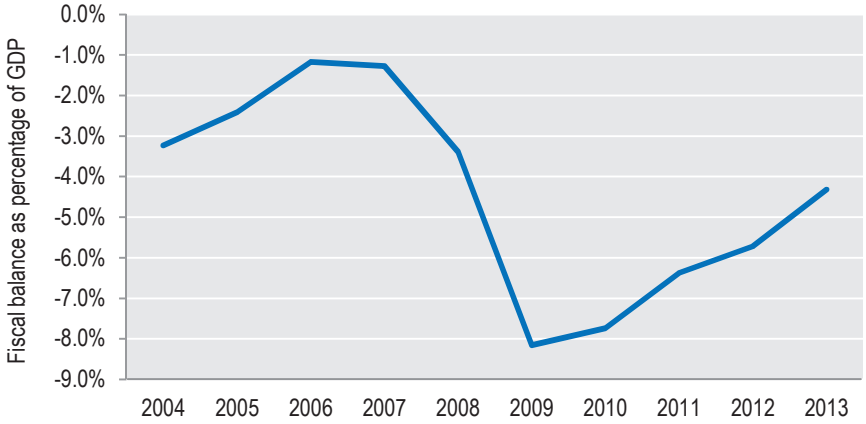


Note: Gross debt is general government financial liabilities as a percent of nominal GDP; weighted averages.

Source: OECD (2013a), "OECD Economic Outlook No. 93", Statistical Annex, OECD Publishing, Paris, *www.oecd.org/eco/outlook/economicoutlookannextables.htm*.

StatLink *http://dx.doi.org/10.1787/888933031047*

Figure 1.17. **Average fiscal balance in OECD countries, 2004-2013**



Note: Fiscal balance is the general government financial balance; weighted averages.

Source: OECD (2013a), "OECD Economic Outlook No. 93", Statistical Annex, OECD Publishing, Paris, *www.oecd.org/eco/outlook/economicoutlookannextables.htm*.

StatLink *http://dx.doi.org/10.1787/888933031066*

Can governments define "optimal" resilience levels? Is there an acceptable level of risk?

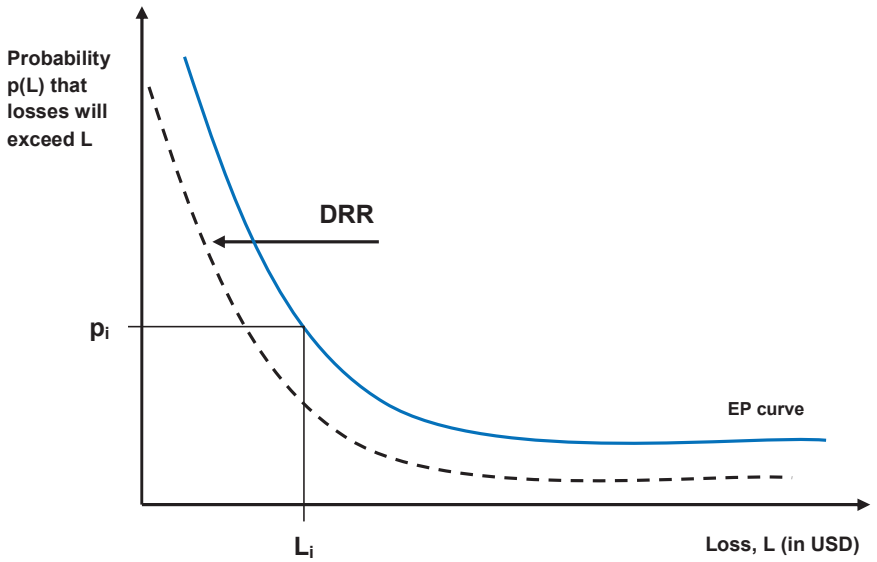
Past disruptive events have triggered debates about whether higher resilience levels could have been achieved to avoid the degree of impact disruptive shocks have had. In some cases, the impacts of past major disruptive events led to legal prosecutions of citizens against their governments for neglecting their responsibility to provide adequate protection levels (such as in Austria after the 2003 floods). The key difficulty of risk management is that it operates under private and public resource constraints. In the case of severe disruptive shocks, it is neither technically nor financially feasible for governments, but also for individual companies or households to aim at achieving a "zero risk" level, as there are usually competing demands and more productive allocation choices for available resources.

Provided that "zero-risk" cannot be feasibly obtained under given resource constraints, the question turns to what level of residual risk individuals and society choose to accept or tolerate. The concept of "acceptable risk" is usually defined as the level of risk a society is prepared to accept without any specific risk management options. The term "tolerable risk" defines the level of risk a society is prepared to live with as long as that risk is monitored and risk management options are taken to reduce it (Bell et al., 2006).

To help individuals and society determine the level of risk they seek to tolerate or accept a number of decision-support tools are available. Technical decision-support tools include cost-benefit or cost-effectiveness analyses, multi-criteria analyses or models such as ALARP (as low as reasonably practicable). Chapter 2 will look at decision support tools more in detail. What all methodologies have in common is to identify the marginal cost of achieving additional levels of risk protection (Manuele, 2010; Liu and Xie, 2008; Gamper et al., 2006; Bell et al., 2006). The methods integrate individuals' preferences, either through prices and hence willingness to accept measures, or through direct preference representation methods, such as through participatory approaches in multi criteria analysis. This allows public decision makers to make trade-offs between competing resource allocation decisions and to determine to what extent they are willing to pay for additional levels in risk reduction. All models usually have an identification of risks in common that are valued against their probability of occurrence and potential damage. Based on that, the cost for avoidance can be calculated.

The standard cost-benefit analysis model is based on the exceedance probability (EP) curve. An EP curve indicates the probability (P) that at least USD X is lost in a given year, where loss in USD is shown on the x-axis and the annual probability that losses will exceed this level on the y-axis. The area under the EP curve is the average annual loss (AAL). Resilience measures are meant to reduce the expected loss and consequently the EP curve will shift to the left reducing the AAL value (Figure 1.18). When comparing different prevention and mitigation measures the most attractive ones have the highest benefit-cost ratio (Hochrainer-Stigler, 2010).

Figure 1.18. **Exceedance Probability Curve**



Source: Hochrainer-Stigler, S. et al. (2010), "The Costs and Benefits of Reducing Risk from Natural Hazards to Residential Structures in Developing Countries", Wharton Risk Management and Decision Processes Center.

A number of countries have established a common framework for determining acceptable levels of risks. In the United Kingdom, for example, the British Health and Safety Executive (HSE) advises on how to determine acceptable levels of risk with regard to work related hazards (UK HSE, 2011). Decision-making on risk management is explicitly based on the criteria elaborated by the HSE (Liu and Xie, 2008). In Iceland, following two catastrophic snow avalanches, acceptable risk levels for snow avalanches and landslides were defined and implemented into national law

(The Ministry of the Environment, 2000 cited in Bell, 2006). Liu and Xie (2008) use this methodology to propose different acceptable earthquake risk levels in China. Based on the size of a city and probable earthquake intensity, they calculate the acceptable level of fatalities and repercussions which would be caused by an earthquake.

Technical frameworks often neglect how other stakeholders go about deciding their acceptable risk levels and hence their individual contribution to increasing resilience. The main advantage of the technical approaches to determining acceptable risk is that it enables administrations and authorities to define acceptable risk levels in a fairly straightforward way. For risk management purposes however, to make effective policies which increase resilience, it is important to understand how other stakeholders that contribute to the overall resilience of society and the economy, make such choices. Only once this is understood can good risk management policies be effective. Two stakeholder groups that are important to look at are individuals and businesses:

- The choice of acceptable risk from an individual point of view is guided by information, of which much is embedded in prices and limited by budgets. People generally undertake prevention up to the point when the expected benefits (avoiding losses) exceed the measures' costs (World Bank, 2010). There is extensive evidence that individual choices of acceptable risk tend to be influenced by different factors that lead to different decisions among individuals with similar budgets, i.e. individuals differ in their risk aversion. In addition, their choices might be biased by distorted prices or inadequate knowledge. Individuals are myopic in the sense that they have short time horizons when planning for the future, especially if they do not expect to benefit, themselves, from the investment. There is evidence that individuals tend to ignore risks with perceived likelihoods falling below some threshold of concern. Many property owners residing in hazard-prone communities have a tendency to dismiss the risk as negligible (Hochrainer-Stigler, 2010).

- Businesses define acceptable risk by choosing between four different strategies to manage their own corporate or supply chain risk exposure, all of which is based on their risk appetite. The first option entails avoiding risk by, for example, pulling operations out of a risk exposed region. The second option includes risk reduction through prevention and mitigation measures. The third choice can be to share risk through risk transfer mechanisms. Finally,

businesses can simply accept all or residual risks (PWC-UN ISDR, 2013).

Once it is understood how many resources governments, businesses and individuals decide to dedicate to increasing resilience, the question turns to what measures they have at their disposal to achieve resilience.

How to achieve "optimal" resilience

Resilience can be boosted through any measure that contributes to increasing the capacity of systems to resist the negative impacts of disruptive shocks and enable a fast re-establishment of the core functions of a system after a disruptive shock. Therefore economic, environmental and social conditions in general influence the level of resilience, such as income, institutions, health etc., some of which will be discussed in the beginning of Chapter 2. What are referred to in this report as resilience measures are concrete measures that directly seek to increase resilience against risks and future shocks. These can include any measures along the risk management cycle, including risk identification and crisis management measures, as well as risk prevention and mitigation measures. Table 1.3 lists the types of risks, their impacts and the options available to build resilience against them. The listed risks, impacts, and resilience measures do not aim to be exhaustive, but rather provide an overview of the options stakeholders have at their disposal.

Measures to increase resilience can have positive effects on other economic sectors. Many of the measures listed in Table 1.3 tackle one single source of risk only, such as vaccines against a contagious disease, or steel nets preventing rocks from falling on settled areas; whereas others can be applied to different risk sources, for example risk awareness campaigns or land-use regulation. Again other measures can have positive spill over effects on other sectors, which is particularly relevant for measures implemented under tight fiscal constraints. For example, the construction of a multi-functional dam or re-forestation to protect human and physical assets against adverse impacts from natural hazards can at the same time serve a recreational purpose, electricity production or greenhouse gas sequestration. Resilience is thereby increased not only by installing a direct risk-reducing measure, but by creating new sources of income and strengthening health and well-being (Box 1.5). Building such multifunctional risk mitigation measures requires the participation of multiple stakeholders from the private and public sectors and can therefore catalyse partnerships between them.

Table 1.3. **Risks, impacts and measures to achieve resilience**

Risk			Impacts	Resilience Measures	
Natural risks	Geophysical: earthquakes, volcano, mass movement (dry), geomagnetic storm	Direct impacts	Losses of human lives, impact on human health	Risk identification and assessment	Multi-hazard risk assessment, multi-stakeholder risk assessment, assessing future risks through scenario planning and other methods
	Meteorological/ climatological: storm, extreme temperature, drought, wildfire		Destruction of physical capital (private and public) and critical infrastructure	Risk awareness measures	Public information campaigns, integration of risk in education curricula
	Hydrological: flood (storm surge, coastal), mass movement (wet)		Destruction of natural capital (natural resources, natural capital stock, natural habitats, animal stocks)	Technical, engineering measures	Dikes, flood gates, rock fall or landslide barriers, retrofitting of buildings, facilities to contain spread of epidemics, elevated roads, back-up and redundant infrastructure
Biological risks	Epidemic, pandemic		Impacts on food and water security	Biological measures	Creation of forests that act as natural barrier, natural dams, flood plains
Technological risks	Cyber threat, nuclear accident, toxic industrial elements (nanoparticles)		Socio-economic impacts (financial market failures, mass migration, demographic shifts)	Socio - economic measures	Liquidity requirements for financial institutions, financial safeguarding institutions (e.g. European Stability Fund), business continuity planning
Socio-economic, geopolitical risks	Financial crisis, terrorism, social unrest	Indirect impacts	Business Interruption (and knock-on effects on bankruptcy, job and wage losses)		Risk transfer instruments (insurance, contingency planning, catastrophe bonds etc.)
Complex risks	Interdependent risks, cascading risks		Reputational costs of businesses and the government		Diversification of supply chains
Unforeseen technological accidents			Increase in diseases, effects on biodiversity	Regulatory, planning Measures	Land-use regulation and planning, building codes, health and safety (e.g. fire, sanitation, air travel) regulation, international agreements on safety standards for industrial and technological risks or risks from terrorism
			Supply-chain, cascading impacts	Health measures	Vaccinations

StatLink http://dx.doi.org/10.1787/888933031142

Box 1.5. **Examples of multifunctional risk mitigation measures**

Multifunctional dams: Cities such as Rotterdam or Dordrecht have launched projects to implement multifunctional dams which mitigate flood risks according to the requirements of the Dutch Water Board and the Rijkswaterstaat while at the same time offer additional services to citizens. Proposed complementary functions include the development of recreational facilities, parking services or roof parks constructed on top of the dams. Another proposed function included the construction of a soil bank that can strengthen existing dams as well as purify contaminated soil or silt. The purified soil can either be sold or applied to the dike system to reinforce its protection against floods.

Smart shelters: Smart shelters are multifunctional facilities which primarily serve as a hospital or a school but that can be transformed into evacuation shelters for before, during or after a disaster. Even though the evacuation function is only the secondary purpose of these buildings, in order to qualify as a smart shelter they need to fulfil all spatial (enough floor space for evacuees) as well as infrastructural requirements (hygiene standards, water and power supply, communication etc.). Therefore the costs to build such smart shelters are estimated to be 22 % higher than regular building costs without evacuation function.

Sources: Blom, E. et al. (2013), "Smart Shelter Strategies – Cost-effective flood preparedness", in Schweckendiek, T. (Ed.), *Comprehensive Flood Risk Management*, Taylor & Francis Group, London; Anvarifar, F. et al. (2013), "Cost-effectiveness study on preventive interventions: a survey of multifunctional flood defences", in Schweckendiek, T. (Ed.), *Comprehensive Flood Risk Management*, Taylor & Francis Group, London.

Resilience measures need constant adaptation and anticipatory governance. As described above, risk patterns evolve over time, as they are in constant interplay with socio-economic, environmental and technological dynamics and changes. Therefore resilience measures need to keep pace and adapt to ever more complex risks whose consequences are difficult to appraise. This is challenging, as the case of the volcanic ash cloud that formed over Iceland in 2010 demonstrated. Experts were confronted with a situation in which they had little understanding about just how much ash is dangerous to an airplane's engine. A precautionary, and very costly, approach was therefore chosen by regulators, which grounded all flights in Europe crossing the affected area. Complex disasters are by definition complex because causal effects are no longer linear and hence difficult to predict, and the consequences are challenging to determine, especially their secondary and spill over effects. Even if some complex risks are becoming better understood, regulations may still be too narrow and unable to adapt to new situations. To overcome a reliance of policy makers and other stakeholders on past events to create informed standards and recommendations, "anticipatory governance" would be useful allowing for more real-time monitoring, and adapting of measures as new information

becomes apparent. The case of the ash cloud demonstrates how this can be done in practice, even if some would say this reaction came too late: regulators worked hand in hand with the airline industry, and after launching test flights, were able to loosen up some of the flight restrictions (WEF, 2012b).

Key policy findings

- **Promote forward-looking risk governance that takes into account complex risks.** In assessing risks and evaluating risk exposure, countries should not only rely on past disruptive shocks, but should take into account evolving risk patterns, including their underlying demographic, economic, technological, and environmental drivers, as well as their inter-dependencies and potential cascading impacts. Forward-looking methods (such as scenario analysis) can support the identification of future, complex risks.
- **Establish a wide understanding of how acceptable levels of risks can be determined at all stakeholder levels.** Identify ways and methods that support the government, businesses, and individual stakeholders to determine their optimal or acceptable levels of risks, based on which risk resilience strategies can be adopted. Ensure the methods and results are published in a transparent way that raises awareness among all stakeholder groups.
- **Decide on an optimal and complementary mix of resilience measures.** Countries should determine a mix of resilience measures that address multiple risks and thereby complement each other, as well as identify opportunities that allow them to promote economic development through positive spill over effects of resilience investments.
- **Ensure resilience measures adapt to changing risk patterns.** Ensure that established resilience measures are adapted at the necessary pace to underlying changes and drivers in risks. Monitoring and evaluation systems for measures and risk trends can help inform such a process.

Notes

1. Events that are reasonably predictable in timing, location and scale (for example an ageing population or climate change) are not considered hazards according to the OECD (2004) but form part of a trend shaping the development and context of hazards. See also definitions in G20/OECD Framework on Disaster Risk Assessment and Financing, *www.oecd.org/gov/risk/G20disasterriskmanagement.pdf.*

2. Some organisations differ in the precise terminology they use and the activities undertaken throughout different phases of this cycle. For example, some organisations include the prediction and early warning of disruptive events as a specific step in the cycle (see the Food and Agriculture Organization or the World Meteorological Organization (FAO, 2004; WMO, 2005), or add the analysis of the distributional impacts of a health or safety threat as part of the risk assessment in the United Kingdom (UK HSE, 2011).

3. The OECD risk assessment work is forthcoming. The OECD crisis management work is summarised in Baubion (2013).

4. Economic losses in the EM-DAT database are defined as direct (e.g. damage to infrastructure, crops, housing) and indirect (e.g. loss of revenues, unemployment, market destabilisation) consequences of a disaster on the local economy, *www.cred.be/emdat*/.

5. Disasters in the CRED database include events where: ten or more people were killed; 100 or more people were affected, injured, or made homeless; significant damage was incurred; a declaration of a state of emergency and/or an appeal for international assistance was made, *www.cred.be/emdat*/.

6. Forecast calculations by the author can be found at *www.nature.com/nclimate/journal/v3/n9/extref/nclimate1979-s2.pdf.*

7. Gross debt entails the general government financial liabilities as a percentage of nominal GDP.

8. The fiscal balance is defined as the difference between government revenues and spending. Fiscal balances include a structural and a cyclical component. A structural deficit arises when a given economy is running at full capacity and the government still spends more than

its revenue. A cyclical deficit occurs when due to an economic downturn the actual output is lower than the potential output of the economy (OECD, 2011b).

9. Fiscal consolidation is defined as concrete policies aimed at reducing government deficit and debt accumulation, e.g. active policies to improve the fiscal position (OECD, 2012b).

