Setting, measuring and monitoring targets for reducing disaster risk

Recommendations for post-2015 international policy frameworks

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October 2014

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Contents

Acronyms iii
Figures, tables and boxes iv
Executive summary vi

1. Introduction 1

1.1 The processes for the Sustainable Development Goals and the post-2015 framework on disaster risk reduction 2
1.2 Setting targets for the Sustainable Development Goals and the post-2015 framework on disaster risk reduction 8
1.3 Structure of the report 11

2. Setting global targets for disaster risk reduction: reviewing the evidence 12

2.1 Introduction 13
2.2 Evidence from investigating disaster mortality and losses at global level and by country income group 14
2.3 Evidence from national historical disaster loss data to investigate disaster risk reduction progress 21
2.4 Evidence from 'disaster pairs' 24
2.5 Recommendations on suitable disaster targets 27

3. Targets on disasters and poverty 29

3.1 Introduction: Poverty dynamics 30
3.2 Has impoverishment been successfully tackled? 35
3.3 A proposal for framing a target on impoverishment 35

4. Creating a baseline and monitoring progress on disaster risk reduction 37

4.1 Introduction 38
4.2 Establishing a baseline and monitoring progress 41
4.3 Impoverishment baselines 46

5. Improving disaster risk reduction data 47

5.1 Coverage of hazard maps, models and associated data for assessing annual progress at country level 48
5.2 Improving disaster risk and loss data 49
5.3 Improving data on extensive risks 49
5.4 Improving data on the poverty impacts of disasters 51

6. Ten recommendations to establish a global system for monitoring progress on disaster risk reduction 55

References 58

Technical annex 1: Country classification per income (gross national income per capita) 62
Technical annex 2: The relationship between shocks and household impoverishment 65

Acronyms

CADRI	Capacity for Disaster Reduction Initiative
CDKN	Climate and Development Knowledge Network
CRED	Centre for Research on the Epidemiology of Disasters
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EM-DAT	Emergency Disasters Database
ERHS	Ethiopian Rural Household Survey
FDMA	Fire and Disaster Management Agency
GDP	Gross Domestic Product
GEM	Global Earthquake Model
GFDRR	Global Facility for Disaster Reduction and Recovery
GIAJ	General Insurance Association of Japan
HDI	Human Development Index
HFA	Hyogo Framework for Action
HLP	High-Level Panel of Eminent Persons on the Post-2015 Development Agenda
IPCC	Intergovernmental Panel on Climate Change
IRDR	Integrated Research on Disaster Risk
IRF	Independent Research Forum
JMA	Japan Meteorological Agency
LDC	Least Developed Country
MDG	Millennium Development Goal
MMI	Modified Mercalli Intensity
MPC	Marginal Propensity to Consume
ODI	Overseas Development Institute
OWG	Open Working Group
PGA	Peak Ground Acceleration
PrepCom	Intergovernmental Preparatory Committee Meeting
RMS	Risk Management Solutions
SDG	Sustainable Development Goal
SDSN	Sustainable Development Solutions Network
UK	United Kingdom
UN	United Nations
UNDESA	UN Department of Economic and Social Affairs
UNDG	UN Development Group
UNDP	UN Development Programme
UNESCAP	UN Economic and Social Commission for Asia and the Pacific
UNFCCC	UN Framework Convention on Climate Change
UNISDR	UN Office for Disaster Risk Reduction
UNTT	UN System Task Team on the Post-2015 UN Development Agenda
URM	Unreinforced Masonry
US	United States
WCDRR	World Conference on Disaster Risk Reduction
WHO	World Health Organization

Figures, tables and boxes

Figures

A: Global trends in disaster events and death tolls, 1980-2013 vi
B: Global disaster-related mortality rate (per million global population), 1980-2013) vii
C: Global economic losses related to gross world product (%), 1980-2013 viii
D: Households escaping from and falling into poverty - selected data to highlight impoverishment potential over particular periods of time viii

1: Processes feeding into the post-2015 development agenda 3
2: Towards a post-2015 framework on disaster risk reduction 5
3: Proposed architecture of the indicator structure 6
4: Gradual progress across all priorities of action 10
5: Global trends in disaster events and death tolls, 1980-2013 15
6: Share of deaths and number of events by disaster type at global level, 1980-2013 15
7: Global disaster-related mortality rate (per million global population), 1980-2013) 16
8: Global economic losses related to gross world product (%), 1980-2013 17
9: Trends in disaster-related deaths, using the Poisson regression, by income group, 1980-2013 18
10: Mortality for different income groups, 1980-2013 18
11: Percentage share (absolute numbers) by disaster type, high-income countries, 1980-2013 19
12: Percentage share (absolute numbers) by disaster type, upper-middle-income countries, 1980-2013 19
13: Percentage share (absolute numbers) by disaster type, middle-income countries, 1980-2013 20
14: Percentage share (absolute numbers) by disaster type, low-income countries, 1980-2013 21
15: Annual typhoon mortality rate (normalised by population) and number of typhoons in Japan, 1945-2009 22
16: Annual flood mortality rate (normalised by population) and number of floods in Japan, 1945-2011 22
17: Annual percentage mortality rate (normalised by population) in Japan by typhoon, 1941-2009 23
18: Average annual percentage mortality rate (normalised by population) in Japan by precipitation floods, 1951-2010 23
19: Number of houses in Japan inundated by either typhoon or precipitation floods, 1945-2011 24
20: Number of deaths (per 10,000 houses inundated) in Japan by typhoons, 1951-2013 24
21: Households escaping from and falling into poverty - selected data to highlight impoverishment potential over particular periods of time 30
22: Earthquake hazard map, Indonesia, showing different hazard zones 43
23: Population at risk by building classification in different hazard zones 43

Tables

A: Rates of impoverishment across different time periods, matched with disasters in these periods ix

1: Potential Structure of SDGs Goals, Targets and Indicators 10
2: A summary of some of the current challenges to monitoring progress to the HFA and some of the proposed solutions 10
3: Comparison between 1906 and 2010 Chile earthquakes 25
4: Comparisons between major cyclones in Bangladesh 26
5: Comparison of major earthquakes in the vicinity of cities 26
6: The main shocks driving downwards mobility and impoverishment over time 31
7: Rates of Impoverishment over Selected Periods of Time 34
8: Fatality rates by building fragility and shaking intensity 44
9: Poverty dynamics and self-reported natural catastrophes 52
10: A proposal for the classification of shocks in household surveys 53
A1: High-income economies ($12,746 or more) 62
A2: Upper-middle-income economies ($4,126-12,745) 63
A3: Lower-middle-income economies ($1,046-4,125) 63
A4: Low-income economies ($1,045 or less) 64
A5: Shocks and impoverishment in Tanzania 65
A6: Rates of Impoverishment over Selected Periods of Time 67
A7: Shocks and impoverishment in Uganda 69

Boxes

1: The primary post-2015 development agenda and SDG processes and actors 4
2: Introduction and proposed goals and targets on sustainable development for the post-2015 development agenda (as of Saturday 19 July 2014) 7
3: Purpose, scope, outcome, goals and priorities of action from the pre-zero draft of the post-2015 framework on disaster risk reduction (as of Friday 8 August 2014) 8
4: The challenge of measuring progress from observed disaster loss data 14
5: The use of hazard maps and catastrophe modelling in the insurance industry 39
6: Considerations when developing national panel data 51

Executive summary

Introduction

In many regions, disaster risk is continuing to increase (UNISDR, 2013c), mostly because greater numbers of vulnerable people and assets are located in exposed areas. It is vital to start reversing these trends. Over the next 18 months, there will be negotiation and hopefully agreement of three major international policy frameworks, each with a key interest in reducing disaster risk and minimising disaster losses. These are 1) the post-2015 framework on disaster risk reduction (DRR); 2) the Sustainable Development Goals (SDGs) – a way of prioritising development actions; and 3) an international agreement on climate change – to establish global action on tackling climate change beyond 2020. If well integrated, these frameworks should be able to provide a unique opportunity to deliver a coherent strategy and implementation plan to address the drivers of disaster risk.

A key way of linking these frameworks, particularly the SDGs and the post-2015 framework on DRR, lies in establishing common global goals, targets and indicators in relation to reducing disaster risks and losses. Such measures can provide a focus for action, a way of tracking progress and an opportunity to gauge the effectiveness of investments. A single set of targets and indicators spanning the SDGs and the post-2015 framework on DRR would clarify priorities, increase logic and coherence and minimise the amount of work required to develop monitoring and reporting capacity.

Hence, we consider the options available. The report investigates a set of possible components for this common target and indicator set, drawing on different evidence to establish potential numerical targets. It considers the data challenges of establishing such targets and how to improve the collection of data on disasters and disaster risk. It ends with ten recommendations on how post-2015 policy frameworks can support the development of a global monitoring system to track changing disaster risk and disaster losses. The international agreement on climate change has different, though linked targets to the SDGs and post-2015 framework on DRR – and this report does not consider these. However, reducing the impact of climate change will be key to ensure that, even with the successful achievement of predetermined DRR targets, disaster risk does not continue to increase in the future.