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Chapter 2

The role of institutions in boosting resilience to disruptive shocks

A lot has been done – a lot remains to be done to boost resilience against future disruptive shocks. This chapter begins with an evaluation of the strengths and weaknesses of OECD countries in achieving resilience over the past decade. Specifically, it studies 15 of the largest disruptive shocks that occurred in OECD countries to get a better understanding of what worked and what could be improved. A major impeding factor to boosting resilience levels has been the institutional environment, and its ability to incentivise actors to invest in resilience. This chapter will demonstrate that identifying such institutional constraints through political economy analyses can open a tremendous window of opportunity for unleashing stakeholder engagement towards resilience. To guide policy makers in such an analysis the chapter introduces a diagnostic framework and concludes with a discussion of how resilience measures can be financed and agreed upon, in light of competing demands for public resources.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Introduction

A lot has been done – a lot more needs to be done when it comes to boosting resilience against future disruptive shocks across OECD countries. The level of social and economic welfare as well as the development of institutions that foster the creation of them has contributed to a relatively high level of overall resilience across OECD countries. All things equal, disruptive shocks in the past 30 years have had much less adverse impacts on OECD countries compared to lower income countries. Also specific measures employed to increase resilience, such as protective infrastructure or regulatory reforms, have proven very effective. Nevertheless, past disruptive shocks have demonstrated that more could be done to further increase resilience. Gaps have appeared, among others, in protective infrastructure, in particular its maintenance; in regulatory reform that has not kept pace with changing risk environments; or in difficulties in enforcing regulations. The private sector, including critical infrastructure providers, has shown a number of vulnerabilities during past disruptive shocks. In addition, individuals and households have consistently underinvested in protecting their own assets, despite being aware of their exposure to risks. Finally, much greater emphasis could be placed on international collaboration to address shocks that have increasing global consequences.

Institutions matter

Many of the persistent gaps can be explained by stakeholders in government bodies, the private sector or individual households lacking awareness about risks or knowledge about what measures exist to increase their contributions to resilience. Constrained resources have also added to widening gaps between optimal resilience levels and the status quo. However, ineffective institutions have undermined many of the valuable efforts to boost resilience. Institutions influence the way each individual actor decides about whether or not to invest in resilience. For example the decision of an individual household not to build protection against floods around their house may depend on the expectation of the government in doing so for them. A local government decision not to invest in a protective dam may be the result of other neighbouring jurisdictions freeriding on the provision. At the central government level, for example, actors may be reluctant to invest more in resilience, because ex-ante investments are not visible, and hence levels of rewards too low. It is therefore crucial to identify such institutional barriers to reforms for boosting resilience.

How resilient are OECD countries?

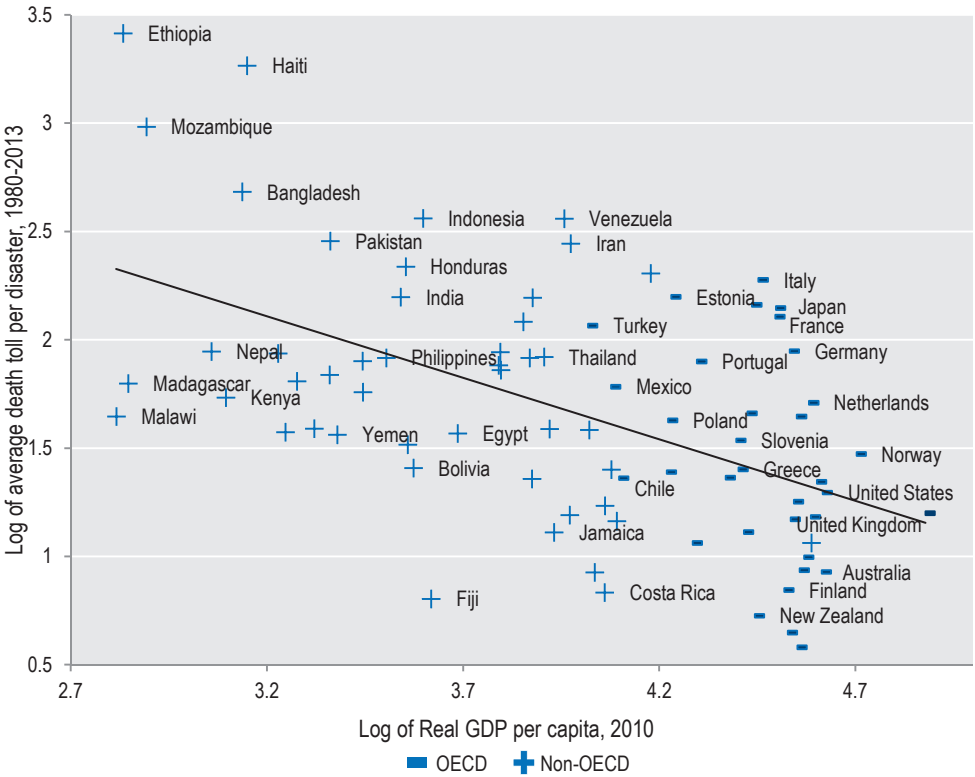
Generally speaking, the level of socio-economic welfare that has been achieved across OECD countries has contributed substantially to their resilience against disruptive shocks. Consistent with results in economic research, OECD countries have shown that income and quality institutions matter for the level of resilience countries have attained against disruptive shocks. High income levels have, over the past 30 years, protected OECD countries from experiencing higher average fatality rates from disasters caused by natural or man-made disasters (Figure 2.1). The relationship in Figure 2.1 presents a broad generalisation that could be caused by a number of other factors. However, Kahn (2005) looks at this correlation more closely and demonstrates that OECD countries have not been exposed to fewer or less intensive shocks than lower income nations, but have nevertheless suffered significantly fewer negative impacts from such disruptions, notably in terms of death rates. In analysing this correlation, Kahn demonstrates that apart from income, institutions play a key role in explaining this trend. All things equal, comparing democratic states with less democratic states, and more unequal nations, the author shows that death rates increase significantly the less democratic and the more unequal societies are. Kaufmann and Tessada (2010) illustrate this relationship by looking at the case of Chile, which suffered a major earthquake in 2010. They show that a lot more fatalities would have been caused by the incident if it had not been for Chile's achievements in good governance and public sector effectiveness.

Resilience, in terms of speed of recovery, is also relatively higher in OECD countries. Whereas in less developed economies it has taken more time to recover and come back to function after a disruptive shock, in more developed economies this process is usually much faster (Figure 2.2).

Single outcome measurements are particularly useful to assess overall performance in terms of the resilience of different countries compared with others. Apart from death tolls or speed of recovery rates, business interruption associated with utility lifeline disruptions (Rose, 2009) have been frequently employed to assess the performance of countries in terms of their resilience. The World Economic Forum (WEF, 2013) has taken this notion a step forward and has advocated for establishing a national resilience rating that would enable Country Risk Officers to benchmark and track a country's level of performance relative to others. However, such outcome measurements of resilience can explain only indirectly what has worked to increase the level of resilience through concrete risk management measures. In order to improve policy making and the effectiveness of measures put in place at different stakeholder levels, monitoring and

evaluation is needed to determine the usefulness and appropriateness of risk management measures that were put in place specifically to reduce vulnerability and exposure to specific risks. This is indispensable for helping countries improve their existing risk management systems.

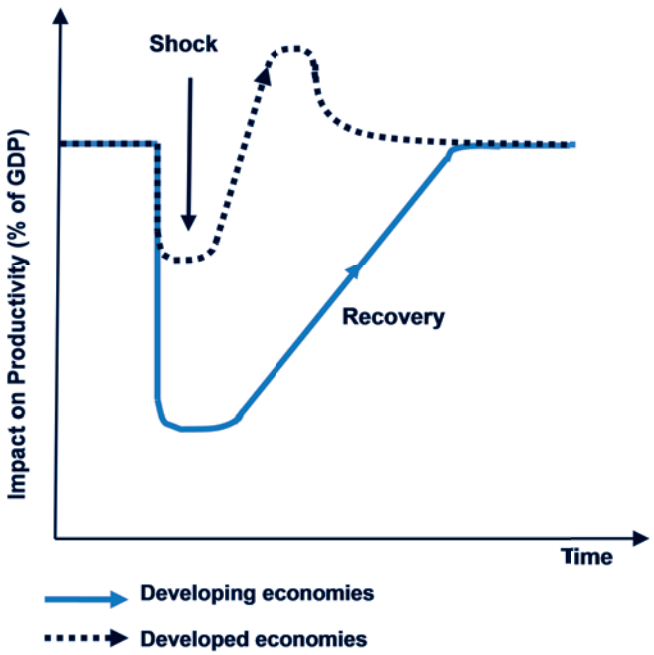
Figure 2.1. **Income and fatality rates from disasters across OECD and non-OECD countries, 1980-2013**



Sources: EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); Heston A. et al. (2011), "Penn World Table Version 7.0", Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, *https://pwt.sas.upenn.edu/php_site/pwt_index.php* (accessed 15 January 2014); OECD (2013d), "Gross domestic product (GDP) MetaData : GDP per capita, USD, constant prices, reference year 2005", *OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en* (accessed 14 November 2013).

StatLink *http://dx.doi.org/10.1787/888933031085*

Figure 2.2. **Impact of disruptive shocks to developing and developed economies**



Source: Ranger, N. and S. Surminski (2013), "Disaster resilience and post-2015 development goals: the options for economics targets and indicators", Policy Paper submitted to The Centre for Climate Change Economics and Policy (CCCEP) and The Grantham Research Institute on Climate Change and the Environment.

To assess ways through which OECD countries can identify opportunities and improve policies to increase resilience against future disruptive shocks, an assessment of the performance of existing measures during past disruptive shocks is useful. This chapter looks at 15 of the biggest disruptive shocks in the past decade (Table 2.1), in addition to the analysis conducted in past OECD risk management works, to assess to what extent OECD countries have proven resilient. We are not only interested in understanding how well the country as a whole proved to be resilient against past shocks but also how its businesses and individual households coped with the adverse impacts. This is why the following analysis distinguishes resilience of the micro (individual), meso (sectoral/business), and macro (government) levels and differentiates measures along a time frame, i.e. immediate response, short-, medium, and long-run resilience measures (Table 2.1). On the government (or macro) level this includes for example the provision of regulatory measures, protective infrastructure, financial or

in-kind aid for affected businesses or households and so on. On the sectoral level (or meso), this includes business continuity capacity to adapt to a supply shock (e.g. in electricity delivery), the continued ability to deliver outputs through for example redundancy measures, and repair or construction of critical inputs and so on. Finally, on the micro level, this corresponds to the ability of households and companies to continue being able to provide their labour and services during a shock, or to invest in retrofitting infrastructure measures.

Sampling and assessment method

For this chapter's review, 15 of the major shocks (Table 2.2) that occurred during the past decade across OECD countries were selected. In selecting the extreme events a mix of both the location and the type of disaster was ensured, including natural hazards (earthquakes, floods, hurricanes, volcanic eruptions, and extreme temperatures) as well as man-made or biological threats (terrorist attacks, oil spills, pandemics). Even though Thailand is not an OECD member country, it was chosen as a case to illustrate complex risks, i.e. how a shock in a non-OECD country can have major impacts on OECD economies.

Table 2.1. **Examples of resilience measures across levels of intervention and over time**

Level of intervention	Timing of measures			
	Immediate	Short-term	Medium-term	Long-run
Macro: Government at different levels	Provide shelter	Provide temporary housing	Revise building codes	Build protective infrastructure
Meso: Sector/business	Use redundancy and back-up measures; input substitution	Temporary relocation of production	Import substitution, production recaptured	Permanent location
Micro: Households	Move to upper floors; temporarily relocate	Damage assessment	Reconstructing damaged assets	Purchase insurance; build back better, seek information about risk exposure and measures to increase resilience

Source: Rose, A. (2009), "Economic Resilience to Disasters", *Published Articles & Papers*, Paper 75, CREATE Research Archive, *http://research.create.usc.edu/published_papers/75*.

StatLink *http://dx.doi.org/10.1787/888933031161*

Table 2.2. **Selected disruptive shocks for assessing past resilience of OECD countries**

	Event/Type	Year	Country	Economic Damages (in USD billion, constant prices 2010)[1]
1	Great East Japan Earthquake	2011	Japan	203.5
2	Chile Earthquake	2010	Chile	30
3	Canterbury Earthquake	2011	New Zealand	14.1
4	L'Aquila Earthquake	2009	Italy	11.7
5	Thailand Floods	2011	Thailand	44.2
6	UK Floods	2007	United Kingdom	5.6
7	Central Europe Floods	2002	Central Europe	37.2
8	Hurricane Katrina	2005	United States	107.1
9	Hurricane Sandy	2012	United States	47.5
10	Eyjafjallajökull Volcanic Eruption	2010	Iceland	3.6
11	9/11 Terrorist Attacks	2001	United States	26.2
12	2011 Norway Attacks	2011	Norway	0.133
13	Heat Wave	2003	Europe	15.4
14	Deepwater Horizon Oil Spill	2010	United States	11.8
15	H1N1 Pandemic	2009	First cases reported in Mexico	9.9

Note: Price index from the OECD Stat consumer prices MEI and currency exchange rates from 05.01.2010 were taken from *www.imf.org/external/np/fin/data/rms_mth.aspx?SelectDate=2010-01-31&reportType=REP*.

Source: See Annex A for details on cost estimates.

StatLink http://dx.doi.org/10.1787/888933031180

Key achievements in resilience across OECD countries

As outlined in Chapter 1, OECD countries have experienced a large number of disruptive shocks that presented governments with many challenges, threatened many citizens' lives, and disrupted the activity of small and medium-sized businesses and transnational corporations. Large critical infrastructure also experienced devastating impacts. Nevertheless, past major disruptive shocks have contributed to increasing resilience across OECD countries through improving the understanding of risk, prevention and mitigation, as well as preparedness and emergency response.

Central government co-ordination has been part of a number of successful policies to increase resilience in most OECD countries.

Addressing critical risks across OECD member countries requires support from the highest political level, but equally an engagement for managing risk reduction across all governmental sectors and territorial levels, including local communities. This requires strategic frameworks, incorporating and co-ordinating strategy, capability, and governance to enable risk-informed policy making related to major disruptive events. Looking at the latest Hyogo Framework for Action (HFA)[1] progress reports[2], risk reduction is overseen by the Centre of Government (mostly the Prime Minister's Office) in four OECD countries and central co-ordination is assured in most others, often located in the national civil protection departments (Table 2.3) (OECD, 2013c).

The mainstreaming of risk management policies across sectors, through strategies, and administrative levels is making progress throughout OECD countries according to the HFA instrument. Nearly all OECD member countries that initiated inter-disciplinary reviews of progress in integrating risk management in public policy and investments systematically consider disaster risk in sectoral public investment strategies and planning (Table 2.4). The Australian national strategy for disaster resilience, for example, is endorsed by the Council of Australian Governments (COAG) and overseen by all States' Emergency Management Ministers. The commitment to the national disaster resilience strategy by leaders across governments, private sector and the non-profit sectors helps to implement resilience across sectors (Australian Government, 2012b). The importance attributed to the local level is reflected by the fact that 86 % of OECD countries have established a legal framework for local responsibilities and that almost two-thirds of OECD member countries have established risk sensitive regulation in land zoning and private real estate development.

Table 2.3. **Responsibility for risk management co-ordination across OECD countries**

	Responsibility for risk co-ordination is situated in :
Prime Minister's Office	Australia, France, New Zealand, Turkey
Central planning and/or co-ordinating unit	Chile, Egypt, Greece, Japan, Korea, Norway, Poland, United Kingdom, Switzerland
Civil Protection Department	Australia, Finland, France, Italy, Norway, Portugal, Slovenia, Sweden
Environmental planning agency	France, Switzerland
Ministry of Finance	France

Sources: OECD (2013c), *Government at a Glance 2013,* OECD Publishing, Paris, *http://dx.doi.org/10.1787/gov_glance-2013-en,* Data extracted from the HFA progress reports[3] published on: *www.preventionweb.net/english/hyogo/progress/?pid:3&pil:1*; HFA (2013a), "Hyogo Framework for Action Progress Reports", UN ISDR, Geneva, *www.preventionweb.net/english/hyogo/progress/.*

StatLink *http://dx.doi.org/10.1787/888933031199*

Table 2.4. **OECD countries integrating disaster risks in public policies**

HFA indicator	Percentage of implementation
DRR integrated in:	
- public investment and planning decisions	96
- national development plan	71
- sector strategies and plans	92
- civil defence policy, strategy and contingency planning	75
National multi-hazard risk assessment with a common methodology	71
Regional or sub-regional risk assessment	83
Protocols for trans-boundary information sharing	92
Social safety nets for risk prone households and communities	88
Investments in:	
- vulnerable urban settlements	92
- retrofitting infrastructures	71
- drainage infrastructure in flood prone areas	96
Risk sensitive regulation in land zoning	71
Post-disaster programmes incorporate and budget for resilience investments	71
Cost Benefit Analysis (CBA) in design and operation of major development projects	83
Future disaster risks considered in scenario development	88
Risk scenarios integrate climate change projections	71
Preparedness plans regularly updated	83
National contingency and calamity funds	88

Source: Data extracted from the HFA progress reports published on *www.preventionweb.net/english/hyogo/progress/?pid:3&pil:1*; HFA (2013a), "Hyogo Framework for Action Progress Reports", UN ISDR, Geneva, *www.preventionweb.net/english/hyogo/progress/*.

StatLink http://dx.doi.org/10.1787/888933031218

In comparison to the challenges faced in lower income countries, the level of risk awareness and information sharing is relatively high in OECD countries. Risk awareness has been fostered through public campaigns and integration of risk management tenets in the standard curricula of primary, secondary and tertiary education institutions. Ninety-six percent of OECD countries which participated in the HFA progress reports indicated that their risk prone communities are well informed about impeding disaster events. Furthermore, the overall risk awareness of the public has been enhanced in 22 out of 24 reporting OECD countries through the installation of a public disaster information system. For example, the state of Saxony in Germany

shows a very good practice example for boosting public information and risk awareness through an easy to access information system available online (Box 2.1). The incorporation of resilience in the national scientific applied-research agenda in 88 % of OECD countries has fostered the creation of a culture of safety and resilience at all levels. Risk awareness and information has also largely facilitated the improvement of emergency preparedness measures: early warning systems have allowed warnings to be transmitted effectively to affected communities that, in turn, generally know how to act upon them.

Box 2.1. **ZÜRS – an easy to access public risk information system**

In 2012, the Ministry of Saxony, as part of a state-wide risk awareness campaign, co-operated with the German Insurance Association (GDV) to create an online risk information system called *Zürs Public*. The system is based on "Zürs Geo", developed by GDV, which is a geographical information system that calculates the risk of flood, backwater and torrential rain in an exact geographical location. This database includes more than 20 million address co-ordinates and covers 200 000 km of rivers with spatial data and flood data from more than 200 public water plants. On the website of *Zürs Public* (*www.zuers-public.de*) users can receive information about risk exposure of their own building. The initiative took off during the 2013 floods in Germany where more than 100 000 visitors visited "Zürs Public" during the month of June. To further increase government transparency, Saxony decided to make information public on applicants and recipients of damage compensation. This practice raises awareness of public disaster compensation expenses and creates pressure to increase efficiency. The concept of *Zürs Public* is now being extended to Lower-Saxony and Bavaria.

Sources: GDV (2013), "ZÜRS public – Naturgefahren per Mausklick erkennen", Gesamtverband der Deutschen Versicherungswirtschaft, *www.gdv.de/2013/06/zuers-public/* (accessed 31 October 2013); Socher, M. (2013), "Flood Risk Management and Risk Governance: Aspects of Risk Management under Pressure", presentation submitted to the OECD Expert Meeting on Risk Prevention and Mitigation, Paris, *www.oecd.org/gov/risk/governingeffectivepreventionandmitigationofdisruptiveshocks.htm.*

Past disruptive shocks: an insight into persistent hurdles for scaling-up resilience

Even though the relative level of resilience is high in OECD countries, as demonstrated by the results in the HFA reports above, past disruptive shocks have highlighted a number of persistent gaps. Gaps appear at all levels of resilience interventions, across levels of government and sectors and individual households. They are also not confined to ex-ante or ex-post measures but emerge in all phases of the risk management cycle. In what follows, the sample of shocks in Table 2.2 will be used to first assess existing gaps and secondly to try to understand why they have persisted. Much of the gaps can be explained by insufficient levels of risk awareness

and of knowledge about measures that can increase resilience. But, as will be shown, there are a number of political economic barriers that once unleashed may be a very cost-effective opportunity to increase resilience.

Macro-level (government) gaps

The contribution of governments to resilience is especially needed where markets would otherwise fail to produce the desired outcomes and where businesses and individual households would not engage their resources voluntarily. As the World Development Report (World Bank, 2013) states, a number of risks are inherently collective: financial crises, the cascading effects of localised disasters (as described in Chapter 1) or simply any large scale disaster that goes beyond the scope of an individual household or business to manage. Instead, government intervention and international collaboration are called upon to respond to disruptive shocks and create an enabling environment for other actors to engage. In the following sections some of the gaps that became apparent in the provision of both soft measures (i.e. enabling factors such as regulations or emergency preparedness) and hard measures (i.e. infrastructure) will be highlighted:

Regulatory gaps

With regards to regulatory frameworks to address existing risks several issues persist across OECD countries. Negative regulatory spill over effects, enforcement problems as well as the pace of ever evolving risk patterns remain a significant challenge:

- **Negative regulatory spill over effects:** Low insurance coverage that was made apparent during Hurricane Sandy in New York in 2012 was due to a lack of awareness caused by public risk assessments. Half of the residential units affected by Sandy were outside of the Federal Emergency Management Agency's (FEMA) 100 year return flood projections, so property owners were not required to purchase insurance. Mortgages backed by the Federal government require such coverage only for buildings in the 100 year return floodplain (City of New York, 2013).
- **Omnipresent enforcement issues**: In Italy, the 500 000 citizens that have settled in the high risk area around the volcano of Vesuvius is a result of failure in land use planning and enforcing existing building codes (OECD, 2010). Another issue Italy is facing is the deficiencies of its national cultural heritage buildings that do not comply with today's building standard (HFA, 2013b). In Mexico, 60 % of new buildings constructed since 2011 are built illegally, with most of them likely in non-compliance with existing

building codes (OECD, 2013b). In the United Kingdom, 11 % percent of new homes have been constructed since 2000 in flood prone areas. In the absence of a formal requirement, little existing guidance in flood resilient construction for developers has been implemented (Pitt, 2008).

- **Updating regulatory frameworks for safety**: In many areas regulatory frameworks have not kept pace with changing risk and vulnerability patterns. In Italy, following the earthquake of L'Aquila in 2009, the building performance assessment revealed that 10-20 year old buildings exhibited unsatisfactory performance, mostly because seismic codes were not sufficiently adapted to ensure modern safety needs (OECD, 2013a). Inflexible regulatory frameworks were at the heart of discussions of impacts that could have been avoided during the formation of a volcanic ash cloud stemming from the eruption of the Eyjafjallajökull volcano in Iceland in 2010. Due to prior neglect in adjusting existing regulation – one that applied a precautionary 'avoid at all costs' rule - significant losses were accumulated by the aviation industry that could have been avoided otherwise. (Sammonds et al., 2010). After the earthquake in Chile a global blackout in electricity led to discussions about introducing regulations for increasing network reliability, however that would increase the already very high prices for electricity in comparison with other countries (Araneda et al., 2010). Finally, following the earthquake in New Zealand, difficulties arose in land titling after the earthquake caused a series of landslips, among others due to liquefaction. The average shift was around 1 metre, but also reached up to 3 metres. A lack of legal prescriptions for such situations impeded surveyors from re-establishing boundaries (Smith et al., 2011).

Gaps in emergency preparedness

Despite relatively sophisticated emergency response systems, major disruptive shocks have brought significant shortcomings to light in several OECD countries, especially related to co-ordination and capacity gaps among responsible stakeholders:

- **Co-ordination gaps:** During the Chile earthquake unco-ordinated interactions between central and local government actors resulted in communication gaps. Pre-established central-local co-ordination chains were disrupted by the destruction of local government buildings as was their capacity to function (World Bank Institute, 2012). In Japan, local governments are the first responders in

emergencies. However local government facilities were completely destroyed during the GEJE, leaving them without capacity to respond (World Bank Institute, 2012; The Regional Spatial Strategy Council for Tohoku, 2012). The same was true for Hurricane Katrina in the United States. Crisis management relies on the local levels to be the first responders, in the absence of which co-ordination becomes a major challenge (The White House, 2005). The terrorist attacks in Norway in 2011 provide another example of failed communications, in which the police operation could have intercepted the terrorist earlier, had orders been accordingly transmitted to the police guard nearby the disaster (NOU, 2012). The 2007 floods in the United Kingdom revealed significant shortcomings in the clarity of roles and the co-ordination across different local actors resulting in an impediment to effective flood management (Pitt, 2008).

- **Capacity gaps:** The Chile earthquake revealed gaps in issuing and communicating emergency warnings, with unclear alarm signals being sent and no one single mass communication channel. The reliance on internet and telephones to communicate alerts was made impossible as both systems of communication had broken down. It was therefore impossible to communicate warnings to all the affected areas about the ensuing tsunami (Kaufmann and Tessada, 2010). A similar challenge surfaced during Hurricane Katrina where emergency call centres were debilitated and three million customers were left without phone service (The White House, 2005). During the GEJE, the government failed to deliver appropriate warnings to communities, despite the existence of sophisticated risk assessment and early warning systems. As a result, many people that had to evacuate were caught in traffic jams and captured by the ensuing tsunami (World Bank Institute, 2012). Finally, the H1N1 pandemic revealed a lack of diagnostic lab capacity, which increased the number of severe cases that resulted in higher fatality rates (OECD, 2011).

- **Law enforcement gaps during emergencies:** Problems in re-establishing law and order in the immediate aftermath of disasters can be observed across the OECD. Looting occurred in Chile after the earthquake (Pina et al., 2012), as well as Hurricane Katrina in 2005 because of ineffective law enforcement in the immediate aftermath of the disruptive events (Kaufmann and Tessada, 2010).

Infrastructure gaps

Though high levels of infrastructure (both critical and non-critical) resilience were proven during past disruptive shocks, they nevertheless highlighted the difficulty in determining the optimal resilience of infrastructure i.e. the physical and economic limits to building resilience into infrastructure measures:

- **Issues of likelihood estimations:** The recent floods in Central Europe in 2013 saw a number of protective measures unable to withstand the impact of the shock, breaking a number of dikes and causing dams to burst. This highlighted the fact that the calculated impact the infrastructure was supposed to withstand did not include such worst case scenarios. The Great East Japan Earthquake (GEJE) saw 190 km of its 300 km long dike structure along the coast destroyed, with the tsunami twice as high as the dikes were estimated to withstand (World Bank Institute, 2012). Similarly, the Canterbury earthquake that struck New Zealand in 2010 caused NZD 2 billion in damages to public infrastructure in Christchurch, including roads and bridges, retention walls, underground water and waste pipes, exceeding previously envisaged potential damage scenarios (Australian government, 2012a). The underestimated impacts of the earthquake and ensuing tsunami in Chile in 2010 severely damaged public infrastructure, destroying entire hospitals and severely damaging the Pan American Highway, including some of its major bridges (ECLAC, 2010).
- **Issues of maintenance**: Austria has built a significant stock of protective measures against natural hazards, amounting to an equivalent stock of EUR 6 billion in permanent structural prevention stock. The challenge and potential hazard for Austria, and many other OECD countries, now lies in ensuring the structures are properly maintained and operated to actually serve their purpose in the event of a disruptive shock (Pichler, 2013). While the construction is usually ensured or a large proportion paid by the central government, local administrations are charged with operations and maintenance (O&M). Their financial capacity is often too weak to ensure an optimal O&M level.
- **Issues of adapting infrastructure to the pace of legislation:** There have also been damages to infrastructure and houses because of building codes were not implemented fast enough: the GEJE triggered landslides that had an impact on many residential buildings, albeit an initiative to retrofit the affected houses to withstand such an impact had already been in place (World Bank

Institute, 2012). In Germany and Austria, many lessons that had been learned during floods a decade ago and policies and measures that were decided on accordingly, were not yet fully implemented by the time the floods struck again in 2013.

Challenges in international collaboration

Despite the demonstrated need for international collaboration to increase resilience, little progress has been made largely due to political, economic and technical capacity differences.

- **Diverging capacity levels:** Different capacity levels have been a major obstacle to successful international collaboration. For optimal flood risk management to take place across border, for example, standardised flood hazard maps would be needed. In the case of the International Commission for the Protection of the Danube River, countries with significantly different levels of technical capacities have experienced difficulties in aligning technical standards (Zavadsky, 2013).
- **Incentives for information sharing**: Comprehensive data exchange between collaborating countries and involved stakeholders is essential for managing resilience. Many countries or private stakeholders withhold their data for reasons of national security or for business reasons. In 2007, the Ministry of Health of Indonesia decided to temporarily withhold its virus samples from the WHO in protest against the collaboration with commercial companies that produced vaccines which were not made available to developing countries due to heavy stockpiling by developed countries. The WHO recognised the need to create equal incentives for all collaborating countries in order to maintain the steady exchange of information and committed to mobilising finance resources for fair influenza vaccine provisions (Morris, 2007).
- **Need to emphasise financial benefits**: Reluctance to finance international collaborative projects to increase resilience along a hazardous zone can stem from insufficient promotion of the benefits of international partnerships. Regional co-operation can significantly reduce costs for resilience. Studies conducted by the South Eastern Europe Disaster Risk Mitigation and Adaptation Program in 2007 demonstrated that by implementing regional co-ordination within National Meteorological and Hydrological Services in South Eastern Europe, a cost reduction of 30 % could be achieved (WMO, 2012).

Business and sector (meso level) gaps

Business continuity planning

A key measure that increases the resilience of individual businesses and sectors against disruptive shocks is business continuity planning, which includes redundancy measures, back-up suppliers, etc. During recent shocks it was made apparent that more could be done to increase business resilience against shocks:

- **Persistent under-investment in business continuity:** The Great East Japan Earthquake (GEJE) caused nearly 700 businesses to go bankrupt, most of them located outside of the earthquake-affected region, but connected to directly affected businesses through supply chains. In terms of business continuity plans, only 40 % of large companies and 12 %, of medium-sized businesses had one in place when the event occurred (World Bank Institute, 2012). For the businesses that had such plans in place, in many cases these were proven ineffective because the potential extent of impacts a shock could cause were underestimated; or because the plans' actions were not clearly communicated to all implicated workers. In the United Kingdom, the number of businesses that were affected by the 2007 floods suffered an average business interruption of 8.75 days. A survey revealed that 90 % of affected businesses were underinsured and 41 % had no business continuity insurance at all. The same study found that seven out of ten small businesses would go bankrupt in the United Kingdom if they experienced a major emergency in their first year of business (Pitt, 2008). A survey among large global companies revealed that 23 % of them do not include their entire supply chain in business continuity planning, thus potentially undermining such efforts all together (The Economist, 2012).

Critical infrastructure

A number of factors were identified in earlier OECD work that help determine the level of resilience of critical infrastructure (Box 2.2). Much critical infrastructure is operated by the private sector in OECD countries. Nevertheless, because the functioning of societies and economies greatly depends on them, there is an element of public-private interface that necessitates regulation to ensure the functioning of lifeline infrastructure during major disruptive shocks. This interface has created critical vulnerabilities. Recent shocks have highlighted the importance of this issue:

- **Significant destruction of critical infrastructure:** The GEJE highlighted that not enough emphasis may have been put on making critical infrastructure resilient. Six out of nine oil refineries were destroyed causing fuel shortages. These large fuel shortages had cascading impacts on the energy demand of heavy machinery and trucks that were needed for the transportation of goods and disaster recovery work (The Regional Spatial Strategy Council of Tohoku, 2012). A similar vulnerability was revealed in nuclear energy, upon which Japan relies for a third of its energy supply. As a result of the earthquake nuclear reactors were shut down, which led to a reduction of 25 % to 50 % in power output. In addition, more than 10 % of earthquake shelters were inundated by the tsunami – in certain locations more than half of existing shelters (World Bank Institute, 2012). Hurricane Katrina destroyed a large number of hospitals, and rendered much of the rest inoperable. This made it difficult for over 200 000 chronically ill patients to have access to their usual medications and sources of medical care (The White House, 2005). In Chile, the 2012 earthquake damaged 130 hospitals, with a number of them entirely destroyed (RMS, 2011). During Hurricane Sandy, all tunnels connecting Brooklyn and Manhattan were flooded along with other important transportation means including several trains and subway lines. Consequently, 5.4 million normal weekday riders were stranded without means of transportation (City of New York, 2013). The summer floods in 2007 in the United Kingdom left more than 350 000 people without access to mains water supply for 17 days (Pitt, 2008).

Box 2.2. **Key elements determining resilience in critical infrastructure**

The following are elements that help define the level of resilience in critical infrastructure:

- *Robustness* describes the ability to keep operating or to remain standing in the face of disaster. In some cases, this entails designing structures or systems which are strong enough to sustain a foreseeable shock. In others, this requires devising substitute or redundant systems that can be brought to bear should something important break down or stop working. It also entails investing in and maintaining elements of critical infrastructure so that they can withstand low probability but high-consequence events.
- *Resourcefulness* describes the ability to skilfully manage a shock event as it unfolds. This includes identifying options, prioritising what should be done both to control damage and to begin mitigating it, and communicating decisions to the people who will implement them. Resourcefulness depends primarily on people, not on technology.

Box 2.2. **Key elements determining resilience in critical infrastructure *(cont.)***

- *Rapid recovery* is the capacity to get things back to normal as quickly as possible after a disaster. Carefully drafted contingency plans, competent emergency operations, and the means to get the right people and resources to the right places are crucial.
- *Adaptability* describes the means to absorb new lessons that can be drawn from a catastrophe. It involves revising plans, modifying procedures, and introducing new tools and technologies needed to improve robustness, resourcefulness, and recovery capabilities before the next crisis.

Source: OECD (2011), *Future Global Shocks: Improving Risk Governance*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264114586-en.*

Supply Chain Management

Global inter-dependencies through international supply chains have increased the risk of contagion, causing local risks to have global adverse impacts:

- **Vulnerabilities of just-in-time business models:** Many businesses have adopted a just-in-time business model to manage their global supply chains in an effort to increase efficiency. Although minimum inventories and lean manufacturing increase profit margins they have also increased the vulnerability and exposure to disruptive shocks. When shocks occur supplies may be cut off, as the substitution of suppliers may be difficult to organise. Recent events such as the Great East Japan Earthquake or the floods in Thailand have highlighted the fragility of current supply chain systems, where the disruption in a critical element of the chain led to the shut-down of entire manufacturing processes (as highlighted in Chapter 1).
- **Increasing complexity of global supply chains**: The number of businesses involved in one supply chain has been continuously rising, which has made the monitoring and management of potential risks and vulnerabilities difficult (WEF, 2012). In addition, an absence of international regulation has diminished the incentives of businesses to monitor risks and increase the resilience of their supply chain.
- **Increasing dependency on air transport**: The just-in-time business model relies heavily on the functioning of transportation systems in general, and more specifically on tight transportation. The volcanic eruption of Eyjafjallajökull in Iceland which led to a formation of an

ash cloud over European air space found that a prolongation of the flying ban for a few more days would have increased the average recovery period of a company from less than a week to more than a month (Lee et al., 2012).

Crisis management

When business crises are poorly managed, the reputational costs or the measures to restore reputation can be extremely high. The Deepwater Horizon oil spill has demonstrated the gaps that exist in managing the aftermath of a major disruptive shock even by large companies. The ill-handling of the immediate aftermath led to the dismissal of the Chief Executive of British Petroleum (BP), the company in charge of the deep-sea oil exploration platform (Cambridge Digest, 2010).

Awareness (micro level) gaps

Significant awareness gaps have been revealed at the individual or household level with regards to risk exposure and knowledge on how individuals themselves can contribute to increased protection against risks. A general shift of responsibility to other actors (e.g. the government) has also been observed. As a consequence, there is a persistently low take-up of existing resilience measures by individuals:

- **Awareness gaps explain individual resistance to take up resilience measures:** Following the 2007 floods in the United Kingdom, a study highlighted that 84 % of affected residents believe there is nothing they can do to better protect their homes in the future, with half of respondents firmly believing that it is not their responsibility to invest in making their homes safer. Even in areas where governments have engaged in a significant effort to overcome the information gap and make citizens in hazard-prone areas aware of the measures that exist to retrofit their properties against potential adverse events, citizens have shown reluctance to take up such measures (Pitt, 2008). In Italy (OECD, 2010) there is wide-spread hesitation to make risk information publicly available due to the fear of inducing unnecessary panic.
- **Low take-up of individual protective measures persists if exposure to risk has been made apparent:** For example, a household survey conducted in Turkey after the major Marmara earthquake in 1999 revealed that only one-fifth of Istanbul's population had taken some preventive action as a result of this event (Fisçek et al., 2002). Similarly, a study conducted after the major floods in Germany in 2002 revealed that 30 % of the directly

affected citizens would still not consider purchasing flood insurance for better individual protection in the future (DKKV, 2003). Hurricane Sandy in 2012 revealed persistent under-investment by individuals (City of New York, 2013).

- **Low take-up of risk transfer products, despite their market availability:** In Germany, only 25 % of households are insured against flood risk. In New York City most of the property owners affected by Hurricane Sandy had no or very low insurance coverage. Even among those in the projected 100 year return floodplain only 50 % of residential buildings had such coverage (City of New York, 2013). In Italy natural catastrophe insurance coverage is equally low, especially for residential property. An estimated 44 % of residential properties have a fire insurance policy, but only 0.4 % of those include earthquake cover (SwissRe, 2008). The table below shows that, apart from New Zealand, the percentage of damages covered by insurance can be relatively low (Table 2.5).