Observations on disaster losses since 1980

The report focuses on three dimensions of disaster losses: mortality, national economic losses and livelihood losses, assessed as ‘disaster-induced impoverishment’. Based on existing international records of disaster losses collected by the Centre for Research on the Epidemiology of Disasters (CRED) and by analysing a number of household survey datasets, we can establish the following observations at global scale:

Figure A: Global trends in disaster events and death tolls, 1980-2013

SOURCE: ADAPTED FROM WWW.EMDAT.BE

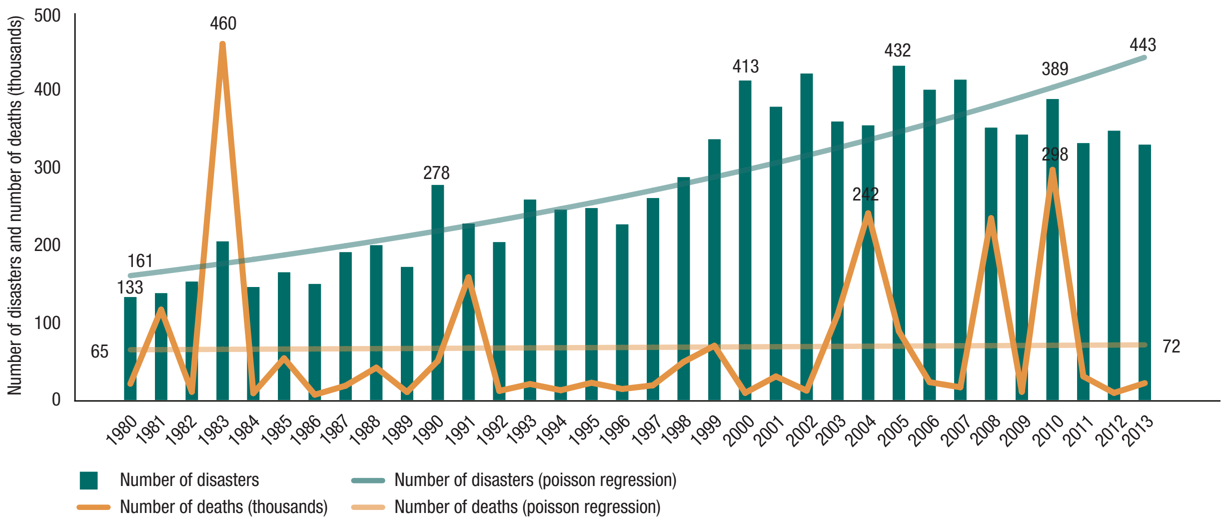
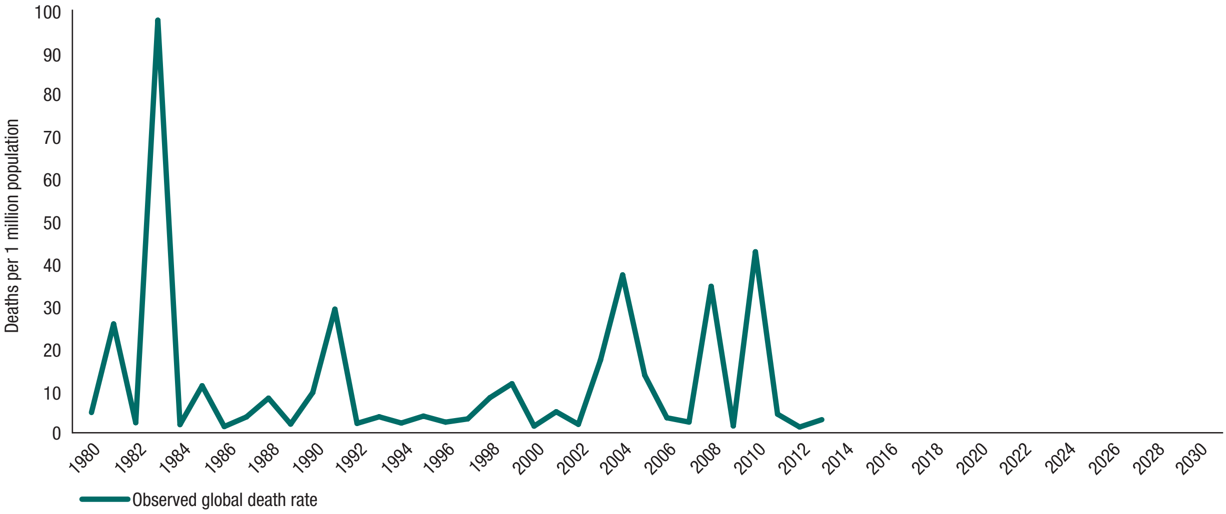


Figure B: Global disaster-related mortality rate (per million global population), 1980-2013)

SOURCE: ADAPTED FROM WWW.EMDAT.BE

NOTE: THE 'X' AXIS HAS BEEN EXTENDED TO 2030 TO HIGHLIGHT THE PERIOD COVERED BY 2015 AGREEMENTS AND TO ILLUSTRATE THE LIKELIHOOD OF ANNUAL VARIATIONS CONTINUING.



Disaster deaths

Disaster deaths, the most commonly reported aspect of disaster events, are key motivators of national and international action on DRR. Taking 34 years of data on absolute disaster deaths (not adjusted for population growth or for the severity of particular hazard events) and applying a Poisson regression highlights that the number of disaster events that have occurred in the past few years has increased compared with two decades ago; the associated total number of annual global deaths from disasters has also increased slightly, because of three high mortality years (2004, 2008, 2010) (see Figure A).

Using these data, adjusting them for population growth and projecting 15 years into the future suggests a decrease in disaster-related deaths (per million population globally). The death rate in 1980 was 14.3 deaths per million people; the figure for 2030 would be 8.1 if the trend is extended. Inevitably given the volatility of the data there is a wide range of uncertainty in how any such statistical forecast can be projected. The high variability in disaster deaths in the observed years also makes it difficult to establish any clear 'trend', and one or two major disasters in the next 15 years, resulting in large numbers of deaths, would challenge any attempts to achieve a reduction in disaster deaths (see Figure B). The global data also hide very significant differences between countries at different levels of economic development. Using the same technique for projecting disaster deaths, the mortality rate in the Philippines for example, would increase by nearly 50% between 1980 and 2030 (22.9 per million in 2030), whereas in the US the decrease would be nearly 60% for the same period (0.8 per million in 2030). Comparing two short time periods using disaster loss data at country level, however, is not reliable statistically, as a major disaster event in the past three decades can greatly influence the variability of the data. This is particularly the case for countries where the total number of disaster events on record is very small.

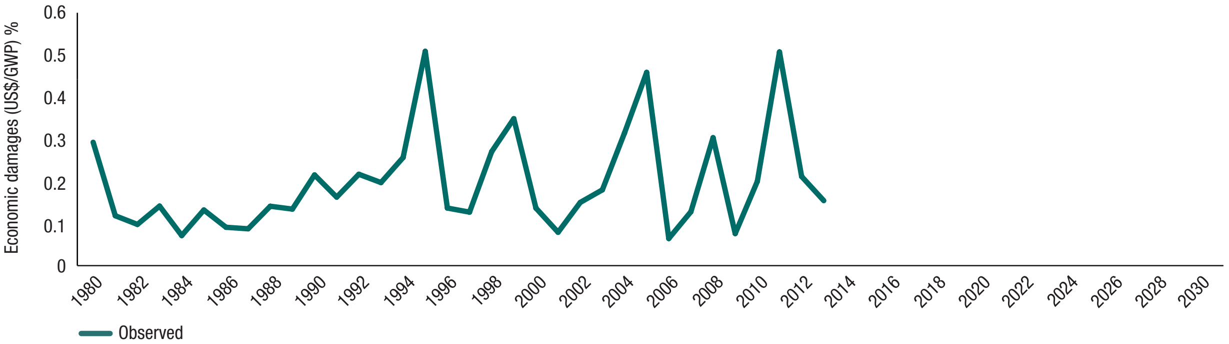
Economic losses

Economic losses from disasters are widely considered to be increasingly rapidly, because more assets are exposed to hazards. Data on global economic disaster losses since 1980, in US dollars based on 2013 US dollar values adjusted by unit of gross domestic product (GDP), show an increase to the present day. When projecting the trend forward to 2030, potential economic losses would be 161% higher in 2030 than they were in 1980. We cannot draw strong conclusions from these economic loss data, however, as it is not easy to disentangle the impact of US dollar inflation, exchange rates and losses arising as a result of the disaster event itself. It should also be noted that only 36% of events recorded for the period 1980-2013 in the CRED database contain data on economic losses. Further, a small number of mega-disasters, dominating the level of global economic losses in any one year, greatly influence the historic record of economic losses (see Figure C). In the future, more reports on direct and indirect economic damages, using a standardised assessment method even for small events, would be desirable. Modelling could also help provide estimates of economic losses where data are missing. Further work is required to produce a reliable record of economic disaster losses, adjusted for inflation and for country GDP.

Figure C: Global economic losses related to gross world product (%), 1980-2013

SOURCE: DRAWING ON HTTP://DATA.WORLDBANK.ORG AND WWW.EMDAT.BE

NOTE: THE 'X' AXIS HAS BEEN EXTENDED TO 2030 TO HIGHLIGHT THE PERIOD COVERED BY 2015 AGREEMENTS AND TO ILLUSTRATE THE LIKELIHOOD OF ANNUAL VARIATIONS CONTINUING.



Links between disasters and poverty

Disasters, climate change and development are inextricably linked: not only do disasters disproportionately affect the poorest and most marginalised people, but also they exacerbate vulnerabilities and social inequalities and harm economic growth. 'Natural' disasters can reverse years of development gains, and threaten efforts to eliminate poverty by 2030. Consequently, any strategy for eradicating extreme poverty must include efforts to prevent impoverishment (the descent below the poverty line of people currently living out of poverty).