Table 2.5. **Percentage of insured losses in recent major earthquake events**

		Economic losses in USD billion	Percentage of insured losses
11 March 2011	Japan	210-300	12-17
27 February 2010	Chile	30	27
22 February 2011	New Zealand	15	80
6 April 2009	Italy	4	14
23 October 2011	Turkey	0.75	4
4 April 2011	Mexico	0.95	21

Note: Figures are shown true to the year of the event

Source: SwissRe (2012a), "New Swiss Re report reveals low earthquake insurance penetration globally, even in countries with high seismic risk", Swiss Re, sigma No. 2/2013, *www.swissre.com/media/news_releases/nr_20120117_low_earthquake_insurance.html* (accessed 14 November 2013).

StatLink http://dx.doi.org/10.1787/888933031237

Understanding gaps in resilience: Institutions matter

Why do gaps exist?

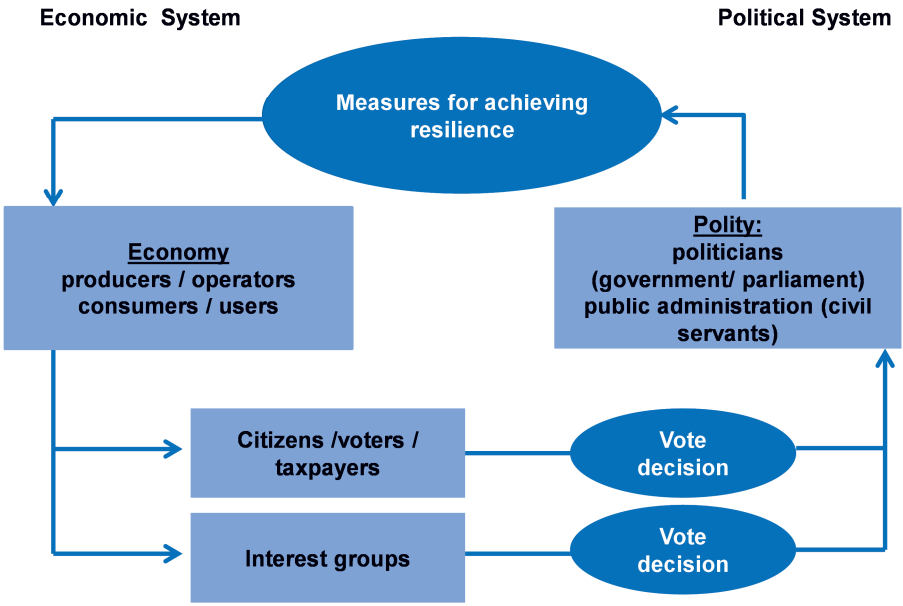
Some of the gaps in resilience outlined in the section above may be explained by an under-estimation of risks or lack of awareness about options

to reduce exposure to them. As demonstrated by the floods in New York City or Germany, investment in higher levels of resilience by individuals and businesses may be impeded by a lack of knowledge about risk exposure and means to reduce it. The high infrastructure damage caused by the GEJE or the floods in Germany was related to a prior under-estimation of risks.

Resource constraints and uncertainty are other impediments that hinder actors from investing more and more effectively in resilience. Generally speaking, in a resource-constrained environment there is a limited amount of budget that governments, individuals or the private sector can and should allocate to managing risks. The current fiscal environment, as discussed in Chapter 1, puts further strain on available financing and makes it harder to justify investments for boosting resilience. The fact that there is a considerable degree of uncertainty regarding the incidence and the level of impact of future shocks makes such investment decisions even more difficult.

However, key obstacles that responsible actors face in boosting resilience have been created by their political and institutional environments. These environments shape stakeholders' decisions in favour or disfavour of investing in additional resilience. Stakeholders' preferences are shaped by their "agency", which is the local government for a bureaucrat for example or the electorate for a national politician. The political economy describes the interactions between political and the economic systems that shape stakeholders' preferences when it comes to investing in resilience (Figure 2.3). For example, the decision of an individual household not to build protection against floods around their home may depend on the expectation that the local or central government will do so for them. A local government's decision to not invest in a protective dam may be the result of freeriding on a neighbouring jurisdiction. At the central government level, for example, actors may be reluctant to invest more in resilience, because ex-ante investments are not visible to their principals (i.e. the electorate), while the costs are immediate (World Bank, 2013), therefore undermining their chances of re-election. A household's decision to not purchase a fairly affordable insurance against a future probable shock may be obstructed by the expectation that the government will pay for eventual damages. A critical infrastructure provider that has a contract with the state to operate a service may rely on the state to provide additional resources to prepare against a shock event.

Figure 2.3. **A simplified institutional model of disaster risk reduction**



Source: Weck-Hannemann, H. (2000), "Acceptance of pricing instruments in the transport sector", Discussion Paper 2000/3, Institute of Public Economics.

Failures in the engagement of actors in resilience that stem from such political and institutional dynamics can be classified as market, collective action or government failures. Market failures occur for example in the risk insurance business when insurers refuse to offer a product because only those citizens or businesses that are particularly exposed to the risk will purchase it (adverse selection), or because customers would tend to display more risky behaviours (moral hazard). Collective action problems may arise for example when some communities' actions to increase resilience have a negative or a positive externality on other communities, which could lead to an under-provision of collective risk protection measures. Finally government failures can arise when government action crowds out other actors' engagement. This can be referred to as "charity hazard", for example when risk affected communities fail to protect themselves in expectation of government compensation in case of a disaster. The EU's solidarity fund or national catastrophe funds are examples of sources of potential charity hazards.

Stronger attention to institutional factors can allow policy analysts to identify opportunities for unleashing investments in resilience by getting the institutional environment right, i.e. enabling actors to take action in favour

of boosting resilience. Such a perspective can help policy makers understand how institutions interact with actors, their interests, and what enables or hinders their co-operation. Past events have shown that a number of institutional constraints have impeded macro-, meso-, and micro-level engagement for resilience. Table 2.6 describes such constraints, as well as identifies opportunities for adjusting the institutional environment to entice actors' decisions in favour of greater resilience investments.

Table 2.6. **Examples of institutional obstacles to boosting resilience**

Political economy obstacle	Example of political economy obstacle	Agent	Opportunity – Emphasise the role of rewards
Government failure (political cycles)	Signalling incentives and political cycles: Political cycles can disincentivise long-term investments in resilience measures as their benefits may be less visible in the short run, or not visible at all within the time of a government's mandate.	Central government actors	Set incentives for governments to obtain rewards for engagements in resilience whose direct benefits may materialise only beyond their political cycle.
Government failure (principal agent)	Signalling incentives after disasters: Frequent changes in legislation induced by past disasters and driven by the need for governments to signal that "something is being done", may lead to rather inefficient uses of available resources.	Central government actors	Make it more attractive for governments to demonstrate what worked well in terms of previously implemented measures during a crisis, rather than to feel obliged to engage in new measures post-event simply to signal that something is being done.
Government failure (cross-government co-ordination)	Overlapping mandates: When informal settlements appear on territory that falls into both federal and local jurisdictions, neither level will take responsibility, which has led to devastating outcomes during disasters.	Central and local government actors	Clarify roles and responsibilities across territorial levels the best and clearest possible way.
Government failure (experts and principal agents)	Disincentivising sound advice under uncertainty: When scientific experts advising governments on risk exposure and on the level of risk reduction and options for reducing risks, are made liable for the consequences of a disaster, experts no longer have an incentive to make adequate assessments (or even engage in such a task), but rather always advise the worst case, leading to inefficient management of resilience.	Scientific experts	Set incentives so to ensure accurate scientific knowledge is taken into account in risk management, without making experts liable for their advice.

Table 2.6. **Examples of institutional obstacles to boosting resilience** *(cont.)*

Political economy obstacle	Example of political economy obstacle	Agent	Opportunity – Emphasise the role of rewards
Government failure	Misaligning incentives with planning responsibility: If local land use planning authorities are not facing sanctions for providing building permits in hazard areas, they may be inclined to respond to the preferences of their electorate and give such permissions in risk prone areas.	Local land use planning authorities (e.g. mayors)	Make liabilities and sanctions more tied to the actual agents in charge of building permits.
Market failure (public-private interface)	No incentive to change for the better: Insurers have often given compensation for rebuilding houses exactly where they were originally built and not somewhere else, hence discouraging the opportunity to rebuild elsewhere or stronger.	Insurance providers, home owners	Governments could subsidise insurance compensations based on efforts to rebuild elsewhere or stronger.
Market failure (public-private interface)	Disincentives for individual insurance take-up: If governments are obliged to assist homeowners in post-disaster recovery and reconstruction, regardless of their insurance take-up prior to the shock, incentives of individual homeowners to invest in ex-ante risk reduction or transfer measures are undermined.	Individuals	Create different rewards for governments to alleviate reliance on inefficient measures that disincentivise individuals to engage their own resources.
Collective action failure	Collective action problems among insurers: Flood risk insurers may not have the incentive to be more exigent in terms of mitigation measures with their clients, as long as other insurances are not. Insurance may render unsustainable.	Private insurance providers	Regulations that would require all insurers to demand clients to invest in additional resilience measures could be an opportunity to make private insurance markets sustainable and increase overall levels of resilience.
Collective action failure (financial incentives)	Resource allocation rules inhibit collaborative project proposals: If funding for resilience measures is decided at the central level, and sub-national governments each seek to obtain the highest possible share of the available funding, scale economies and positive externalities from collaboration between sub-national levels may be undermined, and negative externalities may appear, leading to a potential underinvestment in resilience.	Sub-national government actors	Central funding mechanisms should entail incentives for sub-national governments to collaborate, and to identify and propose joint prevention investments.
Collective action failure (International co-operation)	Disincentives for international co-operation: Similar to local engagement for resilience measures, at an international level countries may have an incentive to free-ride on the provisions for resilience made by other countries.	Several national governments	International agreements and commitments need to be negotiated so as to provide a regulatory framework that incentivises collaboration rather than free-riding.

StatLink http://dx.doi.org/10.1787/888933031256

What can be done to overcome persistent gaps?

There are many ways to address identified gaps in resilience, whereby the gaps that relate to institutional matters may be the most challenging ones to overcome. Addressing shortcomings in risk awareness and knowledge about options and measures that exist to increase resilience are important steps to respond to existing gaps. Identifying and overcoming institutional obstacles may be more challenging, as this requires an in-depth understanding of the motivations and drivers underlying each responsible actor's behaviour. It also requires knowledge about how the context or the governance and institutional environment influence the decisions on whether to invest in increased resilience. This knowledge may not be easily accessible or may be tacit knowledge that can only be understood once a dialogue among all stakeholders is established. However, if such obstacles can be identified they are often a rather cost-effective means for unleashing greater engagement of all actors in favour of increasing resilience.

A diagnostic framework can help policy makers to "get the institutions right" and identify opportunities to adjust the institutional environment so as to facilitate or motivate actors to contribute to resilience. Figure 2.4 proposes a simple framework that can assist in the identification of existing institutional obstacles as well as measures to address them. The framework is built on the articulation of the basic resilience target (i.e. what level of resilience to future disruptive shocks is desired) and the existing level of resilience with respect to the envisaged resilience target. Following this the framework can, based on a set of diagnostic questions, help identify the obstacles that exist to achieving the set targets. It does so by:

- **Analysing the prevailing institutional and governance arrangements:** This step helps policy makers (or analysts) to first map the institutional landscape: mapping of all responsible actors and the tasks they are supposed to carry out with respect to resilience according to existing rules and regulations. This analytical step is completed with an assessment of each actor's capacity and resources to carry out the expected tasks. The latter could be a potential major constraint which impedes an actor from contributing despite his or her willingness to do so.
- **Identifying underlying institutional drivers:** This crucial step requires the elicitation of information that could hamper an actor's contribution to an overall resilience target. It seeks to understand factors such as rents, biases, power relations that are decisive for whether or not an actor decides to engage.

Figure 2.4. **Boosting resilience by overcoming political economy obstacles: A diagnostic framework**

Defining the resilience target

Identifying the gaps in the status quo: Shortcomings in current risk reduction measures

What are the existing gaps at the level of: • Government (*macro*) • Businesses and sectors (*meso*) • Individuals and households (*micro*)	*Evidence of gaps in each category of resilience measures:* • Technical, engineering, biological, socio-economic, planning and regulatory measures • Risk awareness • Risk financing • International collaboration	*Examples:* • Infrastructure has not been adapted at the same pace as regulatory reforms • Building code and land use regulations are not enforced • Business continuity planning is not practiced at the meso-level • Low take-up of individual risk protection measures

Understanding the context

Institutional and governance arrangements and capacities	*What are the associated institutional and governance arrangements and capacities:* • Who is responsible (macro, meso, micro) for providing the different risk reduction measures? • What is each actor supposed to provide? • Does each actor have the relevant expertise and financial resources to carry out the task?	*Mapping of:* • Responsible actors, branches of government, ministries, agencies, private sector actors (insurers), regulatory and planning authorities, critical infrastructure providers, households • Existing laws and regulations • Policy processes (formal rules and de facto) • Policy verification processes and tools (monitoring and evaluation, oversight bodies)

Identifying the drivers

Understanding the political economy drivers	*How can current deficiencies be explained?* • What are the incentives and motivations for each actor's contribution (or lack thereof) to increasing resilience?	*Analysis of:* • Stakeholders: understanding the financial, political, personal, motivations • Incentives for commitments (or lack thereof), collective action, information asymmetries, principal-agent relationships, heuristics and biases, rent-seeking behaviour • Types of relationships between actors and their power relations

Source: Adapted from Fritz, V. et al. (2009), "Problem-Driven Governance and Political Economy Analysis. Good Practice Framework", The World Bank, Washington D.C.

Analytical rigour is required to identify institutional obstacles. The information that needs to be gathered to answer the diagnostic framework questions should be collected in a rigorous and credible way. It should triangulate existing evidence on policies, institutions and actors with an in-depth qualitative and quantitative investigation, such as through structured interviews or focus groups and household or enterprise surveys (Fritz et al., 2009).

Regardless of the existing obstacles to increasing resilience through prevention and mitigation or other risk reduction measures, all actors need to possess a good understanding of the means they have at their disposal to finance such measures. In the following section we will give a brief overview of the challenges governments and other actors are confronted with when deciding not only what level of resources they should dedicate to increasing resilience, but also which portion should go towards financing risk reduction measures (i.e. prevention and mitigation) as opposed to risk transfer mechanisms that provide financing in the event of a disruptive shock (e.g. insurance, contingent liabilities, etc.).

Financing and deciding on resilience measures

Financing resilience

Deciding on risk financing entails making important trade-offs. The disruptions a shock produces have an impact on individual households, businesses, and the public sector alike, and hence all actors have to decide to which degree and how they will invest in reducing risk exposure and to which extent they choose (or are obliged to, given budget constraints) to retain risks. Risk financing can therefore be understood as "the retention of risks combined with the adoption of an explicit financing strategy to ensure that adequate funds are available to meet financial needs should a disaster occur" (OECD, 2012). The following will provide a brief overview of the key strategic elements that need to be decided upon during the development of risk financing strategies. Without trying to be exhaustive, the discussion will focus on what a government needs to decide on and to what extent it can shift responsibility and incentivise other stakeholders to contribute to financing risk reduction.

Governments across OECD countries face three challenges when it comes to designing their risk financing strategies. The first one entails determining the overall amount of resources to be allocated to managing risks, and what risks they choose to retain. The second challenge constitutes the choice of how to finance risks, whereby a myriad of instruments are at the disposal of governments, and each entails different distributional effects.

Finally, to avoid that governments shoulder the entire burden of disruptive shocks, a key challenge also lies in leveraging the engagement of the private sector and individual households to participate in financing resilience measures or investing in individual risk transfer arrangements, and collaborating with other countries to jointly finance risks (Figure 2.5).

The first challenge for a country lies in determining the level of risk financing, which is intimately related with the discussion of the optimal or acceptable level of risk as discussed in Chapter 1. Investments in physical risk reduction measures pay off significantly in the beginning, but will eventually have diminishing returns to investment, in which case retaining or accepting residual risks may be the rational choice for governments (OECD, 2012). Good examples are large-scale infrastructure projects such as the retention walls in Japan. Despite not having withstood the impacts of the Great East Japan Earthquake (GEJE) and the ensuing tsunami, it may not be economically feasible to construct higher retention walls. The same is true for reserve funds (discussed in more detail below) whose marginal contributions may eventually impose opportunity costs that are too high to be justified.

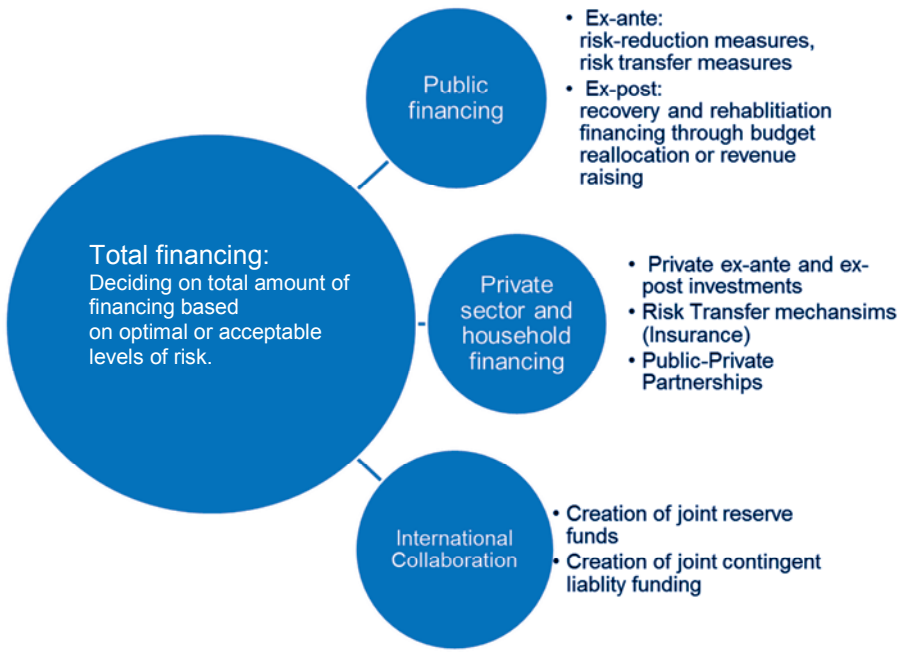
The second challenge for the government lies in mobilising investments by other actors, such as the private sector and individual households. Governments have a key role in facilitating the operation of markets and encouraging the development of tools and arrangements to protect vulnerable populations or economic sectors.

It is also crucial to recognise the limits of what national governments can do to finance shock mitigation. Small island states are too small to diversify their risks. Any shock with an impact of over 100 %, 200 % or 300 % of GDP (such as for example in the Caribbean when major hurricanes occur) would create a liquidity crunch, where the reallocation of budgets is no longer an option. Size, coupled with indebtedness in the case of low income countries, exacerbates this problem necessitating co-operation among states to mutualise risks and risk financing (Ghesquiere and Mahul, 2010). Nevertheless, sharing risks within the European Union has become part of risk financing strategies. The EU Solidarity Fund (EUSF) has been created as a re-financing facility (rather than an emergency response instrument) to assist countries that experience major disruptive shocks. Austria and Germany, for example, benefitted significantly from the fund during the large scale floods of 2002 and 2013, having received over EUR 1.1 billion since the creation of the fund.

For the government, a crucial decision lies in making the trade-off between ex-ante and ex-post investments. The third challenge consists of the choice of risk financing instruments. Broadly speaking, a government has a

choice between financing risks ex-ante, before disruptive shocks occur, or ex-post, i.e. financing the aftermath and the recovery phase. Ex-ante instruments include the creation of reserve or calamity funds, building budget contingencies, transferring risks through, for example parametric or traditional insurances, contingent credit facilities, or catastrophe-linked securities (examples of which can be found in Box 2.3). All of these options are put in place ex-ante before a disaster occurs, but they do not necessarily reduce the exposure of assets or citizens themselves against risks. Therefore, another ex-ante instrument needs to be distinguished, namely ex-ante financing of resilience measures, e.g. protective infrastructure.

Figure 2.5. **A risk financing strategy mix based on a pre-identified resilience objective**



Box 2.3. **Examples of catastrophe-linked securities**

Mexico: As part of its disaster risk financing mix, Mexico introduced the first catastrophe bond issued by a sovereign country in 2006 (CatMex). The bond amount of USD 160 million was used to transfer Mexico's earthquake exposure to international capital markets. In 2009 the country renewed the bond by enlarging its scope to multi-hazards in order to pool risk in different regions of the country and thereby reduce insurance costs. In 2012, the bond was renewed for a third time, increasing both coverage and the amount (USD 312 million). The instrument is based on parametric triggers, including earthquake magnitude and depth as well as maximum hurricane speed measures.

United Kingdom: The first USD 150 million flood bond was issued in the United Kingdom in 2007 for the city of London, but also for other flood prone areas. Albeit low in probability, a rise in the level of the river Thames would be an extremely costly event, given the fact that economic activities around the Thames are a major motor of the country's economy. The instrument is based on a specified parameter, i.e. at least four reference locations in the United Kingdom must be under severe flood warning.

Colombia: Columbia signed a contingent credit line, with the World Bank which offers a traditional Development Policy Loan with a Catastrophe Deferred Drawdown Option (Cat DDO) for an initial USD 65 million. This option provides access to liquidity up to USD 500 million (or the equivalent of 0.25 % of GDP) in the event of a disaster. The "trigger" is the declaration of a state of emergency in the country. Cat DDO's core objective is to provide bridge financing in the event of a disaster.

Sources: GFDRR (2013), "Mexico MultiCat Bond, Transferring Catastrophe Risk to the Capital Markets. Disaster Risk Financing and Insurance Case Study", The World Bank, Washington, D.C.; GFDRR (2011), "Costa Rica Cat DDO: Providing Countries with Rapid Access to Funds after a Natural Disaster", The World Bank, Washington, D.C.; SwissRe (2008), "Disaster Risk Financing: Reducing the Burden on Public Budgets", Focus Report, SwissRe, Zurich.

Deciding on ex-ante financing instruments

The OECD G20 framework establishes a decision hierarchy for risk financing strategies and recommends the following (OECD, 2012): for relatively low risk exposure, i.e. more frequent, lower impact events, a reserve fund that is set aside and drawn upon in the event of a shock is the most efficient instrument (Box 2.4). If risk is higher, contingent credit facilities may be the better option, as it is difficult to build up the needed amounts of financing through an existing reserve. The Austrian reserve fund (Figure 2.6) demonstrates a case when such a fund exceeded its intended capacity. The large-scale floods experienced in 2002 could not be funded with the reserves of this fund and needed a reallocation of budgets. Insurance becomes an indispensable instrument when faced with larger shocks, as it allows for the transfer of risks to insurers and reinsurers whose

business is to pool and diversify risks. Finally for the worst cases and where severe impacts are expected, catastrophe-linked securities are a good instrument, whereby opportunity costs may rise with the size of the risk bearer (Box 2.3). An alternative to the latter could also be index-based GDP bonds that tie interest rates to GDP growth rates and hence allow governments to pay back less debt when a shock occurs (Box 2.5). Ex-ante investments to reduce risks through structural and non-structural measures are a needed complement to other ex-ante financing options, with due consideration given to such investments' diminishing returns.

Box 2.4. **Ex-ante risk financing through a reserve fund: The cases of France and Austria**

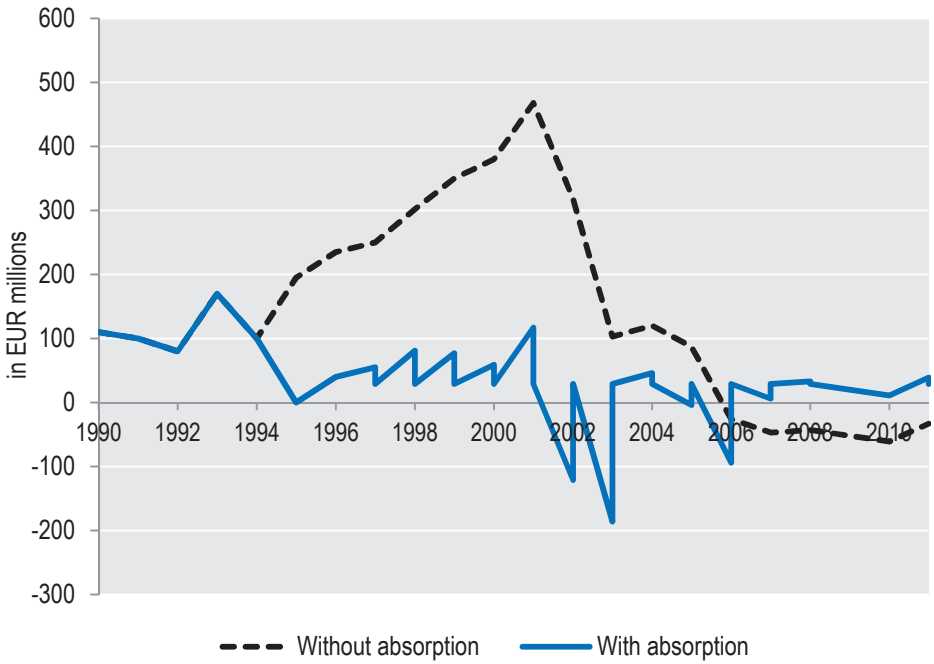
The primary objective of the creation of reserve funds is to avoid having to mobilise and shift budgets from other competing demands for public resources in the aftermath of a catastrophe. Such a reserve fund was created in both Austria and France and has evolved to fulfil several other objectives:

France established a reserve fund in the 1980s, to finance rehabilitation from major disruptive shocks, but also investments in ex-ante risk prevention. It is funded by obligatory contributions from all household and vehicle insurance holders. Initially funds were used to pay the costs associated with an exceptional disruptive shock; however it has recently been called upon for other events that are not exceptional from a technical standpoint. Since the Barnier Law of 1995, the fund has also been used to allocate a certain amount towards prevention investments. This has recently amounted to EUR 180 million annually. Projects concerned include investments in regulating the flow of watercourses, the construction of flood defence systems, protection of housing or the provision of prevention information at a functional level, rather than confined to jurisdictional borders.

In Austria, the Catastrophe Fund ("Katastrophenfonds") was created following a number of disastrous events, starting with an avalanche that occurred in 1951 which necessitated federal help to manage the consequences. The reserve fund was created in 1966. It is financed out of a mix of income, capital and corporate tax, in total 1.1 % of total tax volume annually. It is used to finance damages from disruptive shocks incurred by public bodies. It is also used to finance damages incurred by households and businesses in the case of an exceptional shock. Like in France, the fund is used to finance ex-ante prevention investments. Three-quarters of the fund are used for financing protective measures implemented by the torrent and avalanche service, which has shown to undermine the financial capacity to respond to a disaster.

Sources: OECD (2013c), *Government at a Glance 2013,* OECD Publishing, Paris, *http://dx.doi.org/10.1787/gov_glance-2013-en;* OECD (2014), *Étude de l'OCDE sur la gestion des risques d'inondation : la Seine en Île-de-France 2014*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264207929-fr;* Prettenthaler, F. and N. Vetters (2005), "Finanzielle Bewältigung von Naturgefahren: Vorschläge zur Reform des Österreichischen Modells", *InTeReg Working Paper,* No. 21-2005, Joanneum Research, Graz, Vienna; BMF (2012), "Der Katastrophenfonds in Österreich", Bundeministerium für Finanzen, Vienna, *www.bmf.gv.at/budget/finanzbeziehungen-zu-laendern-und-gemeinden/katastrophenfonds.html.*

Figure 2.6. **The Austrian Catastrophe Fund: The effect of annual absorption of funds, 1990-2010**



Source: Prettenthaler, F. et al., (2014), "Catastrophe Management", in *Climate Change Impact Analysis: The Cost of Inaction*, Springer, submitted for publication.

StatLink http://dx.doi.org/10.1787/888933031104

There are a number of ex-post financing instruments to finance the aftermath of disruptive shocks. Ex-post financing options include budget reallocation, debt financing or borrowing, taxation, multilateral or international borrowing, or international aid. Many past large-scale disasters made ex-post financing necessary, even if ex-ante measures had been in place. The Marmara earthquake in Turkey necessitated an increase in various taxes, including value added taxes (VAT) that increased from 15 % to 17 %. The reconstruction and rehabilitation efforts after the earthquake in Chile were largely financed by permanent and temporary increases in taxes and a number of budget reallocations (see Box 1.3 for more examples). Financially developed countries are found to significantly increase government expenditures after disruptive shocks, by as much as 55 %, unless there is a wide insurance penetration (Melecky and Raddatz, 2011).

Traditionally there has been emphasis on post-event financing, including taxes, reallocation of funds from other budget items and accessing credit (SwissRe, 2008). As many researchers have highlighted, this may be very costly in terms of opportunity costs: the reallocation in budgets can have important negative distributional impacts, just like increasing taxes. Increasing debt may be a costly alternative too, especially if funds are needed in a short period of time. Costly ex-post financing of recovery still takes the lion's share of funding for risk management, compared to ex-ante risk prevention and mitigation financing. Some indicative figures on government expenditure from Colombia, Indonesia, Mexico and Nepal[4] suggest that ex-post spending is up to three times higher than preventative, ex-ante spending (De la Fuente, 2010). Looking at specific country cases and risks, a similar picture appears: The German flood events of 2002 caused an estimated EUR 10 billion in damages, for which a solidarity fund was established that covered almost all of these costs. Yet, in the aftermath, to avoid similar damages, only around EUR 0.5 billion was invested in structural and non-structural measures up until 2013. This relatively low ex-post funding may help explain the similar amounts of damage incurred following 2013 floods in Germany.

Box 2.5. **GDP-indexed bonds to enhance resilience of public finances**

Frequent or large-scale shocks cause a sharp rise in a government's risk rating and hence the interest rates it has to pay on international financial markets. This was the case for Turkish Treasury bonds after the 1999 Marmara earthquake. GDP-indexed bonds link the level of the interest payment to the issuing country's economic growth. Hence the issuing government pays either more or less than the usual borrowing rate when its economic growth deviates from "normal" growth projections. To be eligible to issue such a bond, governments are obliged to pay an "insurance premium" and might need to offer a lower boundary under which the coupon of the bond cannot fall. The advantage of the GDP-indexed bond is that it can enhance resilience of public finances against negative shocks and subsequent debt crises. Lower interest payments during negative macroeconomic shocks ease the pressure for fiscal adjustments and additional borrowing during times of disasters. The downsides of GDP-indexed bonds, however, are the absence of a liquid secondary market; investors' concerns regarding the uncertain character of the financial product; potential moral hazard problems and inaccuracy of national GDP data. Currently there are very little GDP-indexed bonds in the market as most of them are issued during times of debt restructuring and/or financial crises.

Sources: Ahrend, R. et al. (2011), "The Sharing of Macroeconomic Risk: Who Loses (and Gains) from Macroeconomic Shocks", *OECD Economics Department Working Papers*, No. 877, OECD Publishing, Paris, *http://dx.doi.org/10.1787/5kg8hw5467wd-en;*Akgiray, V. et al. (2004), "The 1999 Marmara Earthquakes in Turkey", in OECD, *Large-scale Disasters: Lessons Learned*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264020207-4-en.*

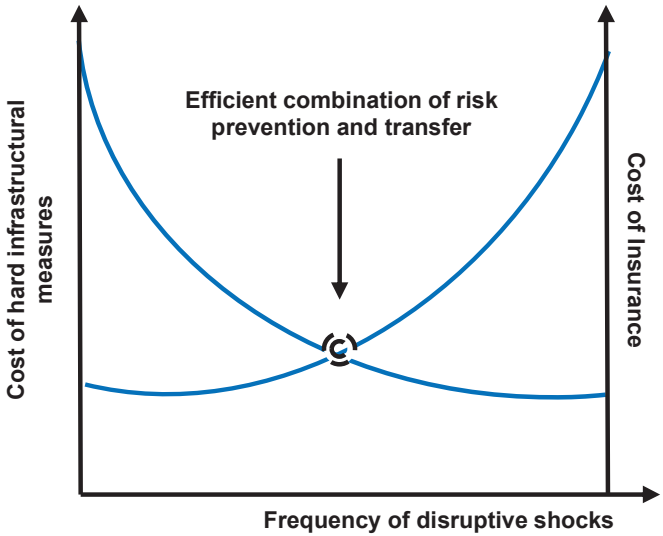
Deciding on which resilience measures to invest in

Policy makers are confronted with complex decision trade-offs when it comes to financing resilience. The decisions they take affect a myriad of different interest groups, from consumers or producers to tax payers, whereby some of them will be direct beneficiaries of a measure and others will not. A number of criteria have to be considered in the decision making process in addition to purely financial ones, including for example, the consequences different alternatives have in terms of technical and scientific aspects; or the impacts on social, environmental or distributional dimensions. For example, if the objective is to protect a flood prone area against future flood events, a possible measure to consider would be the development of retention zones, and thereby the re-allocation of existing settlements and activities. Another alternative measure could be to install public flood defence systems, or to require private retro-fitting measures or risk transfer mechanisms through private insurances. Such decisions will affect private property owners, industry, farmland users, and other communities indirectly both up- and downstream, as well as communities at large that have to co-finance measures that they do not directly benefit from.

There are trade-offs to be made between hard and soft resilience measures. Hard infrastructure and financial risk transfer mechanisms are complementary and can reinforce each other. While insurance caps exist for excessive damages incurred following rare high-impact events, infrastructural prevention measures provide protection from recurrent events and reduce insurance costs due to the resulting lower risk exposure (SwissRe, 2012b). Figure 2.7 depicts the potential trade-off between risk transfer and hard prevention measures on cost-benefit curves. The cost of hard prevention measures declines with increasing frequency and decreasing impact of disruptive shocks while the cost efficiency of insurance improves with decreasing frequency and rising impact of events. Therefore there is an optimal combination of insurance and hard infrastructural prevention measures as depicted in Figure 2.7.

A tight fiscal environment increases the difficulty of making trade-offs and decisions in favour of resilience. As has been shown in the introduction, risk prevention and mitigation measures are generally given less priority, and spending has remained much higher for ex-post financing in the event of a disaster. If the resources become ever more constrained such as in the current fiscal environment it will be increasingly difficult to prioritise risk prevention and mitigation investments.

Figure 2.7. **Illustration of trade-off between hard and soft resilience measures**



Source: Illustration based on SwissRe (2012b), "Shaping a Climate-resilient development", report of the economics of climate adaptation working group, ClimateWorks Foundation, Global Environment Facility, European Commission, McKinsey & Company, The Rockefeller Foundation, Standard Charted Bank and SwissRe, *http://media.swissre.com/documents/rethinking_shaping_climate_resilient_development_en.pdf.*

Zero-risk versus optimal levels of resilience

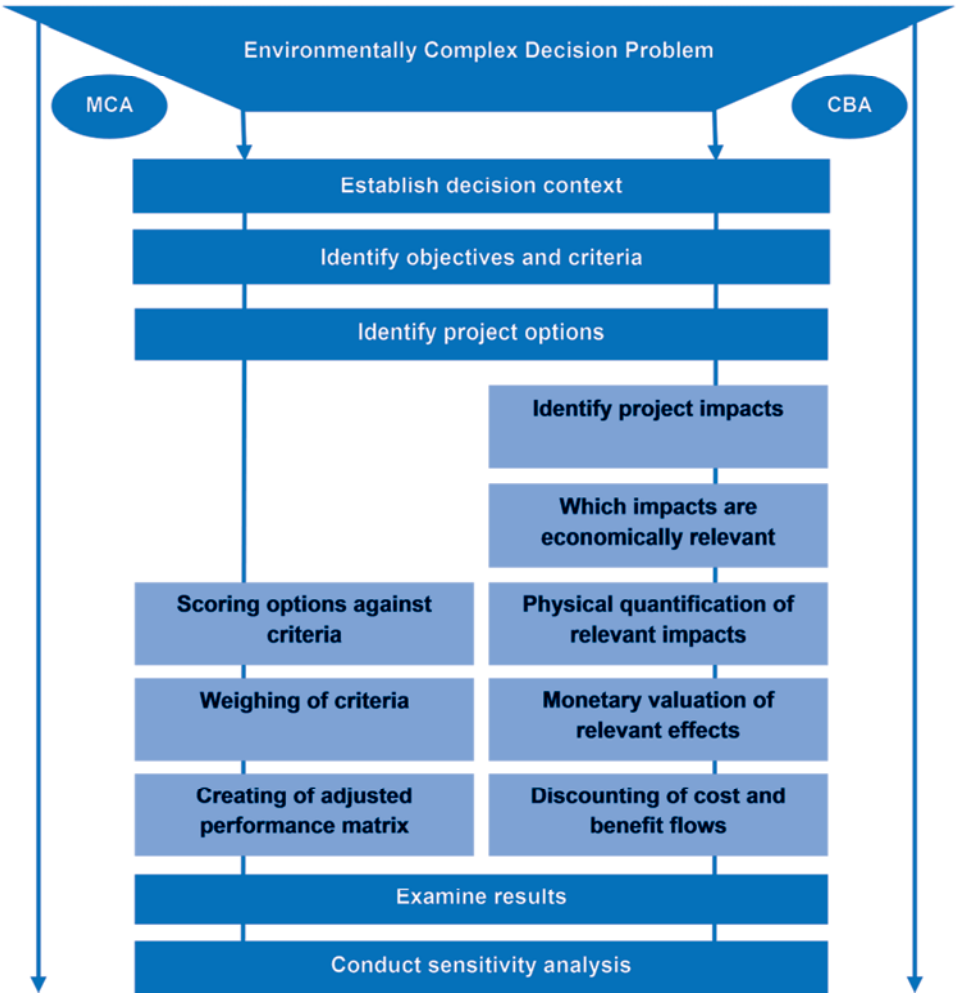
Full protection from disruptive shocks cannot be achieved, as already outlined in Chapter 1, since the opportunity costs of investments at a zero-risk level would be too high, and therefore the allocation of funds towards this level of resilience would be inefficient (Gamper, 2008). Distributional aspects have to be carefully considered when making decisions on resilience investments in comparison to other public spending priorities, adding to the already complex environment that is created when decisions must be made in the face of significant uncertainty.