Rates of impoverishment are significant and, in some contexts and over certain periods of time, can exceed those related to escapes from poverty (see Figure D, showing an illustrative sample, where comparable data are available, showing high impoverishment rates). Disasters are commonly cited as a major driver of impoverishment and are a significant obstacle to escaping poverty. Their impact on poverty and human development can vary according to both the characteristic of the hazard (e.g. whether it is rapid- or slow-onset and the recurrence time between events) and the degree of resilience at household and community

Figure D: Households escaping from and falling into poverty - selected data to highlight impoverishment potential over particular periods of time

SOURCE: ADAPTED FROM SHEPHERD ET AL. (2014).
NOTE: CALCULATIONS USE NATIONAL POVERTY LINES.

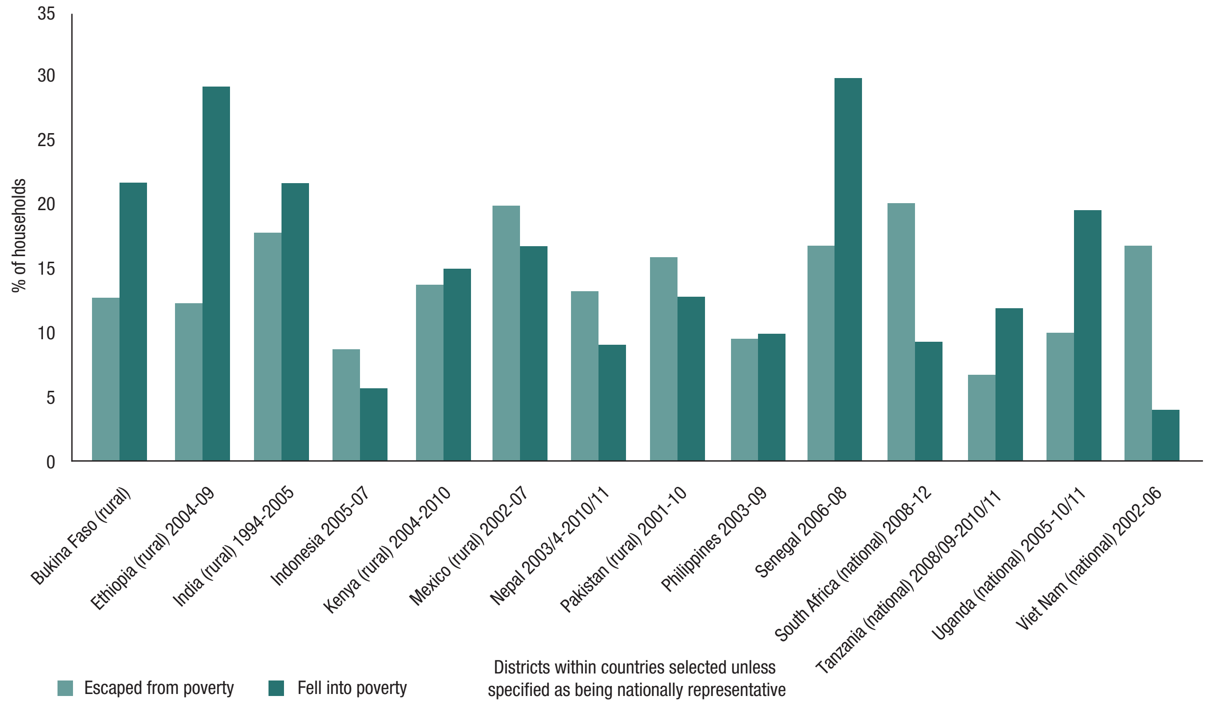


TABLE A: RATES OF IMPOVERISHMENT ACROSS DIFFERENT TIME PERIODS, MATCHED WITH DISASTERS IN THESE PERIODS

Country	Years/ period of time	Annual rate of impoverishment (%)	Information on main disasters (www.emdat.be)
Ethiopia (rural)	1990-1994	4	
	1999-2004	3.6	Drought September 1999 affecting 4.9 million people. Drought 2003 affecting 12.6 million people.
	2004-2009	6	Drought start of 2009 affecting 6.2 million people.
Kenya (rural)	2004-2007	4.7	Drought July 2004 affecting 2.3 million people. Drought December 2005 affecting 3.5 million people.
	2007-2010	4.7	Drought July 2008 affecting 3.8 million people.
South Africa	2008-2010	5	
	2010-2012	4.5	Floods 2011 affecting 200,000 people. Floods October 2012 affecting 125,000 people.

SOURCE: DRAWING ON ETHIOPIA: ETHIOPIAN RURAL HOUSEHOLD SURVEY; KENYA: TEGEMEO AGRICULTURAL SURVEY; SOUTH AFRICA: NATIONAL INCOME DYNAMICS STUDY AND WWW.EMDAT.BE

level (itself a function of assets and endowments). The balance of evidence suggests droughts and extreme rainfall volatility are the hazards most correlated with an increase in poverty.

Without the benefit of more detailed research, only anecdotal comparisons are possible of rates of impoverishment in a given time period in a country with major disaster events falling in the same period. The table above presents an assessment of trends in impoverishment over time using household panel surveys undertaken across different periods. It also gives information on major national covariant shocks. The aim is not to attribute particular rates of impoverishment to these events, but rather to illustrate the context within which countries have been successful, or more usually unsuccessful, at reducing their impoverishment rates. This is a small sample of a longer table included in the main report.

Specifying targets

As described above, a global dataset of disaster losses covering 34 years is not a strong basis on which to establish global disaster mortality targets for 2030, but it is probably the best we have. Loss data would need to be available for a much longer period to enable establishment of a more accurate baseline and projection – although this would also introduce a problem in that demographics and building stock would likely have changed significantly over the time period. Accordingly, until it is possible to produce a reliable global assessment of the risk of losses across a range of hazards at country level, the establishment of targets around disaster losses is as much an art as it is a science. By looking at global and national data and considering the scale of mortality risk reduction some countries have achieved, as well as the relative blend of hazards (those that offer a chance of evacuation or not), **we propose a global target of halving disaster deaths by 2030 (normalised by population exposed)**.The reductions achievable around earthquake fatalities (which accounted for 38% of global mortality from disasters between 1980 and 2013) are likely to be much lower than those for hazards that offer early warning potential – storm surges, tropical cyclones, river floods and tsunamis, for example. Evacuations are much more effective than incremental changes in building stock at saving lives. Relatively radical changes in building types need to be made, such as from unreinforced masonry to wood or steel, depending on the specific hazard involved, in order to make a significant difference. Additionally, cost and time taken to replace building stock are key considerations.

Based on an assessment of country-level evidence and relative trends related to mortality risk and economic loss risk, and given that even standard building codes are designed to save lives rather than limit damages, a proposed target of **reducing economic losses from all disasters by 20% (per unit of GDP) by 2030** could be set. We consider this highly ambitious, given the background trend in many countries of increasing exposure of economic assets. For floods, progress towards this target could be achieved through improved zoning of new construction as well as through the development of flood defences. For earthquakes, progress could be made by replacing the most dangerous buildings with new earthquake-resistant construction and building in areas of low risk. Our analyses for Japan show reductions achieved in casualties have been much larger than those achieved around economic losses.

It is equally difficult to ascertain a globally representative figure for rates of impoverishment, given the relative paucity of household surveys investigating the role of natural hazards and disasters in any depth. However, based on the few data points available, it is clear that preventing all impoverishment resulting from disasters will not be possible, as the immediate impacts (hours, days and weeks) following a disaster are very difficult to mitigate entirely, even in the wealthiest societies. However, it appears reasonable (based on case study evidence) to expect to be able to reverse post-disaster impoverishment after a period of months or at maximum a year. Accordingly, a target within the context of poverty eradication could be as follows: **A shock, such as a disaster, does not increase poverty levels, as measured 12 months after the event.** It is important to note that a target focused on disasters alone may not be appropriate, as processes of impoverishment are complex and commonly involve interconnected factors that are hard to distinguish. This is a challenging target, since the impact of a disaster on poverty depends on the type of hazard, the context, the scale and the nature of the recovery process. More process-oriented and input targets could focus on 'reducing the exposure of poor people to extreme hazards by x%' or be as follows: '100% of post-disaster recovery plans address the impact of disaster on poverty'.

Factors to consider in developing global and national disaster risk reduction targets and tracking progress

In establishing a target and indicator framework across the SDGs and the post-2015 framework on DRR, we need to address some fundamental questions:

Is a global aggregate target directly applicable at country level? If a proposed global target is to 'halve disaster deaths by 2030', is it appropriate to adopt this as a national target also? Based on the data assessed in the report, we believe it is vital to establish a global target to guide progress but, given the wide variety of national risk contexts, it does not make sense to apply this single common target directly to every country. Support should be given instead to a process of national differentiation, shaped by agreed parameters for establishing national commitments, and registering these within an international reporting framework. This increases the likelihood of country ownership. This process of setting national targets would need to be independently reviewed, and guidance given based on the country profile (hazard risk, possible mitigation methods, economic band, exposure at risk).

Should progress reports on implementing the SDGs and the post-2015 framework on DRR be synchronous? The target timeframe and reporting protocol for the SDGs and the post-2015 framework on DRR need to align fully to avoid unnecessary duplication or burdening on reporting capacity at the national level.