Decision-aiding tools can support policy-makers in the sense-making of existing problems and complex choices they confront. They enable the comparison and evaluation of costs and benefits of different policy alternatives, measured along a set of criteria, and in different decision contexts. They can aggregate the flows of advantages and disadvantages of decisions, and highlight distributional impacts. A number of instruments have been developed to support policy makers' decisions, and have already

been widely applied in different public policy domains, including, to some extent, the evaluation of decisions on risk reduction investments. Existing instruments all share some common characteristics in the way they support decision makers. Usually the methods include (i) establishing the decision context and supporting the formulation of the decision problem; and (ii) identifying the objectives and the criteria against which the policy alternatives should be evaluated. This step usually involves breaking down an overall policy objective (such as the level of protection one wishes to achieve) into lower levels, such as alternative preventative and mitigating measures. (iii) identifying policy alternatives: methods usually allow for identifying from two to a finite discrete number; of policy options (iv) evaluating the alternatives along different objectives (some of which are monetised); and finally (v) examining results and conducting sensitivity analysis.

Some decision support instruments in a number of OECD countries have become obligatory in evaluating the worth of resilience measures. Among the most frequently used instruments are cost-effectiveness analysis, cost-benefit analysis, or multi-criteria analysis, which follow similar steps (as visualised in Figure 2.8), and mainly differ in the extent to which they harmonise the measurement of criteria in evaluating alternatives. Such instruments have been prescribed for justifying investments above certain threshold levels in a number of OECD countries, such as for example Austria or France.

Figure 2.8. **Comparison of analytical steps in multi-criteria and cost-benefit analysis**



Source: Gamper, C. et al. (2006), "A conceptual approach to the use of Cost Benefit and Multi Criteria Analysis in natural hazard management", *Natural Hazards and Earth System Sciences*, Vol. 6, pp. 293-302.

Key policy findings

- **Promote a holistic assessment of resilience:** In evaluating how resilient a country is against future disruptive shocks, single outcome measures (such as the speed of recovery, days of business interruption, etc.) should be combined with an assessment of the performance of each measure, which is specifically implemented to increase resilience. A systematic assessment of resilience needs to distinguish responsible actors and the provision of measures at the macro (government), meso (businesses, sectors), and micro (households, individuals) levels, as well as include an evaluation of short-, medium-, and long-term measures.

- **Recognise the importance of institutions and political economy obstacles to increasing resilience:** Gaps in the provision of resilience measures are frequently related to low levels of risk awareness and constraints in resources available for investments in resilience. However, these arguments explain only part of the story. It has been demonstrated that a number of shortcomings are rooted in the institutional environment governing each stakeholder's actions or inactions when it comes to resilience. A failure in the institutional set-up has caused government, market, and collective action failures in risk management that have impeded the achievement of higher levels of resilience. Once such institutional bottlenecks are addressed, they present very cost-effective opportunities for boosting resilience.

- **Employ diagnostic frameworks to identify institutional barriers and realign incentives for boosting resilience**: Such frameworks can systematically detect the drivers of existing institutional failures in increasing resilience. Based on a comparison of the current status quo of achievements against resilience objectives, the framework suggested in this report helps identify gaps in each category of resilience measures. The framework guides policy makers through an institutional and governance mapping process to help understand who, in principle, is expected to contribute what, as well as analyse what the underlying drivers are in cases where actors do not contribute their expected share. This framework helps depict the motivations behind such behaviours, the incentives for commitments (or lack thereof), as well as identifies the power relationships between different actors that either facilitate or impede collaboration. Based on this diagnosis, opportunities can be identified for adjusting the institutional environment in favour of

obtaining greater stakeholder engagement towards higher levels of resilience.

- **Promote a complementing mix of risk financing strategies at all stakeholder levels:** To finance resilience against future disruptive shocks, governments, businesses and stakeholders have a myriad of instruments at hand. This includes financial tools to invest ex-ante, for example, in physical and non-physical risk reduction measures, as well as risk transfer mechanisms. It also includes measures to finance the aftermath of a shock, i.e. response, recovery and rehabilitation. Governments and other stakeholders not only must decide on a mix of instruments, but also on the right balance between ex-ante and ex-post investments in resilience, as well as overall commitments in comparison to other, competing demands for public resources. Established decision support tools can aid in making these trade-offs.

Notes

1. The Hyogo Framework for Action (HFA) is the key instrument for implementing disaster risk reduction, adopted by the Member States of the United Nations. Its overarching goal is to build the resilience of nations and communities to disasters, by achieving substantive reduction of disaster losses by 2015 - in lives, and in the social, economic, and environmental assets of communities and countries. The HFA offers five areas of priorities for action, guiding principles and practical means for achieving disaster resilience for vulnerable communities in the context of sustainable development, *www.preventionweb.net/files/1217_HFAbrochureEnglish.pdf*.

2. HFA progress reports can be accessed at: *www.preventionweb.net/english/hyogo/progress/*. Results reported here reflect the latest reporting period (2011-2013). The progress reports are based on a self-assessment undertaken through multi-stakeholder processes.

3. OECD countries that have participated in the 2011-2013 reporting cycle of the HFA Progress reports include Australia, Canada, Chile, Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Sweden, Switzerland, Turkey, United Kingdom, United States and the information on Canada draws on HFA data for the period 2009-2011.

4. It is difficult to make a general assertion on this trend across OECD countries at this point, since data on disaster spending in general, and moreover data distinguishing between ex-ante and ex-post expenditure items, are neither readily available nor easily discerned in general budget items.

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Chapter 3

How to make resilience happen

This chapter highlights a number of measures that governments can take to enhance their own resilience actions and to strengthen the engagement of private and non-governmental stakeholders. Non-action among governmental actors in dealing with existing risks can lead to considerable erosion in trust among their electorate, which in turn undermines the confidence and willingness of other stakeholders to invest in resilience. The chapter demonstrates that policy reforms have often been unleashed by past disasters, however at high costs. Recommendations are given on how policy makers can engage more pro-actively and cost-effectively to reform risk governance policies. This will be done by introducing policy recommendations put forward by the OECD Recommendation of the Council on the Governance of Critical Risks.

Introduction

Chapter 1 discussed the rationale for boosting resilience against future shocks despite the fiscally constrained conditions imposed by the economic environment in OECD countries in recent years. It showed that not just the frequency, but especially the damage potential from disruptive shocks has been continuously increasing over the past years, with various social and economic development factors driving this trend. Even if resources are constrained, investments in resilience are needed, because shocks can cause fiscal balances and debt to become disproportionately difficult for governments, businesses and households to handle during economic downturns. Chapter 1 also highlighted that a high degree of uncertainty undermines good policy making, because rewards for investments in resilience are not immediately visible for government actors, nor directly beneficial to businesses and households.

Chapter 2 assessed the level of resilience OECD countries have attained, as well as critically evaluated the success of measures that were meant to contribute to resilience. OECD countries are relatively resilient against shocks, at least in comparison to other countries, and progress in economic and institutional development has largely contributed to this. Nevertheless, a number of gaps in risk management have impacted the level of damages resulting from major shocks making it clear that there is room for improvement in boosting resilience. Chapter 2 demonstrated that a number of institutional shortcomings exist which hinder the more effective adoption of resilience investments among public and private stakeholders. The strategic drivers behind such deficits can be explained by a misalignment of incentives for actors that have resulted in government, market and collective action failures. The proposed diagnostic framework seeks to support policy makers in identifying and addressing such shortcomings.

From diagnostics to action

Based on the analysis of the previous chapters, this final chapter seeks to highlight a number of measures that governments can engage in to enhance their own resilience actions for and to also strengthen the engagement of private and non-governmental stakeholders. The chapter will first of all show that non-action among governmental actors in dealing with existing risks can lead to considerable erosions in trust among their electorate, which in turn undermines the confidence and willingness of other stakeholders to invest in resilience. The same is true for when government action is overly reactive instead of proactive in terms of prevention and mitigation investments. The chapter will demonstrate that a reactive approach to resilience has often led to inefficient investments, also at higher costs to

society as opposed to ex-ante investments. Blockages to policy reforms have often been unleashed by past disasters, however at high costs to some parts of the population and economic activity. This chapter therefore seeks to recommend governments how pro-active, cost-effective reforms to risk governance policies can be taken by putting forward propositions for the OECD Recommendation of the Council on the Governance of Critical Risks.

The role of trust

Trust in government is put to particular test during a disruptive shock, and is generally lower in many countries following the recent economic crisis (OECD, 2013b). As a result, governments in many countries have been forced to take drastic actions to restore trust. Previous neglect or non-action in terms of resilience that becomes apparent during a major shock often has a disproportionately negative effect on trust in government. The Great East Japan Earthquake (GEJE) has raised serious concerns among citizens on whether the government did enough to foresee and protect citizens against the cascading impacts of the large earthquake on nuclear power stations. The earthquake in L'Aquila in Italy raised concerns among citizens on their level of risk awareness and on the lack of communication by the government on how to improve resilience. Natural disasters are not the only events which have sparked such trust issues. Plane crashes, mass killings (for example the Columbine massacre in the United States), or financial crises have raised similar questions in terms of trust in the government's policies and engagement. In many cases governments had to react with drastic measures to restore trust among citizens. Senior leaders were forced to resign from their functions or government officials and experts were condemned in courts to prison sentences for neglect, or banned from practicing their professions in the future. In none of these cases however, can one single person be blamed, and such drastic measures can be avoided if governments invest more in resilience and communicate these efforts to citizens and other stakeholders more effectively.

Expensive spending measures have been used by governments to restore trust. There is of course a significant need for governmental financial assistance in the aftermath of a disruptive shock. This spending is key to ensure confidence among citizens that the government can handle the situation, but is also crucial for the private sector. After the attacks of 9/11 the United States government injected liquidity in banks, which was an essential measure to restore confidence among bank account holders. However, governments have mobilised and spent significant amounts of resources in ways that have not been very efficient in an attempt to restore trust after a disruptive shock. Building public trust through such measures

after an event has often resulted in large-scale financial support without careful consideration of actual needs (OECD, 2004).

Rather than eroding trust, disruptive shocks can and should be an opportunity for governments to showcase prospective governance based on long-term commitments to protect citizens. Governments have a great window of opportunity to strengthen citizen trust in their ability to prevent or mitigate the negative impacts of large-scale disruptive events by promoting and communicating the efforts they engage in prior to a shock. This may not only help to ensure trust in the aftermath of a disruptive shock, but may equally make investments more attractive and visible. Governments can improve such communication through existing, top-down, information channels, but also through efforts to engage citizens bottom-up through, for example, policy making processes for prevention and mitigation measures.

Recent survey evidence corroborates the importance of transparency and accountability to maintain and increase trust in governments. Generally speaking, factors that have been shown to erode trust in governments are corruption and fraud, and erroneous incentives for driving policies. A recent survey[1] indicated that corruption and fraud explain 50 % of the factors that make citizens trust governments less (Edelman Trust Barometer cited in OECD, 2013b). In turn, positive perception of the transparency of policy making processes is strongly positively correlated to trust. If policy makers want to maintain and increase trust during shocks, the underlying policy making processes and institutions need to be rendered more credible through greater integrity, transparency and openness (OECD, 2013b). The initiative of the state of Saxony (Germany) to make information on risks widely and easily accessible to the public (see Box 2.1) can be seen as a stepping stone in this direction.

To increase transparency and accountability, a more active implication of citizens in the decision making process of policies to increase resilience can be useful. Citizen participation is one way of making the governments' "black box" of decision-making more accessible and transparent. The implication of citizens has been shown especially useful for increasing the acceptance and awareness of investments in resilience against rather uncertain future shock events. Since governments are often held responsible for the negative effects of a disaster, the inclusion of citizens in ex-ante policy making could limit the blame-game that is often observed in the aftermath of a disaster (Gamper, 2008). Renn et al. (1995) explain that participation can, through the creation of forums for exchange, enhance and facilitate "communication between government, citizens, stakeholders and interest groups, and businesses regarding a specific decision or problem".

Finally, to strengthen trust and confidence among stakeholders, governments have to actively manage conflicts of interests. Despite the high degree of uncertainty of future shock events, in many instances governments are aware of existing deficiencies in protection against future possible events (i.e. known "unknowns"), yet reforms have been blocked by interest groups. During the 2006 flood events in Central Europe, a village in Lower Austria (Dürnkrut) was destroyed because protective measures could not hold against the impact of the flood. When it became known that policy makers were aware of the existing under-protection, outrage erupted among the population. The local government argued that protection measures had long been planned, but were not implemented due to the resistance of land and property owners to collaborate on these measures. Similar issues became apparent in the recent large-scale floods in Central Europe. Policy makers and experts argue that many of the protective measures that were decided upon as a result of to the 2002 events were not implemented by the time the 2013 floods hit Austria because of significant resistance among the affected population.

Low-cost, high-return actions to boost resilience

Ensure risk ownership is crucial for boosting resilience

A framework that determines who "owns" a risk, or who is responsible for sharing the responsibility and management of a risk and which also clarifies accountability and liability for damages to third parties, is the foundation to strengthen risk management responsibilities across levels of government and among different stakeholders (such as the private sector, non-governmental actors or individual households). Risk ownership can be fostered by increasing risk communication, raising awareness, engaging in risk dialogues among all stakeholders, and inculcating owners and managers of risks as well as other relevant stakeholders in risk management strategies that span across sectors and levels of governments.

Re-align incentives

The determination of ownership alone may not necessarily change whether stakeholders engage at all in boosting resilience. As highlighted in Chapter 2, the institutional environment is a determinant factor influencing an actor's behaviour. If an actor is aware of owning or sharing a risk, but has little reward or incentive attached to managing responsibilities (e.g. in case of a shared risk there is no incentive to co-operate), a potential under- or over-provision of risk reduction measures may occur as a result. Generally speaking, the higher the complexity and fragmentation in assigning roles for

risk management, the greater the chances are for having misalignment in incentive structures.

Strengthen the role of rewards

To strengthen pro-active engagement in resilience, there is a need to increase the role of rewards. For example, governments' actions are often driven by the occurrence of actual events, rather than a long term vision that identifies opportunities to reduce risk exposure and increase resilience. The rewards attached to long-term investments whose benefits might accrue only over the long term, potentially even beyond an actor's term of office or responsibility, are in many cases very low, which makes them unattractive for some governments. The key priority for policy making should be to cultivate a culture that rewards pro-active behaviour to increase resilience. Such a culture would foster responsible actors who raise issues about shortcomings or gaps in current resilience measures and would create rewards for critical thinking. The management of risks can be compared to a business strategy, where the emphasis is placed on achieving objectives rather than avoiding bad outcomes. On a more aggregate level rewards could take the form of sovereign risk ratings reflecting levels of risk exposure of countries, and maybe even states and sub-national governments. This practice seems currently restricted only to small, relatively risk exposed countries, such as New Zealand.

Facilitate the action of private actors

As this report has demonstrated various market failures can arise when it comes to the private provision of resilience measures. As some share in the costs of increasing resilience has to be contributed by private actors, the government plays a key role in facilitating their engagement. For example, if citizens do not invest in making their homes safer against the impacts of disruptive shocks because they may not know how to proceed, the government can help raise awareness of the options available to protect their homes. Or, if insurers do not provide insurances for citizens and companies against disaster risk because of adverse selection or moral hazard, the government can counteract this dynamic by rendering hazard information public.

Encourage joint action

International collaboration

As highlighted in Chapter 1, disruptive shocks in one country have had increasing global cascading impacts. Similar to national government action,

international co-operation has been very much driven by the exposure and the reaction to disruptive shocks, rather than an ex-ante engagement for increasing resilience. To address the trans-boundary nature of risks, national risk assessments must first of all take into account the potential trans-boundary characteristics of future threats. This in turn necessitates: (i) information and knowledge sharing between different countries; (ii) co-ordination of national initiatives with other countries; and (iii) the development of co-operation agreements. The transfer of knowledge globally from North to South is necessary, but not a sufficient condition for successful management of trans-boundary shocks. Finally, for shocks that can potentially surpass several countries' coping capacity, international risk transfer mechanisms should be established.

Public-private partnerships

Governments can and should collaborate with the private sector, especially where mutual benefits and economies of scale can be achieved. One obvious need for such collaboration arises because businesses are at the heart of restoring the economy after a shock. Another important role is given to the private sector for operating and maintaining public (including critical) infrastructure. The private sector also provides crucial technology for managing risks (infrastructure, technological equipment for assessing risks, etc.), whereby the government can encourage research and development and the creation of such product markets.

Collaboration across governmental sectors and levels

Risks are rarely confined to a community level, and most often span across states and regions within countries. However, roles are assigned as such that actors across jurisdictions, but also between different central governmental sectors, have little incentive to collaborate. Funding is often allocated by jurisdictions and government sectors, incentivising each of them to receive the largest share. In addition, if protective measures are installed in one community, the neighbouring community may enjoy the benefits without having to contribute (see Chapter 2). Governments can overcome these collective action problems by changing the way projects are financed, incentivising joint project proposals, and by regulating the way local risk assessment, prevention and preparedness measures are implemented.

Increase the collection and sharing of risk information and taking advantage of "Big Data"

To make all of the above recommendations operational, the availability of risk information is indispensable. Information is needed not only on the type of risks and the estimations of potential damages, but also about the nature of the activities implemented to prevent and prepare for risks as well as the recovery and rehabilitation after a shock. Governments across OECD countries have largely developed risk assessments and have to a smaller or larger extent engaged in efforts to share available information with relevant stakeholders. However, the knowledge of governments and stakeholders about the existing measures, their functionality, as well as the efficiency of spending on such measures ex-ante and ex-post of a shock is fairly limited. Equally, the triangulation of information that is available on the governmental side with the information generated and owned by the private sector, such as among insurers, has also been limited, except for risk identification and accounting of impacts. For example, when a government decides in the aftermath of a disaster to support the rebuilding of an individually-owned home, it often does not have access to information on the compensation the owner received from other sources, such as insurances. Beyond this, crowding information from web-based sources could also offer some promising options, with "Big Data", to help systematically collect experiences in real time.

Disruptive shocks can enable future resilience

Making reform happen to overcome incentive distortions created by existing governance mechanisms has often been facilitated following large-scale adverse events. Many instances can be shown where past disruptive shocks have acted as trigger events to loosen reform blockages and to overcome existing reform distortions. Marginal changes to building and land use codes are almost always implemented as a consequence of major disruptive events and some examples are listed in Table 3.1. More importantly however, past large-scale shocks have triggered major policy changes that had received wide resistance prior to the event:

- After 9/11 policy changes were made. Most prominently the United States' "Patriot Act" was enacted,[2] a central provision for removing obstacles to information sharing between the intelligence and law enforcement communities with the aim of intercepting and obstructing terrorism (National Commission on Terrorist Attacks upon the United States, 2004). The act was issued 20 days after the attacks, an indication that it had been conceived some time before the event took place. When similar acts were drafted under the

Reagan and Bush administrations their provisions were declared unconstitutional and rejected by Congress, and also saw wide opposition among policy making bodies in the United States (Global Issues, 2002). In addition to the Patriot Act, the United States Department of Homeland Security (United States DHS) was established in 2003, following the elaboration of the Homeland Security Act in 2002. Its main purpose is to protect the American homeland, which includes protection against terrorism, but also the management of federal emergencies, preparedness and response. Its creation was the most significant change in the United States government in over half of a century, bundling together around 100 different responsible public agencies into one single body. In 2011 the DHS was allocated USD 98.8 billion (United States DHS, 2002).

- The United States Union Oil spill of January 1969 on the Dos Cuadras Offshore Oil Field triggered the creation of the United States Environmental Protection Agency (US EPA), the enactment of the National Environmental Policy Act and the California Environmental Quality Act. The Deepwater Horizon incident has led to profound changes in national and international policy, following a six month moratorium on deep-water drilling at the time (Cambridge Digest, 2010).

- The World Conference on Disaster Reduction held in Kobe in 2005, a month after the devastating Indian Ocean Tsunami, was a moment closely watched by the entire global community as answers were sought to the question on how such tragedies could be avoided in the future. The momentum gave way to the establishment of the Hyogo Framework for Action (HFA), a ten year international action framework and commitment (2005-2015) signed by 168 countries that sought to increase resilience against disasters.

- The International Energy Agency, which is today set-up to ensure energy supply and security for its member countries, was founded in 1974 in response to the first oil crisis. This event was preceded by fundamental political and economic changes in the international oil market leading up to the Middle East War crisis of 1973-1974. The main industrialised countries realised that they could not sustain a growing system of oil dependency on Middle East oil producers, with a lack of strategies diversifying energy sources and improving energy efficiency, as well as an absence of data on global energy, especially, oil markets (IEA, 1994).

- The earthquake that hit the area of Christchurch in New Zealand in 2011 facilitated a change in the legislation of the Resource

Management Act. The act over-emphasised nature conservation at the expense of identifying and managing natural hazards, which led to many zones affected by the earthquake being destroyed and in the aftermath subject to unaffordable insurance prices. Hazard zone identification in the planning process should reduce future adverse impacts (New Zealand Government, 2012).

- The Great East Japan Earthquake (GEJE) in 2011 triggered a major re-thinking in the energy policy of Japan and beyond. The majority of nuclear power stations in Japan have not been re-opened since the event, and instead of the initial plan of expanding the share of nuclear power to 50 % in its national energy mix before the earthquake, it is now estimated the share will be reduced to below 30 %. This significant change in energy policy was not confined to national borders. As a consequence of the earthquake, Germany decided to phase out its nuclear energy and close all plants by 2022 (Siemens, 2012).

- The National Civil Protection System of Mexico, SINAPROC, was established to improve Mexico's civil protection capacities following the devastating earthquakes of 1985. Mexico realised that ad-hoc co-ordination efforts for response and recovery was no longer sufficient to address challenges from large-scale disasters, and that a comprehensive and systematic approach to co-ordination was needed (OECD, 2013a).

- The natural catastrophe funds that were established for example in Austria and France were the result of major preceding disasters. In Austria an avalanche catastrophe in 1951 had first raised the awareness about the need of the federal level to help the states finance such catastrophes. Subsequent flood catastrophes in 1965 and 1966 then led to the permanent establishment of the national catastrophe fund. Similarly in France, the catastrophe fund was established in 1982 after devastating floods in 1981-1982.

Table 3.1. Policy changes after major disruptive events

	Year	Policies implemented after disasters
United States: Hurricane Katrina	2005	The "Post-Katrina Emergency Management Reform Act of 2006" was passed after Hurricane Katrina, which increased the autonomy of the Federal Emergency Management Agency (FEMA) within the Department of Homeland Security (DHS). The FEMA Administrator would from now on directly report to Congress and have statutory advisory status to the President and the Secretary of Homeland Security. After the disaster, FEMA was put in charge of the nation's complete Comprehensive Emergency Management (CEM) efforts for all hazards.
New Zealand: Canterbury Earthquake	2011	In response to the Canterbury Earthquakes the Government of New Zealand implemented legislation to change the system for managing earthquake-prone buildings. With the new legislation, all identified earthquake-prone buildings need to be strengthened or demolished within 20 years. Along with these strengthened building requirements, a public register for earthquake-prone buildings will be set up by the Ministry of Business, Innovation and Employment (MBIE).
Great East Japan Earthquake	2011	During the Great East Japan Earthquake it became apparent that the heavily decentralised system of disaster management in Japan could also exhibit ineffectiveness during a large-scale disaster where the responsible local authorities were unable to act. This gave rise to revisions of the Disaster Measures Basic Act in 2012 wherein the prefectures assume greater responsibility for overall crisis management, which originally only included firefighting and flood prevention measures. Specifically, the prefectures gained additional duties in the collection and the exchange of information of local municipalities and they act as a substitute in case a municipality fails to operate during a disaster.
United Kingdom: general summer floods	2007	In 2010 the United Kingdom government passed the Flood and Water Management Act which addresses the former institutional gaps regarding surface water and groundwater flooding and the need for a more risk-based approach regarding reservoir safety. The Act clearly allocates responsibilities. The Environment Agency (EA) is responsible for strategic co-ordination whereas local flood risk management is conducted by local authorities. Through the allotment of responsibilities the government ensures that the local authorities can be held accountable for the delivery of flood management services.

Sources: Bea K. et al. (2006), "Federal Emergency Management Policy Changes – After Hurricane Katrina: A Summary of Statutory Provisions", CRS Report for Congress, Congressional Research Service, Library of Congress, United States; International Recovery Platform (2013), "The Great East Japan Earthquake 2011", Recovery Status Report, Kobe; MBIE (n.d.), "Managing earthquake-prone buildings – policy decisions", New Zealand Ministry of Business, Innovation and Employment, *www.dbh.govt.nz/epb-policy-review* (accessed 25 November 2013); UK Groundwater Forum (2011), "Groundwater flooding and the Flood & Water Management Act", *www.groundwateruk.org/Flood-and-Water-Management-Act.aspx* (accessed 25 November 2013).

Making reform happen is a needed and welcome change; however aiming to do so before a disaster occur is more effective and efficient. The above examples demonstrate that major disruptions can unleash bottlenecks that impeded previous reforms from being implemented. Even though such changes are welcome and needed for better risk management, they often come at a very high cost, especially those that suffer the direct costs of large-scale catastrophes. In addition changes in the aftermath of a disaster are often rushed and resources spent swiftly, without a thorough needs assessment. All of this underscores the importance of making reform happen before the onset of disasters, and not waiting until other, more devastating, events occur.

Towards a frame of reference to boost resilience

To promote good practices in risk management in general, and in ex-ante engagement to increase resilience through prevention and mitigation in particular, the OECD has elaborated the Recommendation of the Council on the Governance of Critical Risks. The Recommendation is designed to assist governments, policy makers and senior officials charged with developing and maintaining robust risk management frameworks and their implementation. The conclusions of this report have contributed to the development of the Recommendation which raises awareness of critical risks in order to mobilise households, businesses and international stakeholders and to foster investment in risk prevention and mitigation. The Recommendation recognises the role of governments in establishing an institutional environment that incentivises all actors to contribute to boosting resilience. The Recommendation also acknowledges the importance of raising awareness of existing risks as well as defining the role and responsibility each actor has in contributing to the common goal of boosting resilience. This builds on the recognition that collecting and sharing information on existing risks as well as on the exposure to risks and underlying drivers of risk, is crucial. The conclusions of this report and the elaboration of the Recommendation will both contribute towards establishing a catalogue of criteria to assess the achievements made in OECD countries in implementing the advice set out in the Recommendation.

Notes

1. The survey looks at 26 countries, including the largest global economies and a number of OECD countries, *www.slideshare.net/EdelmanInsights/global-deck-2013-edelman-trust-barometer-16086761*.
2. The "US Patriot Act" is short for the: "Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism", USA Patriot Act of 2001, *www.gpo.gov/fdsys/pkg/PLAW-107publ56/pdf/PLAW-107publ56.pdf*.

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Annex A:

Selected disruptive shocks for assessing OECD resilience

	Event/Type	Date	Country	Economic Damages EM-DAT source[1], Billion USD	Economic Damages, other sources, Billion national currency	Economic Damages, USD constant prices, 2010 (OECD Base Year), USD[2] billions
1	Great East Japan Earthquake	11 March 2011	Japan	210	210 USD[3]	203.5
2	Chile Earthquake	27 February 2010	Chile	30	30 USD[4]	30
3	Canterbury Earthquake	22 February 2011	New Zealand	15	20 NZD[5]	14.1
4	L'Aquila Earthquake	6 April 2009	Italy	2.5	8 EUR[6]	11.7
5	Thailand Floods	5 August 2011 – 4 January 2012	Thailand	40	46.5 USD[7]	44.2
6	UK General Summer Floods	June - July 2007	United Kingdom	4.448[8]	3.2 GBP[9]	5.6
7	Central Europe Floods	August 2002	Central Europe	17.9[10]	21.1 EUR[11]	37.2
8	Hurricane Katrina	29 August -19 September 2005	United States	125	96 USD[12]	107.1
9	Hurricane Sandy	22 – 31 October 2012	United States	50	50 USD[13]	47.5
10	Eyjafjallajökull Volcanic Eruption	15 -23 April 2010	Iceland		2.5 EUR[14]	3.6
11	9/11 Terrorist Attacks	11 September 2001	United States		21.6 USD[15]	26.2
12	2011 Norway Attacks	22 July 2011	Norway		0.77 NOK[16]	0.133
13	Heat Wave	July - August 2003	Europe	12.12[17]	13 USD[18]	15.4
14	Deepwater Horizon Oil spill	20 April 2010	United States	20[19]	12.7 USD[20]	11.8
15	H1N1 Pandemic	2009	First cases reported in Mexico		127 MXN[21]	9.9

StatLink http://dx.doi.org/10.1787/888933031275

Notes

1. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013).
2. Price Index numbers are taken from the OECD Stat Consumer Prices MEI and Currency Exchange Rates from 05.01.2010 were taken from *www.imf.org/external/np/fin/data/rms_mth.aspx?SelectDate=2010-01-31&reportType=REP*.
3. Cabinet Office and Reconstruction Agency, Japan; only direct economic costs.
4. Government of Chile, direct and indirect economic costs.
5. Pre-election Economic and Fiscal Update 2011, The Treasury of NZ, only direct economic costs; NZD 30 billion if "business disruption or additional costs from inflation, insurance administration or rebuilding to higher standards" are included.
6. OECD (2013), *Policy Making after Disasters: Helping Regions Become Resilient – The Case of Post-Earthquake Abruzzo*, OECD Publishing, doi: *10.1787/9789264189577-en*, estimation only includes direct damage to physical capital (data provided by the Department for Planning and Coordination for Economic Policy, Italy).
7. World Bank Report with the Ministry of Finance, direct and indirect economic costs (Damage, Loss and Needs Assessment (DALA) Methodology).
8. Data from EM-DAT split into three events, incorporated damage data from two events.
9. Environment Agency, calculation included direct and indirect damages to households, businesses, water & power utilities, communication, public infrastructure and agriculture.
10. Data from EM-DAT for Austria, Bulgaria, Czech Republic, France, Germany, Hungary, Italy, Romania, Slovak Republic.
11. DKKV citing MunichRe, calculation of direct or indirect economic costs unclear.

12. United States Federal Government, direct economic costs include housing, consumer durables, business and government property.

13. United States National Hurricane Center, preliminary damage estimate.

14. EU Transport Commissioner estimation, damages to aviation firms only .

15. The Federal Reserve of New York, estimate of costs to infrastructure (clean up, replacement of World Trade Towers, repairs to damaged buildings).

16. Press release from government of Norway on 15 May 2012, Government appropriations, *www.regjeringen.no/en/dep/fad/press-centre/press-releases/2012/770-million-to-cover-expenses-after-the-.html?id=682462#.*

17. Data from EM-DAT for Austria, Switzerland, Spain, France, Germany, Italy, Slovak Republic, Slovenia.

18. UNEP (2004), "Impacts of Summer 2003 Heat Wave in Europe", United Nations Environment Programme, *www.grid.unep.ch/index.php?option=com_content&view=article&id=73&Itemid=400&lang=en&project_id=7F2D053,* (accessed 28 March).

19. Data from EM-DAT based on the Deepwater Horizon Oil Spill trust fund of USD 20 billion.

20. BP Official Report of paid claims, figures refer to data from 30 September 2013: *www.bp.com/en/global/corporate/gulf-of-mexico-restoration/claims-information.html.*

21. OECD (2013), *OECD Reviews of Risk Management Policies: Mexico 2013: Review of the Mexican National Civil Protection System*, OECD Publishing, doi: *10.1787/9789264192294-en*, estimated losses in Mexico.

Annex B:

Disruptive shocks factsheets*

*Values reported in each factsheet are true to year of reporting.

1. Great East Japan Earthquake, 2011

Type of disaster(s)	Earthquake (Richter scale 9.0), tsunami, industrial accident
Date(s) of occurrence	11 March 2011
Country(ies)/Region(s)	Japan/ Tohoku, Honshu, Hokkaido[1]
Social and economic impacts	
Death toll	15 884 (direct)[2]; 2 916 (indirect)[3]
Estimated affected	~ 370 000[4]
Estimated total economic damages (USD, billion)	May approach 300[5]
Direct damages (USD, billion)	210[6]
Decline of GDP in the second quarter of 2011 compared to last year	2.1%[6]
Decrease of industrial production	7%[6]
Decrease of national exports	8%[6]
Critical infrastructure impacts	
Number of affected households by reduced power supply of the Tokyo Electric Power Company (TEPCO) (million)	4.4[7]
Duration of 15 port closures	18 days[7]
Duration of the Tokaido Shinkansen high-speed rail line closure	13 days[7]
Environmental impacts	
Affected coastline (km)	1 000[6]

Sources: 1. Only directly affected locations mentioned; 2. Direct deaths from the earthquake and tsunami, National Police Agency as of 10/01/2014; 3. Indirect deaths from deteriorated health condition due to injury from the earthquake and tsunami, Reconstruction Agency as of 10/01/2014; 4. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, www.emdat.be (accessed 14 November 2013); 5. UN ISDR (2013), "Lessons Learnt from Two Unprecedented Disasters in 2011: Great East Japan Earthquake and Tsunami in Japan and Chao Phraya River", background paper prepared for the Global Assessment Report on Disaster Risk Reduction 2013, The United Nations Office for Disaster Risk Reduction, Geneva, *www.preventionweb.net/english/hyogo/gar/2013/en/bgdocs/Okazumi%20et.%20al.%202012.pdf;* 6. World Bank Institute (2012), "Learning from Megadisasters", set of 32 Knowledge Notes, World Bank Institute, The World Bank, Washington D.C., *http://wbi.worldbank.org/wbi/megadisasters*; 7. Norio, O. et al. (2011), "The 2011 eastern Japan great earthquake disaster: Overview and Comments", International Journal of Disaster Risk Science, Vol. 2, No. 1, pp. 34-42, *http://dx.doi.org/10.1007/s13753-011-0004-9.*

2. Chile Earthquake, 2010

Type of disaster(s)	Earthquake (Richter Scale 8.8) and tsunami
Date(s) of occurrence	27 February 2010
Country(ies)/Region(s)	Chile/ Valparaíso, Santiago Metropolitan, Libertado General Bernardo O'Higgins , Maule, Bío Bío, La Araucania
Social and economic impacts	
Death toll	~ 550[1,2,3]
Estimated affected (million)	~ 2.6 – 12.8[1,3]
Estimated total economic damages (USD, billion)	30 – 60[1,2]
Direct damages (USD, billon)	20.9[1]
Indirect damages (USD, billion)	7.6[1]
Critical infrastructure impacts	
Damages to public infrastructure (USD, billion)	10.6[1]
Duration of electricity shortage in the affected areas	2 weeks[4]
Period of closure of public schools	45 days[1]
Number of damaged hospitals	79[1]
Environmental impacts	
Affected coastline (km)	604[1]

Sources: 1. Fermandois A. (2011), "Chile and its earthquake: Preparedness, response and lessons", Government of Chile, Ambassador's Office, http://dels.nas.edu/resources/static-assets/materials-based-on-reports/presentations/AmbassadorFermandois.pdf; 2. Medina, F. et al. (2010), "The magnitude 8.8 offshore Maule region Chile earthquake of February 27, 2010 Preliminary summary of damage and engineering recommendations", Report to the World Bank, Washington D.C.,*http://documents.worldbank.org/curated/en/2010/12/16398478/chile-magnitude-88-offsore-maule-region-chile-earthquake-february-27-2010-preliminary-summary-damage-enginering-recommendations*; 3. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); 4. Araneda, J. et al. (2010), "Lessons from the 2010 Chilean earthquake and its impact on electricity supply", submitted to the 2010 International Conference on Power System Technology, Hangzhou.

3. Canterbury Earthquake, New Zealand, 2010

Type of disaster(s)	Earthquake (Richter Scale 6.3)
Date(s) of occurrence	22 February 2011
Country(ies)/Region(s)	New Zealand/ Canterbury
Social and economic impacts	
Death toll	182[1]
Estimated affected	~ 600 000[2]
Estimated total economic damages (USD, billion)	24.6[3]
Direct damages (USD, billion)	16.4[4]
Insurance costs (USD, billion)	~ 16.4[4,5]
Critical infrastructure impacts	
Infrastructure damages (USD, billion)	2.5[4]
Duration of water supply shortage (in weeks)	4[1]
Duration of sewerage outage (in weeks)	10[1]
Damage to roads and underground water and waste pipes (USD, billion)	1.6[1]
Water and sewer pipes to repair (km)	424[1]

Sources: 1. Australian Government (2012), "Disaster Response: Lessons from Christchurch", Paper 01/2012, *http://acmc.gov.au/wp-content/uploads/2011/11/12089_CMAC-Paper_1_Christchurch_1.pdf*; 2. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, www.emdat.be (accessed 14 November 2013); 3. Parliamentary Library (2011), "Economic effects of the Canterbury earthquakes", Current Issues for the 50th Parliament, The New Zealand Parliamentary Library, *www.parliament.nz/resource/0000178684;* 4. New Zealand Treasury (2011), "Pre-election Economic and Fiscal Update 2011", *www.treasury.govt.nz/budget/forecasts/prefu2011* (accessed 14 November 2013); 5. 12.5 NZD billion insurance claims and 7.5 NZD billion from the Earthquake Commission (EQC) liability.