Do global disaster loss data offer the best way of tracking progress? Any global, regional or national trends in disaster losses must be treated with caution, as accurate data on disaster losses are not available for many countries. In addition, severe hazard events and major disasters can be so rare in any one region that they are not taken into account within the time sample. A global disaster monitoring system rooted at the national level, as described below, will need to tackle these challenges. A common target and indicator framework should have targets linked to disaster risk as a way of estimating expected losses. This is necessary to establish a clear picture of progress on DRR at national and global level.

How can progress in reducing expected losses be measured globally and nationally? National disaster data are often very 'noisy', meaning they may be dominated by whether an extreme event has, or more often has not, occurred within that observation period. Accordingly, it is not possible to establish a true statistical average for mortality or economic losses from only a few decades of national loss data. An example of this is for Haiti, where earthquakes killed fewer than 10 people between 1900 and 2009 before over 220,000 people were killed in a single afternoon in 2010. Therefore, both in establishing baselines and in measuring progress on DRR, it is necessary to use other methods of measuring disaster risk.

One way is to use a catastrophe loss model containing a synthetic catalogue of tens of thousands of years of potential events, as widely used by the insurance industry. However, such models are complex, do not cover every country and can be expensive to build. A simpler and more practical method, available globally, involves employing 'proxies' for expected disaster casualties and economic loss. For earthquake, the proxy method takes the level of ground-shaking hazard established at one or more consistent annual probability as shown on a hazard map (such as the 0.2% or 500-year average return period), and collects data on the numbers of buildings in each hazard zone, classified into categories according to their susceptibility to collapse. Based on identifying the population expected to be within these collapsed buildings, it becomes possible to sum across all zones, multiplying by the probability of the hazard, to find the expected number of casualties per year. For hazards with the potential for early warning and evacuations, such as floods, the method also uses consistent hazard maps to identify the population at risk. Based on expected warning times, and the rigour of the evacuation planning, the proportion of this population expected to be saved is calculated. The use of hazard maps and proxies provides a simpler way of tracking risk-based loss information. Agreement on the hazards measured and standardisation of data are critical for the application of this monitoring framework.

Ten propositions for a global monitoring framework on disaster risk reduction

The following propositions, based on assessments in this report, focus on agreeing common targets and indicators for DRR and establishing national and global monitoring systems to track progress:

1. **A target set on DRR should combine the targets with a methodology that assesses levels of disaster risk.** Only then can we adequately track progress on reducing disaster risk. Given the short timeframe between now and 2030, assessing trends in observed disaster losses might give a false impression of success if countries or regions are lucky in avoiding severe disaster events in the period.

2. **Such targets should be included in both the SDGs and the post-2015 framework on DRR, using identical language.** A single set of goals, targets and indicators spanning the SDGs and the post-2015 framework on DRR would clarify priorities, increase logic and coherence and minimise the amount of work required to develop monitoring and reporting capacity. Such indicators could monitor inputs and outputs, such as the presence of plans or legislation, or the number of people effective early warning systems cover or of school and health facilities built to hazard-resistant building codes, linked to the hazard risk in the area.

3. **It is important to establish clear, numerical targets at a global scale to act as eye-catching awareness-raising components of the SDGs and the post-2015 framework on DRR, and also to help direct actions. Space should be created for the differentiation and self-determination of targets at national level, however.** Differences between countries in terms of their potential to reduce risks, as a result of previous actions and exposure to certain types of hazards, means one-size-fits-all targets – like halving disaster deaths – are not appropriate for all. Instead, countries should be encouraged to establish their own levels, in light of the global target, and to select from a basket of indicators, and then to register these as part of the reporting process. This is likely to promote greater ownership and relevance. However, this would necessitate independent review and guidance based on the country profile (hazard risk, possible mitigation methods, economic band, exposure at risk).

4. **A disasters data revolution is needed, involving the systematic collection of data on disaster risk and losses across countries, to enable the establishment of national and global trends.** This revolution can happen only if DRR targets and indicators are included in the SDGs and are treated as part of a much wider movement to improve the quality and availability of data on sustainable development. This is why it is so vital to include DRR in the SDGs. Without such data, no country can truly know if it is becoming more or less resilient to the impacts of hazards. Disaster risk data can be used to monitor progress over time, whereas disaster loss data improve our understanding of the risk and how best to provide mitigation measures, as well as feeding hazard maps and models.

5. **A monitoring methodology for tracking national progress on DRR must focus on the use of detailed disaster risk information**, including high-resolution data on national building inventories, population data (including by socioeconomic group), mapped hazard data and DRR plans. This makes it possible to measure levels of disaster risk using the real experience of disaster losses to validate findings. Although there has been some progress, there will be a need for investment in setting up a technical support programme to address the challenge outlined here.

6. **Upgrades to poverty data should involve modules on shocks.** Where countries start more comprehensive and regular monitoring of poverty dynamics, potentially by extending household surveys, these or other data collection methods should incorporate modules or questions on the impact of disaster events on income poverty and other dimensions of human development, such as health or school attendance.

7. **To increase simplicity, logic and integration, the SDGs and the post-2015 framework on DRR should include DRR targets with the same start and end points (e.g. targets set from 2015 to 2030), with synchronous reporting periods.** Any mismatch of timeframes or irregularity of reporting periods will increase the workload for countries, stretching their capacity to monitor progress across a range of targets.

8. **Tracking progress on disaster losses and risks requires the normalisation of data for key variables, like population or GDP, to allow for comparisons between time periods. It also requires the establishment of a baseline against which progress can be assessed.** As records of losses from only a few decades typically under-sample the impact of the most extreme disasters, the baseline should be based principally on the assessed level of risk (of losses) in that country, based on the use of proxies indicative of casualties and economic losses. The methodology to define the baseline must be consistent with how progress is measured.

9. **The institutional architecture for delivering a global monitoring system needs to involve multiple**

groups at different scales, each serving a distinct function. While the responsibility for monitoring progress on DRR lies with national governments, a facilitating body at international level, such as the UN Office for Disaster Risk Reduction (UNISDR), is needed to collect data and help strengthen national and local monitoring capacity. Such a body would need to involve national statistical offices and other relevant governmental bodies in order to be able to collect the required data, including census data. This could be supported by regional technical agencies, with data also drawn from the scientific community to establish risk profiles, from technology companies (satellite data to approximate building coverage, for example) and from other groups on disaster losses. The institutional architecture should span the post-2015 framework on DRR and the SDGs so as not to create duplication.

10. **While governments will continue to self-report progress, it is vital that independent groups at all levels can contribute to the overall framework for monitoring progress on DRR. This will help with transparency and accuracy.** The original framework for monitoring progress on the post-2015 framework on DRR – the Hyogo Framework for Action (HFA) monitor – has suffered from being a self-reporting platform, with global and regional institutions unable to check claims or accurately compare reports between countries. An independent international technical group has an important role to play in helping guide standards (e.g. in definitions[1] or methods for risk assessment), assess data quality and transparency and support other potential processes of accountability, including country-to-country peer review.

1. The Integrated Research on Disaster Risk (IRDR) programme is currently leading a working group on definitions.

1.

Introduction

Disasters, climate change and development are inextricably linked: not only do disasters disproportionately affect the poorest and most marginalised people, but also they exacerbate vulnerabilities and social inequalities and harm economic growth. 'Natural' disasters can reverse years of development gains, and threaten efforts to eliminate poverty by 2030. Weather-related hazards are increasing in scope, frequency and intensity (IPCC, 2012), but exposure to hazards is also increasing quickly, as more people, infrastructure, assets and livelihoods are present in hazard-prone areas (Mitchell et al., 2012).

The Hyogo Framework for Action (HFA)[2] – the global agreement to reduce disaster risk – and the Millennium Development Goals (MDGs)[3] will come to an end in 2015, and the UN Framework Convention on Climate Change (UNFCCC)[4] deadline to create a legally binding climate agreement for global action on tackling climate change is fast approaching. The time is ripe to consider how to align these independent processes and join up the development, climate and disaster frameworks in an effort to secure disaster resilience. It is therefore essential to consider how to effectively integrate climate change and disaster risk reduction (DRR) into development strategies and to ensure efforts to eradicate poverty by 2030 are realistic and can be met in the face of complex and growing disaster risk. This must be done while simultaneously considering how to more closely align the post-2015 framework on DRR with the post-2015 development goals in order to enable action at all levels 'to manage disaster risks and climate change in a way that facilitates sustainable development' (UNISDR, 2014a; 2). If integrated well, they provide a unique opportunity to deliver a coherent strategy and implementation plan to tackle the drivers of disaster risk and reduce disaster losses, and represent an important step towards safer lives and livelihoods.

We have discussed how to include DRR in the post-2015 development agenda at length in previous publications, which have aimed to show why a target on reducing disaster losses is crucial for ending poverty by 2030. Three scenarios are explored in 'Disaster Risk Management in Post-2015 Development Goals: Potential Targets and Indicators'[5]: a standalone goal on disasters, supported by targets; a target on disasters within a goal on 'resilience', 'security' or 'tackling obstacles to development'; and integration of DRR into other goals (Mitchell et al., 2013; viii). 'The Geography of Poverty, Disasters and Climate Extremes in 2030' [6] examines the relationship between disasters and poverty more closely, and concludes that, 'without concerted action, there could be up to 325 million extremely poor people living in the 49 countries most exposed to the full range of natural hazards and climate extremes in 2030'[7] (Shepherd et al., 2013; vii). The report argues that, 'if the international community is serious about eradicating poverty by 2030, it must address the issues covered in this report and put DRM [disaster risk management] at the heart of poverty eradication efforts. Without this, the target of ending poverty may not be within reach' (Shepherd et al., 2013; vii).