4. L'Aquila Earthquake, Italy, 2009

Type of disaster(s)	Earthquake (Richter scale 5.8)
Date(s) of occurrence	6 April 2009
Country(ies)/Region(s)	Italy/ Abruzzo
Social and economic impacts	
Death toll	~ 300[1,2]
Estimated affected	56 000 - 67 500[1,2]
Direct damages (USD, billion)	10.6[1]
Number of damaged buildings	37 000[1]
Critical infrastructure impacts	
Number of collapsed bridges in L'Aquila	3[3]

Sources: 1. OECD (2013), Policy Making after Disasters: Helping Regions Become Resilient – The Case of Post-Earthquake Abruzzo, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264189577-en*; 2. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); 3. Global Risk Miyamoto (2009), "L'Aquila Italy M6.3 Earthquake", Field Investigation Report, *www.grmcat.com/images/Italy-EQ-Report.pdf* (accessed 14 November 2013).

5. Thailand Floods, 2011-12

Type of disaster(s)	General floods
Date(s) of occurrence	5 August 2011 – 4 January 2012
Country(ies)/Region(s)	Thailand/ 66 of Thailand's 77 provinces
Social and economic impacts	
Death toll	680 – 884[1,2,3]
Estimated affected (million)	9.5 - 13[1,2,3]
Estimated total economic damages (USD, billion)	40 - 46.5[1,2]
Direct damages (USD, billion)	21[1]
Indirect damages (USD, billion)	26.5[1]
Most affected industries	Electrical appliances, medical equipment, automobile, food and beverages[3]
Lost wages (USD, billion)	3.5[1]
Critical infrastructure impacts	
Costs to water resource management (USD, million)	276[1]
Costs to transport (USD, billion)	966[1]
Period of closure of Bangkok's secondary airport (Don Mueang)	6 months[3]
Costs to telecommunication (USD, million)	122[1]

5. Thailand Floods, 2011-12 *(cont.)*

Costs to electricity (USD, million)	282[1]
Costs to water supply and sanitation (USD, million)	174[1]
Environmental impacts	
Damaged cropland (Hectares, million)	1.9[1]

Sources: 1. World Bank (2012), "The Thai Flood 2011 Overview Rapid Assessment for Resilient Recovery and Reconstruction Planning", Ministry of Finance Thailand, The World Bank, Bangkok, *www.gfdrr.org/sites/gfdrr.org/files/publication/Thai_Flood_2011_2.pdf;* 2. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, www.emdat.be (accessed 14 November 2013); 3. AON Benfield (2012), "2011 Thailand Floods Event Recap Report", AON Benfield, Impact Forecasting LLC, Chicago, *http://thoughtleadership.aonbenfield.com/Documents/20120314_impact_forecasting_thailand_flood_event_recap.pdf.*

6. UK General Summer Floods, 2007

Type of disaster(s)	General floods
Date(s) of occurrence	June - July 2007
Country(ies)/Region(s)	United Kingdom/ South and East Yorkshire, Worcestershire, Gloucestershire, Oxfordshire
Social and economic impacts	
Death toll	13[1,2]
Estimated affected	48 000 households and 7 300 businesses[1]
Estimated total economic damages (USD, billion)	6.2[1]
Percentage of insured damages (including government aid)	63%[2]
Damages to households (USD, billion)	2.3[2]
Damages to businesses (USD, billion)	1.4[2]
Critical infrastructure impacts	
Number of people affected by the mains water supply shortage	350 000[1]
Period of mains water supply shortage (in days)	17[1]
Damage to public infrastructure (USD, billion)	1.3[2]
Children's' absence in school (in days)	400 000[2]
Environmental impacts	
Flooded farmland (hectares)	42 000[2]
Damages to the agriculture sector (USD, million)	98[2]

Sources: 1. Pitt, M. (2008), "The Pitt review–learning lessons from the 2007 floods", UK Cabinet Office, London, Environment Agency (2010), "Delivering benefits through evidence: The costs for the summer 2007 floods in England"; 2. Environment Agency (2010), "Delivering benefits through evidence: The costs for the summer 2007 floods in England", The United Kingdom Environment Agency, Flood and Coastal Erosion Risk Management Research and Development Programme, Bristol.

7. Central Europe Floods, 2002

Type of disaster(s)	General floods
Date(s) of occurrence	August 2002
Country(ies)	Italy, France, Germany, Austria, Czech Republic, Hungary, Romania, Bulgaria, Slovak Republic
Social and economic impacts	
Death toll	37[1]
Estimated affected	~ 600 000[3] out of which 340 000 from Germany[2]
Estimated total economic damages (USD, billion)	17.9 – 20.8[1,3]
Germany (USD, billion)	9[4]
Austria (USD, billion)	2.9[4]
Czech Republic (USD, billion)	2.3[4]
Percentage of insured losses	~ 20% - 30%[2]
Total compensations from the European Solidarity Fund (USD, million)	~ 822

Sources: 1. DKKV (2003), "Hochwasservorsorge in Deutschland Lernen aus der Katastrophe 2002 im Elbegebiet", Deutsches Komitee Katastrophenvorsorge e.V., Bonn; 2. MunichRe (2003), "Münchener Rückversicherungs-Gesellschaft: topics Jahresrückblick Naturkatastrophen 2002", MunichRe, Munich, *http://hagel.at/site/download.cfm?extFile=naturkatastrophen_des_jahres_2002.pdf*; 3. Data from EM-DAT for Austria, Bulgaria, Czech Republic, France, Germany, Hungary, Italy, Romania, Slovak Republic, EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); 4. EC (2004), "Solidaritätsfonds der Europäischen Union Jahresbericht 2002-2003 und Bericht über die Erfahrungen nach einjähriger Anwendung des neuen Instruments", The European Commission, Brussels, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2004:0397:FIN:EN:PDF.

8. Hurricane Katrina, United States, 2005

Type of disaster(s)	Tropical storm, hurricane (category 3)
Date(s) of occurrence	29 August -19 September 2005
Country(ies)/Region(s)	United States of America/ Louisiana, Texas, Florida, Mississippi, Alabama
Social and economic impacts	
Death toll	~ 1 500[1,2,3]
Estimated affected (million)	0.5 – 1.2[1,3]
Estimated total economic damages (USD, billion)	125[1]
Direct damages (USD, billion)	96 -108[2,4]
Insured losses excluding the National Flood Insurance Program (USD, billion)	41.1[2]
Critical infrastructure impacts	
Damaged oil platforms	More than 30[5]
Evacuated oil platforms	75% of the total number of manned oil platforms[3]
Damaged and/or closed oil refineries	9[5]
Environmental impacts	
Number of oil spills	10[3]
Oil infiltrating the Gulf of Mexico (million gallons)	7.4[3]
Clean-up costs (USD, billion)	1.5[6]

Sources: 1. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); 2. National Hurricane Center (2005), "Tropical Cyclone Report Hurricane Katrina", National Hurricane Center, Miami; 3. The White House (2005), "The Federal Response to Hurricane Katrina Lessons Learned", The White House, Washington D.C., *http://georgewbush-whitehouse.archives.gov/reports/katrina-lessons-learned/*; 4. National Hurricane Center's estimation for total damages : 41.1 billion (insured losses) + 41.1 billion (uninsured) + 25.8 billion (insured loss from flooding, National Flood Insurance Program) = 108 billion; 5. United States Department of Commerce (2006), "Hurricane Katrina", National Oceanic and Atmospheric Administration (NOAA), Silver Spring, Maryland, *www.nws.noaa.gov/om/assessments/pdfs/Katrina.pdf;* 6. RMS (2005), "Hurricane Katrina: Profile of a Super Cat: Lessons and Implications for Catastrophe Risk Management", Risk Management Solutions, Newark, *https://support.rms.com/publications/katrinareport_lessonsandimplications.pdf.*

9. Hurricane Sandy, United States, 2012

Type of disaster(s)	Tropical storm, hurricane (category 3)
Date(s) of occurrence	22– 31 October 2012
Country(ies)/Region(s)	United States of America/ New York City, New Jersey
Social and economic impacts	
Death toll	54 – 147[1,2]
Estimated total economic damages (USD, billion)	50[1,2,3,4]
Number of damaged buildings	~ 650 000[2]
Number of affected businesses in New Jersey	~ 19 000[2]
Business disruption costs in New Jersey (USD, billion)	8.3[2]
Critical infrastructure impacts	
Number of affected people from electricity shortages (million)	8.5[2]
Cost of repairs to electricity, water and sewage services in New Jersey (USD, billion)	4[2]
Damage to the transport infrastructure in New Jersey and New York (USD, billion)	10.4[2]
Number of affected people from the loss of subway services (million)	5.4[4]
Environmental impacts	
Significantly damaged parks	400[4]
Damaged or drowned park and street trees	~ 20 000[4]

Sources: 1. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, www.emdat.be (accessed 14 November 2013); 2. National Hurricane Center (2013), "Tropical Cyclone Report Hurricane Sandy", National Hurricane Center, Miami; 3. Hurricane Sandy ranks as the second costliest cyclone after Hurricane Katrina in the United States, when adjusting for inflation, population and wealth normalisation factors it ranks as the sixth-costliest cyclone. Records of the costliest cyclones in the United States start in 1900; 4. City of New York (2013), "A Stronger More Resilient New York", Mayor of New York, New York City, www.nyc.gov/html/sirr/html/report/report.shtml.

10. Eyjafjiallajökull Volcanic Eruption, Iceland, 2010

Type of disaster(s)	Volcanic eruption
Date(s) of occurrence	15 -23 April 2010
Country(ies)/Region(s)	Europe and its airspace
Social and economic impacts	
Estimated affected air travel passengers (million)	10[1]
Estimated total economic damages (USD, billion)	3.6[2]
Direct damages of aviation firms, during 15 – 23 April 2010 (USD, billion)	2.5[3]
Reduction in air traffic cargo per week	61%[3]
Duration of flying ban	8 days[1]
Estimated number of cancelled flights, during 15 – 22 April 2010	104 000[4]
Reduction of the within-Europe and Europe-rest of the world passenger flows	24% of the within EU passengers flow (9% of the worldwide flow)[4]
Number of disabled European airports	313 (represents 75% of the European Airport Network)[4]

Sources: 1. IATA (2010), "IATA Economics Briefing: The Impact of Eyjafjallajokull's Volcanic Ash Plume", International Air Transport Association, *www.iata.org/whatwedo/Documents/economics/Volcanic-Ash-Plume-May2010.pdf;* 2. Muench, V. (2013), "Eyjafjallajökull volcanic eruption", in Allianz Expert Risk Articles, *http://www.agcs.allianz.com/insights/expert risk articles/eyjafjallajokull volcanic eruption/* (accessed 14 November 2013); 3. Mazzochini, M. et al. (2010), "The 2010 Volcanic Ash cloud and its financial impact on the European airline industry", CESifo Forum, No. 2/2010; 4. EUROCONTROL (2010), "Ash-cloud of April and May 2010: Impact on Air Traffic", STATFOR/Doc394, European Organisation for t he Safety of Air Navigation, *www.eurocontrol.int/sites/default/files/content/documents/official-documents/facts-and-figures/statfor/ash-impact-air-traffic-2010.pdf*.

11. 9/11 Terrorist Attacks, United States, 2001

Type of disaster(s)	Terrorist attack
Date(s) of occurrence	11 September 2001
Country(ies)/Region(s)	USA/ New York City, Arlington, Shanksville
Social and economic impacts	
Death toll	2 749[1]
Estimated total economic damages (USD, billion)	33 – 36[2,3]
Direct damages (USD, billion)	21.6[2,4]
Estimated lost jobs in New York City between September 2001 to February 2002	71 000[2,5]
Critical infrastructure impacts	
Damages to trains, phones and electricity (USD, billion)	4.3[6]
Damage to public infrastructure (USD, billion)	3.7[2]

Sources: 1. Chernick, H. (2005), Resilient City: The economic Impact of 9/11, The Russell Sage Foundation, United States; 2. Bram, J. et al., (November 2002), "Measuring the Effects of the September 11 Attacks on New York City", Economic Policy Review, Federal Reserve Bank of New York, Vol. 8, No. 2, pp. 5-20; 3. Comprising earnings losses, property damage, and the clean-up and restoration of the site; 4. Cost of cleaning up the site, replacing the destroyed World Trade Center buildings, and repairing damaged buildings and infrastructure; 5. Based on estimates using a standard dynamic forecasting model of New York City's employment; 6. Comptroller, City of New York (2002), "One Year Later: The Fiscal Impact of 9/11 on New York City", http://comptroller.nyc.gov/wp-content/uploads/documents/impact-9-11-year-later.pdf.

12. Norway Attacks, 2011

Type of disaster(s)	Terrorist attack (shooting)
Date(s) of occurrence	22 July 2011
Country(ies)/Region(s)	Norway/ Oslo and the island Utøya
Social and economic impacts	
Death toll	77[1]
Estimated total economic damages (USD, million)	127[2]

Sources: 1. Norwegian Government (2012), "Gjørv Review", Preliminary English Version of selected chapters, Oslo, *www.icpem.net/LinkClick.aspx?fileticket=LY5lNxLGDw0%3D&tabid=107&mid=588*;
2. Based on government appropriations, Norwegian Government (15 May 2012), "770 million to cover expenses after the terrorist attack on the Government Quarter", Press release, *www.regjeringen.no/en/archive.*

13. Heat Wave, Europe, 2003

Type of disaster(s)	Heat wave
Date(s) of occurrence	July – August 2003
Country(ies)	Italy, France, Portugal, Switzerland, Netherlands, Germany, UK, Belgium, Latvia, Spain
Social and economic impacts	
Death toll	~ 35 000[1,2,3]
Estimated total economic damages (USD, billion)	~ 12.5[4,5,6]

Sources: 1. Death toll numbers from IFRC do not include deaths from Switzerland and Latvia; 2. IFRC (2004), "World Disaster Report 2004", International Federation of Red Cross and Red Crescent Societies, London, *www.ifrc.org/PageFiles/89755/WDR2004/58000-WDR2004-LR.pdf; 3*. UN ISDR (2003), "Heat wave in Europe in 2003, new data shows Italy as the most affected country", The United Nations Office for Disaster Risk Reduction, Geneva, *www.unisdr.org/archive/5597; 4*. Data from EM-DAT for Austria, Switzerland, Spain, France, Germany, Italy, Slovak Republic, Slovenia; 5. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); 6. UNEP (2004), "Impacts of Summer 2003 Heat Wave in Europe", United Nations Environment Programme, *www.grid.unep.ch/index.php?option=com_content&view=article&id=73&Itemid=400&lang=en&project_id=7F2D053*, (accessed 28 March).

14. Deepwater Horizon Oil Spill, United States, 2010

Type of disaster(s)	Industrial accident; oil spill
Date(s) of occurrence	20 April 2010
Country(ies)/Region(s)	United States of America/ Florida, Alabama, Mississippi, Louisiana, Texas
Social and economic impacts	
Death toll	11[1]
Direct damages (total claims and payments paid by BP) (USD, billion)	12.7[2]
Gulf Coast Claims Facility Trust Fund by BP and the US government (USD, billion)	20[3]
Environmental impacts	
Number of forced closures of fisheries (km^2)	118 000[4]
Estimated damage to fishing industry (USD, billion)	4.36[4,5]
Crude oil infiltrating the Gulf of Mexico (million barrels)	4.9[6]
Affected beaches and wetlands (kilometres)	966[6]

Sources: 1. EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium, *www.emdat.be* (accessed 14 November 2013); 2. Gulf of Mexico Oil Spill claims and Other Payments, public report from 30/09/2013, British Petroleum (2013), "Gulf of Mexico Oil Spill Claims and Other Payments Public Report 9/30/2013", British Petroleum, *www.bp.com/en/global/corporate/gulf-of-mexico-restoration/claims-information.html;* 3. BDO Consulting (19 April 2012), "Independent Evaluation of the Gulf Coast Claims Facility Executive Summary", submitted to the US Department of Justice, BDO USA LLP, *www.justice.gov/iso/opa/resources/697201241917226179477.pdf* (accessed 14 November 2013); 4. Trannum, H. and Bakke, T. (2012), "Environmental Effects of the Deepwater Horizon oil spill – focus on effects on fish and effects of dispersants", Report to the Norwegian Institute for Water Research, Oslo; 5. However, the overall estimated damage is estimated to be higher if taking into account the decreased consumption of seafood in the affected areas; 6. Norse, A. and J. Amos (2010), "Impacts, Perception, and Policy Implications of the Deepwater Horizon Oil and Gas Disaster", Environmental Law Institute, Vol. 40, Washington D.C.

15. H1N1 Pandemic, Mexico/Global, 2009 - 2010

Type of disaster(s)	Epidemic
Date(s) of occurrence	2009 – 2010
Country(ies)/Region(s)	> 214 countries, (Origin in Veracruz, Mexico)
Social and economic impacts	
Death toll	~ 15 000[1,2]
Estimated affected (million)	61[1]
Estimates total economic damages to Mexico (USD, billion)	9.9[3]
Lost visitors due to pandemic in Mexico (million)	1[4]
Loss in revenue in the tourism industry in Mexico (USD, billion)	2.8[4]
Mexico's pork trade deficit in 2009 (USD, million)	27[4]
Critical infrastructure impacts	
Duration of closures of day care centres, schools, universities and cultural activities	10 days[3]

Sources: 1. Centers of Disease Control estimates of 2009 H1N1 cases from April 2009 through April 2010, CDC (2010), "CDC Estimates of 2009 H1N1 Cases and Related Hospitalizations and Deaths from April 2009 through April 10, 2010, By Age Group", Centers for Disease Control and Prevention, *www.cdc.gov/h1n1flu/pdf/graph_April%202010N.pdf* (accessed 14 November 2013); 2. WHO weekly update as of 9 May 2010, WHO (2010), "Pandemic (H1N1) 2009: update 100", World Health Organisation weekly update as of 9 May 2010, *www.who.int/csr/don/2010_05_14/en/index.html?utm_source=twitterfeed&utm_medium=twitter* (accessed 14 November 2013); 3. OECD (2013), OECD Reviews of Risk Management Policies: Mexico 2013, Review of the Mexican National Civil Protection System, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264192294-en*; 4. Rassy, D. and R. Smith (2013), "The economic impact of H1N1 on Mexico's tourist and pork sectors", Health Economy, Vol. 22, No. 7, pp. 824–834, *http://dx.doi.org/10.1002/hec.286*.

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