Although there are many synergies among the post-2015 agendas for the three frameworks mentioned above, this report focuses mainly on the post-2015 development agenda (what has been termed the Sustainable Development Goals (the SDGs)) and the post-2015 framework on DRR.

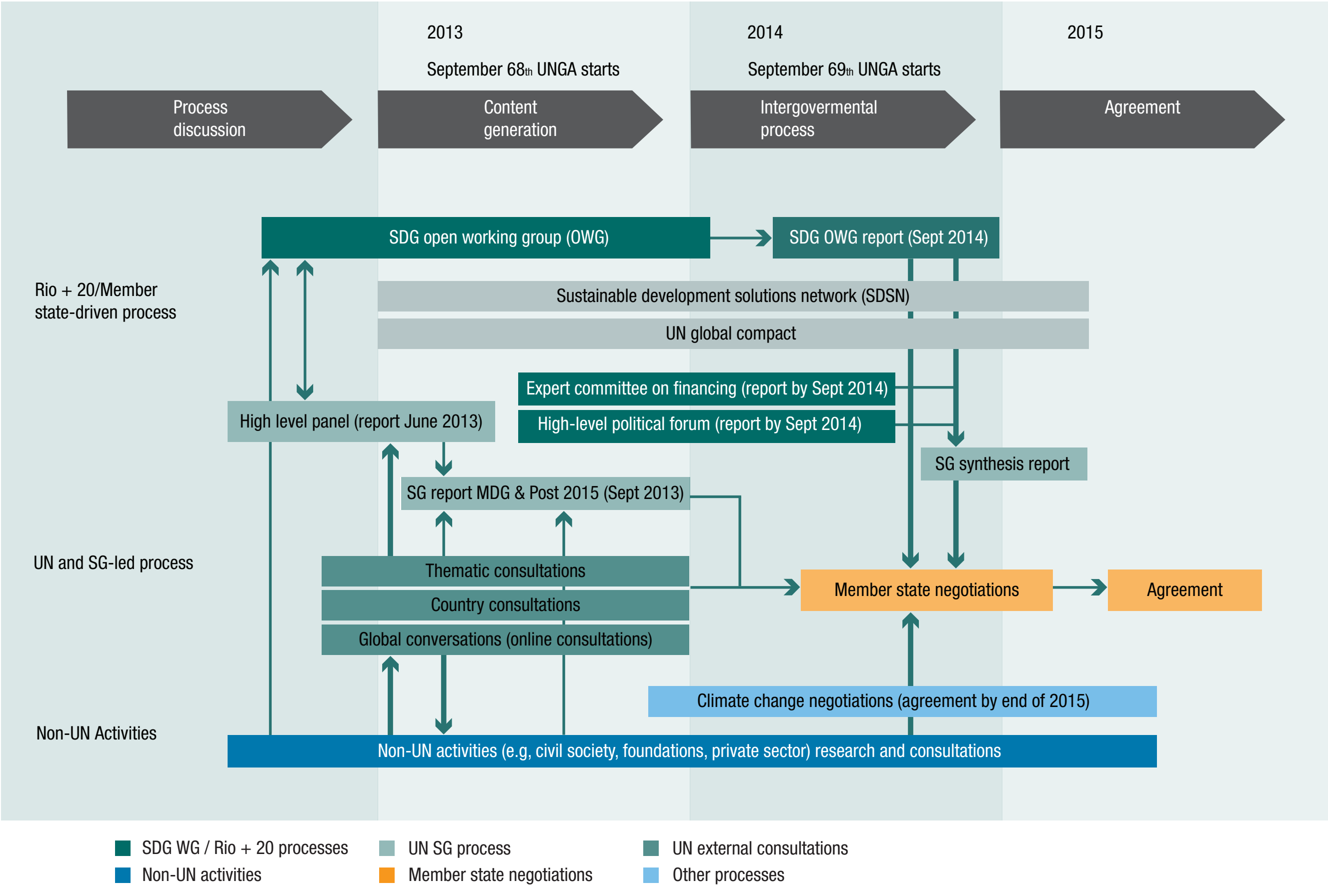
1.1 The processes for the Sustainable Development Goals and the post-2015 framework on disaster risk reduction

The post-2015 processes mentioned above have been running relatively independently until recently – and not solely because different stakeholders and UN agencies manage them. This section considers what some of these processes are for the SDGs and for the post-2015 framework on DRR, and goes on to discuss some of the considerations involved in setting targets under each.

2. http://www.unisdr.org/we/coordinate/hfa
3. http://www.un.org/millenniumgoals/
4. http://unfccc.int/2860.php
5. http://bit.ly/1mKRdjZ
6. http://bit.ly/1uyvcYr
7. According to the World Bank (2013), 1.2 billion people still live on less than $1.25 per day, despite massive strides on poverty in the past 30 years. The number of people living in extreme poverty in Sub-Saharan Africa has actually increased, from 205 million in 1981 to 414 million in 2010 (Shepherd et al., 2013).

Figure 1: Processes feeding into the post-2015 development agenda

SOURCE: ADAPTED FROM UN FOUNDATION AND DALBERG ANALYSIS.
AVAILABLE FROM: HTTP://UNSDSN.ORG/WHAT-WE-DO/SUPPORT-FOR-POST-2015/POST-15-PROCESSES/



1.1.1 The Sustainable Development Goals

The 2010 MDG Summit recognised the need to initiate thinking on the post-2015 development agenda. In June 2012, at the Rio+20 Conference on Sustainable Development, Member States agreed to converge the MDGs, environment concerns and the post-2015 development agenda in order to create a set of global SDGs, to incorporate economic, social and environmental dimensions of sustainable development. Although much of this goal framework can already be anticipated, its final shape will not be decided until September 2015. A number of processes and initiatives have been established to help support the SDGs; Figure 1 gives a summary. Box 1 discusses the primary post-2015 processes and the actors helping develop the SDGs.

1.1.2 The post-2015 framework on disaster risk reduction

The post-2015 framework on DRR builds on implementation of the International Framework for the International Decade for Natural Disaster Reduction (1989), the Yokohama Strategy and Plan of Action (1994), the International Strategy for Disaster Reduction (1999) and the HFA (2005-2015): Building the Resilience of Nations and Communities to Disasters (UNISDR, 2014a).

In December 2011, UN General Assembly Resolution 66/199 requested that the UN Office for Disaster Risk Reduction (UNISDR) facilitate the development of a post-2015 framework on DRR.[8] The HFA has since been going through considerable deliberations in order to prepare for the post-2015 successor framework related to DRR. Consultations began in March 2012 and have included international meetings, regional platforms, intergovernmental organisation meetings, national dialogues, stakeholder forums and social networks, 89 of which were held between March 2012 and May 2013.[9] Figure 2 summarises some of the consultations that have taken place since 2013. In March 2015, at the Third World Conference on Disaster Risk Reduction (WCDRR) in Sendai, Japan, UN Member States are due to adopt a successor to the HFA, which the UN General Assembly is then due to endorse later in 2015.

8 http://www.unisdr.org/we/coordinate/hfa-post2015

9 http://www.preventionweb.net/posthfa/

BOX 1: THE PRIMARY POST-2015 DEVELOPMENT AGENDA AND SDG PROCESSES AND ACTORS

At the Rio+20, the UN General Assembly mandated an Open Working Group (OWG) of the General Assembly on Sustainable Development Goals to formulate proposals for the SDGs (UN General Assembly, 2013); the OWG was charged with making these proposals 'limited in number, aspirational and easy to communicate'.[10] In addition to the OWG, a number of other groups play an important role in helping design the SDG framework. **The High-Level Panel (HLP) of Eminent Persons on the Post-2015 Development Agenda** has been asked to 'propose a framework for the post-2015 Development Agenda and to highlight priority areas for post-2015 goals'.[11] The **UN System Task Team (UNTT) on the Post-2015 UN Development Agenda** helps provide outreach as well as analytical and substantive inputs to the process, and is currently focused on three work streams: global partnership for development; monitoring and indicators; and financing for sustainable development.[12] The **Sustainable Development Solutions Network (SDSN)** aims to mobilise scientific and technical expertise on sustainable development and promotes integrated approaches to economic, social and environmental issues.[13] The **UN Global Compact** has been 'actively involved in ensuring that the views and contributions of businesses and the private sector feed into the post-2015 process'.[14] And the **UN High-Level Political Forum on Sustainable Development** provides leadership and helps review progress on sustainable development implementation.[15]

The **UN Development Group's (UNDG's)** 'common objective is to deliver more coherent, effective and efficient support to countries seeking to attain internationally agreed development goals'.[16] The UNDG has consequently initiated national and **regional consultations** as well as 11 thematic consultations. A total of 88 countries have arranged national consultations on the post-2015 development agenda to exchange ideas for a shared vision of **'The World We Want'.**[17] **My World** has also been established, which allows users from across the world to select their 6 priorities out of a list of 16 different themes; the results of this are then submitted to the UN Secretary-General's High-Level Panel. The Regional Economic Commissions are also engaged in **regional consultations,** which have resulted in a report on regional perspectives on the post-2015 development agenda. The UNDG's 11 **thematic consultations** have been on education; inequalities; health; governance; conflict and fragility; growth and employment; environmental sustainability; hunger, nutrition and food security; population dynamics; energy; and water; the 'consultations aim to explore the role such themes could play in a new framework, different ways in which they can be best addressed, and the interlinkages between them'.[18]

In addition, there are 'many civil society and business processes underway in support of the post-2015 development agenda.'[15] These include the **Independent Research Forum** and the **Southern Voice on the Post-2015 MDG Development Agenda**; additional resources on 'post-2015 are available on post2015.org (coordinated by the Overseas Development Institute) and worldwewant2015.org (hosted by the United Nations)'[19].

In the lead-up to March 2015, there have been a number of ministerial conferences and regional platforms on DRR, the outcome documents are as follows:

- Outcome of Fifth Africa Regional Platform for Disaster Risk Reduction, 13-16 May 2014, Abuja, Nigeria (A/CONF.224/PC(I)/7)[20]
- Outcome of Fourth Session of Regional Platform for Disaster Risk Reduction in the Americas, 27-29 May 2014, Guayaquil, Ecuador (A/CONF.224/PC(I)/8) [21]
- Outcome of Sixth Session of Pacific Platform for Disaster Risk Management, 2-4 June 2014, Suva, Fiji (A/CONF.224/PC(I)/9) [22]
- Outcome of Second Arab Conference on Disaster Risk Reduction, 14-16 September 2014, Sharm El Sheikh, Egypt (A/CONF.224/PC(I)/10) [23]
- Outcome of Sixth Asian Ministerial Conference on Disaster Risk Reduction, 22-26 June 2014, Bangkok, Thailand (A/CONF.224/PC(I)/11) [24]

10 http://sustainabledevelopment.un.org/owg.html
11 http://unsdsn.org/what-we-do/support-for-post-2015/post-15-processes/
12 http://www.un.org/en/ecosoc/about/mdg.shtml
13 http://unsdsn.org/about-us/vision-and-organization/
14 http://sustainabledevelopment.un.org/index.php?menu=1561
15 http://unsdsn.org/what-we-do/support-for-post-2015/post-15-processes/
16 http://www.undg.org/content/about_the_undg
17 http://www.worldwewant2015.org/sitemap#thematic
18 http://www.un.org/en/development/desa/policy/untaskteam_undf/process.shtml
19 http://unsdsn.org/what-we-do/support-for-post-2015/post-15-processes/
20 http://bit.ly/YGwe6P
21 http://bit.ly/10jqnFG
22 http://bit.ly/1pnWVnz
23 http://bit.ly/1vsUc1U
24 http://bit.ly/1rq2FD5

Figure 2: Towards a post-2015 framework on disaster risk reduction

SOURCE: ADAPTED FROM UNISDR (2014B) VERSION 27 MAY 2014

NOTES: REQUESTED BY THE UN GENERAL ASSEMBLY RESOLUTION A/RES/66/199 – MODALITIES AGREED IN A/RES/68/211. UNISDR IS FACILITATING CONSULTATIONS THAT ENGAGE A FULL RANGE OF ACTORS FROM MEMBER STATES TO CIVIL SOCIETY. CONSULTATION EVENTS INCLUDE THE GLOBAL AND REGIONAL PLATFORMS, NATIONAL AND LOCAL EVENTS AND TARGETED EVENTS OF STAKEHOLDERS, PARTNERS AND NETWORKS. BUILDS ON THE INTERNATIONAL FRAMEWORK FOR THE INTERNATIONAL DECADE FOR NATIONAL DISASTER REDUCTION OF 1999, THE HYOGO FRAMEWORK FOR ACTION 2005-2015: BUILDING THE RESILIENCE OF NATIONS AND COMMUNITIES TO DISASTERS (HFA), AND THE MID-TERM REVIEW OF THE HFA (2010-2011). EXPECTED TO BE ADOPTED AT THE 3RD WORLD CONFERENCE ON DISASTER RISK REDUCTION AND ENDORSED BY THE UN GENERAL ASSEMBLY IN 2015.

2013	2014	2015
Consultations started in March 2012 (with some 89 events up to the Global Platform) therough 2013…	… and continues in 2014	
Ministerial conferences and regional platforms on disaster risk reduction Feb 13-15 : Africa (Arusha, Tanzania) Mar 19-21: Arab states (Aqaba, Jordan) Sept 23-25: Europe (Oslo, Norway)	Ministerial conferences and regional platforms on disaster risk reduction. Apr 1-2: Central Asia (Al-Maty, Kazakhstan – consultation meeting) May 13-16: Africa (Abuja, Nigeria) May 27-29: Americas (Guayaquil, Ecuador) Jun 2-4: Pacific (Suva, Fiji) Jun 23-26: Asia (Bangkok, Thailand) Jul 8: Europe (Milan, Italk / Ministerial Session) Sep 14 – 16: Arab States (Sharm El Sheikh Oct 6-8: Europe (Madris, Spain / European Forum)	Mar 14-18 / Sendai, Japan The 3rd World Conference on Disaster Risk Reduction will renew the implementation of the Hyogo Framework for Action and is expected to adopt a successor framework for disaster risk reduction.
May 19-23 Global Platform for Disaster Risk Reduction (Geneva, Switzerland)		Sep-Nov UN Secretary- General's report and UN General Assembly Resolution on the International Strategy for Disaster Reduction. The UN General Assembly Session will also consider the post 2015 disaster risk reduction framework for endorsement.
Sep-Nov UN Secretary-General's Report and UN General Assembly resolution on the International Strategy for Disaster Reduction.	Jul 14-15 1st preparatory committee meeting (Geneva, Switzerland) Subject to an anticipated decision of UN General Assembly 2013.	
	Nov 17-18 2nd preparatory committee meeting (Geneva, Switzerland) Subject to an anticipated decision of UN General Assembly 2013.	
	Sep-Nov UN Secretary-general's Report and UN General Assembly Resolution on the International Strategy for Disaster Reduction	

- Outcome of European Ministerial Meeting on Disaster Risk Reduction, 8 July, Milan, Italy (A/CONF.224/PC(I)/12) [25]

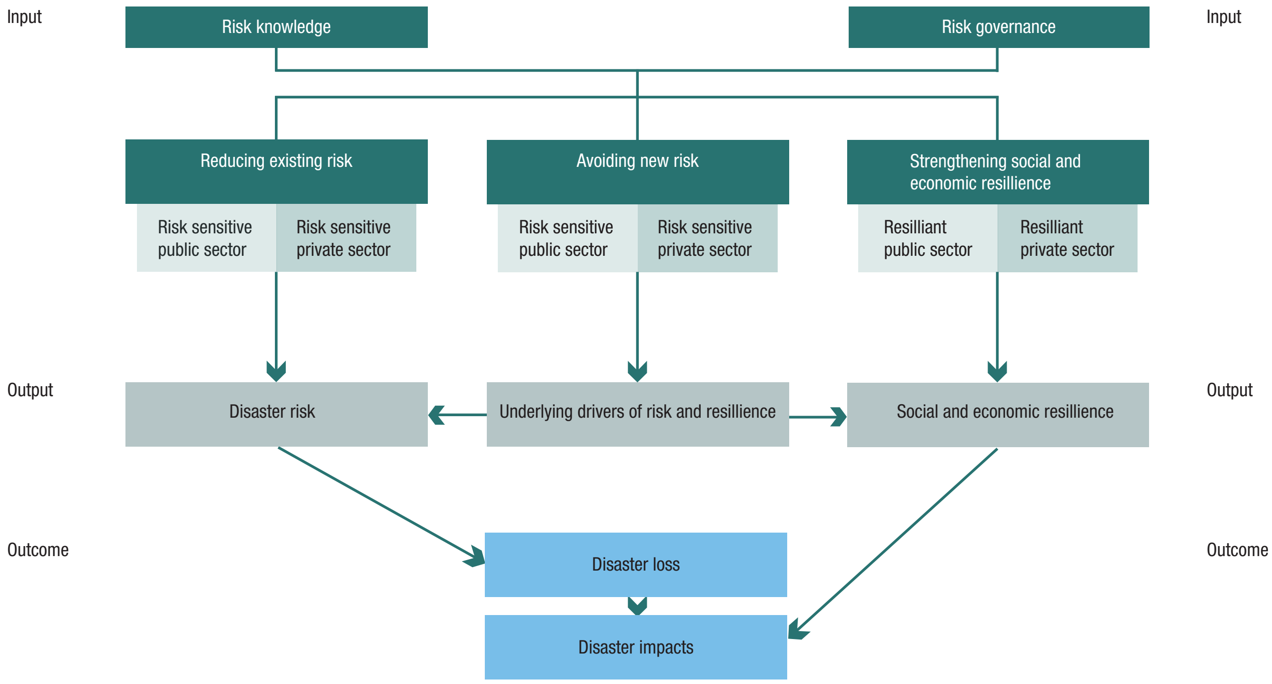
Following the regional platforms, UN General Assembly Resolution A/RES/68/211 called for two Intergovernmental Preparatory Committee Meetings (PrepComs) of the WCDRR: PrepCom1[26] was held in July 2014, and PrepCom2 is planned for 17-18 November 2014. The PrepComs have been tasked to review the organisational and 'substantive preparations for the conference, approve the programme of work of the Conference, and propose rules of procedure for adoption by the Conference'.[27] PrepCom1 was mandated to produce a pre-zero draft of the post-2015 framework on DRR[28], which PrepCom Co-Chairs Ambassadors Päivi Kairamo (Finland) and Thani Thongphakdi (Thailand) presented on 8 August 2014. This pre-zero draft will serve as the basis for the open-ended informal consultative meetings[29] that will take place in September and October 2014. Based on these consultative meetings, the co-chairs will prepare a zero draft by mid-October 2014 for consideration at PrepCom2.

The recent UNISDR draft paper 'Post-2015 Framework on Disaster Risk Reduction: A Proposal for Monitoring Progress' [30] (UNISDR, 2014a) provides guidance on the

25 http://bit.ly/1ou7dT0
26 http://bit.ly/1wU3TWr
27 http://www.wcdrr.org/preparatory/prepcom1
28 http://bit.ly/1uqHmlK
29 http://bit.ly/1ou8KbH
30 http://wcdrr.org/documents/wcdrr/prepcom1/Indicator%20system%20for%20Post%202015%20Framework%20June%202015_v3.pdf

Figure 3: Proposed architecture of the indicator structure

SOURCE: ADAPTED FROM UNISDR (2014;11).



indicators, monitoring and review process for the post-2015 framework on DRR. Figure 3 shows the proposed architecture of the indicator structure. The paper proposes a number of global goals (at the outcome level) which countries can then use to help frame their national plans; they would then be expected to develop national targets at the output level to help them implement these national plans. In addition, 'the monitoring framework includes a menu of public policy indicators at the Input level' which countries could then select in line with their policy approaches to DRR (UNISDR, 2014a; 7). At the outcome level, indicators will consider disaster loss in terms of mortality, physical damage and economic loss; and impacts in terms of 'health, education, employment, productivity, income poverty, inequality and other metrics – many of which are both causes and consequences of disasters' (UNISDR, 2014a; 10); this would try to indicate to what 'extent disaster loss is affecting social and economic development' (UNISDR, 2014a; 10). However, using disaster losses to measure progress poses problems, as we discuss later. As a guide to some of the important aspects of the successor to the existing HFA, the Overseas Development Institute (ODI) and the Climate and Development Knowledge Network (CDKN) recently produced 'The Future Framework for Disaster Risk Reduction: A Guide for Decision Makers'[31] (Kellett et al., 2014). By presenting evidence in the form of data, facts and summary messages, the modules highlight what a new agreement should cover. There are seven modules: Making the Case; The Architecture; Financing; Vulnerability and Inclusion; Climate Change, Conflict and Fragility; and Stakeholders and Leadership, with a number of modules already planned for a future edition of the guide, including including Interfaces with other agreements; Monitoring and accountability and Environment and Ecosystems.

1.1.3 Proposed targets

Targets on reducing disaster risk and tackling disaster losses are rightly included in the latest set of targets under consideration by the OWG for the SDGs (see Box 2).

Box 3 presents the purpose, scope, outcome, goals and priorities of action suggested in the pre-zero draft of the post-2015 framework on DRR. Of the global goals proposed in the pre-zero draft, goals (10) a, b and c are most closely aligned with proposed goal 11.5 in Box 2. At this stage, both the SDG proposal and the post-2015 DRR framework proposal have not clarified what the percentage rates or reporting periods should be.

1.1.4 Aligning these processes

There are many synergies between the SDGs, the post-2015 framework on DRR and the UNFCCC agenda. The latter is organised around climate change mitigation, climate change adaptation and loss and damage, and is therefore closely aligned with the SDGs

31 http://bit.ly/1qtMa5r

BOX 2: INTRODUCTION AND PROPOSED GOALS AND TARGETS ON SUSTAINABLE DEVELOPMENT FOR THE POST-2015 DEVELOPMENT AGENDA (AS OF SATURDAY 19 JULY 2014)

Proposed goal 1. End poverty in all its forms everywhere

1.5 by 2030 build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

Proposed goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

2.4 by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality

Proposed goal 3. Ensure healthy lives and promote well-being for all at all ages

3.d strengthen the capacity of all countries, particularly developing countries, for early warning, risk reduction, and management of national and global health risks

Proposed goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

11.5 by 2030 significantly reduce the number of deaths and the number of affected people and decrease by y% the economic losses relative to GDP caused by disasters, including water-related disasters, with the focus on protecting the poor and people in vulnerable situations

11.b by 2020, increase by x% the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, develop and implement in line with the forthcoming Hyogo Framework holistic disaster risk management at all levels

Proposed goal 13. Take urgent action to combat climate change and its impacts *

*Acknowledging that the UNFCCC is the primary international, intergovernmental forum for negotiating the global response to climate change.

13.1 strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries

13.3 improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning

13.b Promote mechanisms for raising capacities for effective climate change related planning and management, in LDCs, including focusing on women, youth, local and marginalized communities

SOURCE: ADAPTED FROM HTTP://SUSTAINABLEDEVELOPMENT.UN.ORG/FOCUSSDGS.HTML

through Goal 13 on climate change, and with the post-2015 framework in terms of DRR, adaptation and building resilience. The SDGs and the post-2015 framework on DRR are clearly closely aligned, and the achievement of one set of goals/targets will have a direct impact on the achievement of the other; they therefore need to be 'mutually supportive' (UNISDR, 2014a; 13).

Although discussions have arisen with regard to how long the period for the post-2015 framework on DRR should be, and what the monitoring periods should be, it is essential that these be aligned with the SDGs in order to streamline these processes for Member States trying to take action and implement numerous frameworks and policies to reduce disaster risk and build sustainable development. Given the timing of these agreements, coherency is troubling: the WCDRR in Sendai, Japan, is in March 2015, before the finalisation of the SDGs, which are not due to be decided until September 2015. There is also likely to be differentiation between the frameworks in terms of whether there will be different targets at the national level or not. This is another consideration when thinking about implementation, monitoring and evaluation. It is therefore essential to consider the politics of who decides what and how. A report on these issues would be extremely timely.

BOX 3: PURPOSE, SCOPE, OUTCOME, GOALS AND PRIORITIES OF ACTION FROM THE PRE-ZERO DRAFT OF THE POST-2015 FRAMEWORK ON DISASTER RISK REDUCTION (AS OF FRIDAY 8 AUGUST 2014)

7. The purpose of the present framework is to manage disaster and climate risk in development at local, national, regional and global levels for resilience of people, communities and countries.

8. The present framework applies to the risk of small and large-scale, frequent and infrequent, disasters caused by natural hazards and related environmental and technological hazards and risks.

9. In keeping with the HFA expected outcome, the present framework aims to achieve the substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries.

10. To support the assessment of global progress in achieving the expected outcome, five global targets are identified:
   a. reduce disaster mortality by [a given percentage in function of number of hazardous events] by 20[xx];
   b. reduce the number of affected people by [a given percentage in function of number of hazardous events] by 20[xx];
   c. reduce disaster economic loss by [a given percentage in function of number of hazardous events] by 20[xx];
   d. and reduce disaster damage to health and educational facilities by [a given percentage in function of number of hazardous events] by 20[xx];
   e. increase number of countries with national and local strategies by [a given percentage] by 20[xx].

11. To attain the expected outcome, the following three strategic and mutually-reinforcing goals are pursued:
   I. The prevention of disaster risk creation which requires the adoption of risk informed growth and development measures that aim to address increase in exposure and vulnerability.
   II. The reduction of existing disaster risk which requires measures that address and reduce exposure and vulnerability, including preparedness for disaster response.
   III. The strengthening of persons, communities and countries' disaster resilience which requires social, economic and environmental measures that enable persons, communities and countries to absorb loss, minimize impact and recover.

D. Priorities for action

13. In pursuing the three strategic goals, and drawing from the knowledge and experience matured in the implementation of the HFA and the previous instruments, there is a need for focused, specific, yet mutually supportive actions in the local, national, regional and global contexts, in key priority areas, namely understanding disaster risk; strengthening governance to manage disaster risk; preparedness for response, recovery and reconstruction; and investing in social, economic, and environmental resilience.

SOURCE: ADAPTED FROM: WWW.WCDRR.ORG/DOCUMENTS/WCDRR/PREZERO_DRAFT_POST2015_FRMWK_FOR_DRR_8_AUGUST.PDF

1.2 Setting targets for the Sustainable Development Goals and the post-2015 framework on disaster risk reduction

1.2.1 The Sustainable Development Goals

The SDGs will likely comprise an overarching narrative or chapeau accompanied by a framework of goals, targets and indicators. The OWG report, to be considered by the General Assembly in September 2014, will be followed by a report from the UN Secretary-General, and then a draft final text, which Member States will negotiate during 2015. The OWG proposals include global goals and targets but not indicators. It is not certain that the agreement in September 2015 will include indicators – the means of measuring progress on the post-2015 development agenda.

A well-formulated goals framework would have several key attributes if it were to be useful and effective. The framework of goals, targets and indicators needs to be aspirational and to specify desired outcomes. It needs to be easy to understand and to be time-bound. The different elements of the framework have their own attributes, summarised in the Table 1.

The SDGs will have to balance the need to reflect the full range and complexity of sustainable development challenges facing the world, including disaster risk, with the need for a focused, concrete and easy-to-understand goals framework (IRF, 2014a). These challenges may be captured in the framework at

TABLE 1: POTENTIAL STRUCTURE OF SDGS GOALS, TARGETS AND INDICATORS

Element	Definition		Scope
Goal	Aspiration:	An ambitious commitment to address a single challenge.	Global
Target	Action:	A specific, measurable and time-bound outcome that contributes to achievement of a goal.	Global or national; may be aggregated to assess global progress
Indicator	Accountability for results:	A metric used to measure progress towards a target; generally based on available or established data.	Global or national; may be aggregated to assess national or global progress

SOURCE: ADAPTED FROM IRF (2014B).

the level of goal, target or indicator. While the goals should address the most significant development challenges, some key challenges may be mainstreamed across goals and targets rather than feature as goals in themselves. Reducing disaster risk, for example, is one of fourteen mainstreamed topics identified in the zero draft of the OWG (2014). Its outcome document specifically addresses disasters under five different goals (1, 2, 3, 11 and 13).

The number of potential targets in the SDG framework is large (the OWG proposal has 169 targets). The selection of targets will therefore be an important part of the SDG process, and UN agencies and other stakeholders have suggested several criteria for this. Among technical experts, there is general agreement about the key factors to be considered. The Independent Research Forum (IRF) (2014c), Stakeholder Forum (Cutter et al., 2014) and SDSN (2014) all argue the overall goal framework should be universal, transformative and integrated. They also agree targets should be results- or action-oriented (outcome- rather than output-based) and measurable and time-bound.

Each of these criteria for selecting or assessing goals and targets presents its own challenges and questions. The concept of universality, for example, has more than one meaning in the SDGs (IRF, 2014d), including that they are applicable to all countries. This universality needs to be balanced by differentiation between countries, to reflect their widely varying country conditions, including exposure to disasters, and the principle that national governments should determine national goals and targets. The SDGs could therefore have global targets that are relevant to only some countries, or it could have different global targets for different categories of country. The latter presents a further challenge in terms of categorising countries in a more meaningful way than the developed–developing approach the MDGs use.

Targets that meet the transformative criterion will address the drivers of change and systemic barriers for sustainable development. In the area of DRR, this might include targets that address the underlying drivers of disaster risk (UNISDR, 2013a). However, all targets do not necessarily have to be transformative in themselves, and some of these drivers will be relevant to several development challenges and are not unique to DRR. When considering how the SDGs address particular challenges, it will be important to consider the framework as a whole, as well as its individual elements.

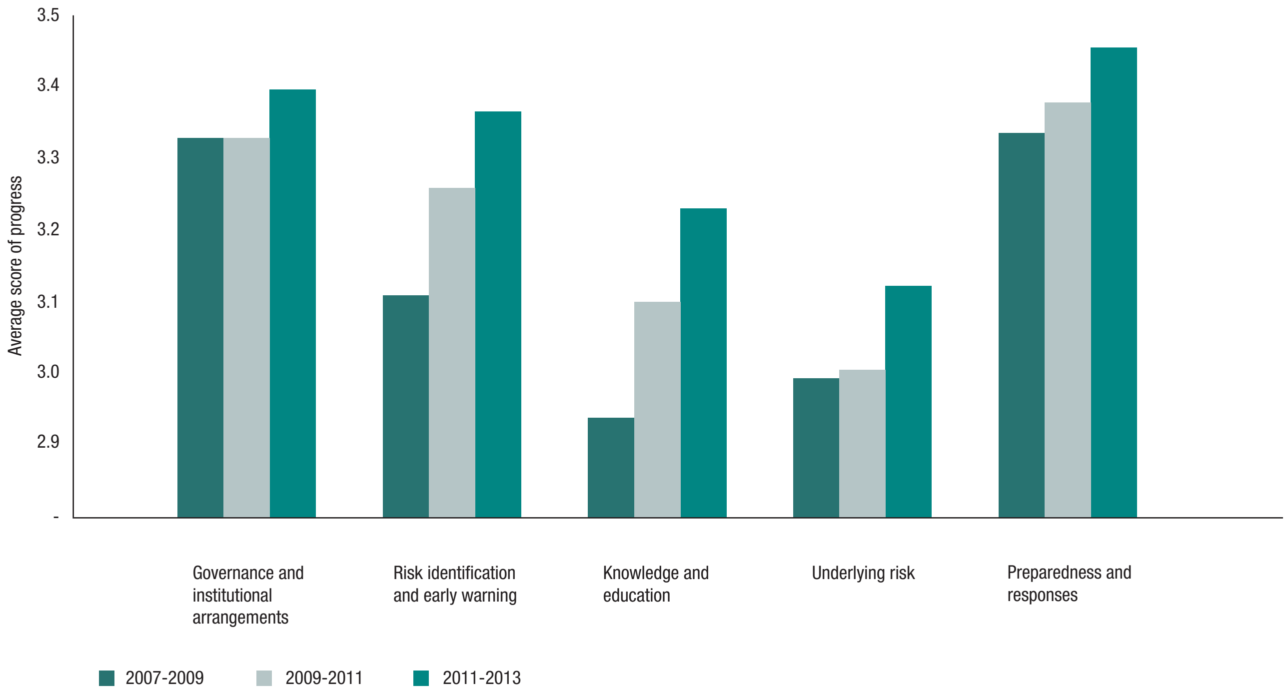
1.2.2 The Hyogo Framework for Action

Since 2007, Member States have reported steadily increasing progress in the implementation of the five priority areas of the HFA, as seen in Figure 4. The least progress has been achieved on Priority Action 4, which aims to address the underlying drivers of risk; this is because its targets and indicators were less actionable and specific than in other priority areas, meaning limited progress in terms of integrating DRR into development policies and practices aiming to reduce the underlying drivers of risk.

In recognition of some of the failures of the current HFA framework, UNISDR (2014a) in the new draft proposes the new agreement act as a tool to support the development of national plans, priorities and targets, and claims it has been designed to suit all countries regardless of income, geographic area, risk profile and progress on DRR to date. This allows states the 'flexibility to evaluate and choose nationally appropriate policies and strategies to achieve the Global Targets' (UNISDR, 2014a; 12).

Figure 4: Gradual progress across all priorities of action

SOURCE: ADAPTED FROM MASKREY (2014).



A number of challenges related to monitoring progress on the current HFA have been raised. UNISDR (2014a) recommends progress be monitored every four years, at the input, output and outcome level, which will 'enable governments to systematically assess, not only what policies and mechanisms they have in place to manage their disaster risks but whether these are effective in producing desired outputs in terms of reduced risk and strengthened resilience and outcomes in terms of reduced disaster loss and impacts' (UNISDR, 2014a; 6). A summary of some of the current challenges to monitoring progress on the HFA and some of the proposed solutions are provided in Table 2.

The framework and guidance in the paper will be 'pilot tested in selected countries, peer reviewed and circulated to countries for comments and feedback during the preparatory process' (UNISDR, 2014a; 2); the paper and recommendations will then be reviewed accordingly.

1.2.3 Piloting targets and indicators on disaster risk reduction for the successors to the Millennium Development Goals and the Hyogo Framework for Action

Measurability and the feasibility of collecting information are important factors in the definition and selection of indicators. The wider scope of the SDGs and lessons learnt in monitoring the MDGs suggest many new indicators will be needed, or existing indicators will need to be adapted. Although the OWG is not considering indicators, and the 2015 international agreement on the SDGs may not include them, UN agencies and other organisations have begun to develop indicators for the SDG framework (Carin and Bates-Eamer, 2013; SDSN, 2014; UNTT, 2013). There is also consideration of new ways to collect and analyse monitoring data, through the use of information technology and social media.

TABLE 2: A SUMMARY OF SOME OF THE CURRENT CHALLENGES TO MONITORING PROGRESS TO THE HFA AND SOME OF THE PROPOSED SOLUTIONS

Current HFA monitor	Proposed
1. Input rather than output or outcome focused	Link input indicators to outputs and overcome
2. Does not measure generation of new risks or resilience	Measure not only risk reduction but also risk generation and resilience
3. Progress not related to risk levels of country	Integrate risk levels in the system
4. Subjective, not allowing international benchmarking	Objective, supporting peer to peer learning

SOURCE: ADAPTED FROM MASKREY (2014)

The UN Development Programme (UNDP) and UNISDR are currently leading a country piloting exercise initiated to examine and test the validity of DRR targets and indicators developed so far in the context of succeeding the MDGs and the HFA. Four initial countries have been selected, representing a number of different contexts: Armenia, Japan, Mozambique and Paraguay. The aim is to use these pilot case studies to help refine the current proposed DRR indicators and targets, as well as to help support the inclusion of DRR in the SDGs and discussions on the successor to the HFA.

1.3 Structure of the report

This report focuses on three dimensions of disaster losses: mortality, national economic losses and livelihood losses, assessed as disaster-induced impoverishment. Based on existing international records of disaster losses, collected by the Centre for Research on the Epidemiology of Disasters (CRED), and by analysing a number of household survey datasets, the report makes observations that can be established at the global scale. It looks at trends recorded from 1980 to 2013.

This report is designed to support governments in negotiating the SDGs and the post-2015 framework on DRR. It investigates possible components of a common target and indicator set to span the two policy frameworks, drawing from different evidence to establish potential quantitative targets (Sections 2 and 3). It considers how to measure progress in terms of reducing disaster risk and losses (Section 4) and explores the data challenges involved in establishing such targets and how to improve the collection of data on disasters and disaster risk (Section 5). It ends with 10 recommendations on how post-2015 policy frameworks can support the development of a global monitoring system to track changing disaster risk and disaster losses (Section 6).

2.

Setting global targets for disaster risk reduction: reviewing the evidence

This section reviews information relevant to establishing what could constitute a realistic and measurable DRR target related to disaster losses. A variety of ways could be explored. We could investigate global disaster statistics or levels of reduction in fatalities and economic losses achieved in countries that have instituted active programmes of disaster risk reduction. However, whenever we use actual data on disaster fatalities and economic losses, we encounter the problem of the statistical sampling of highly right-skewed or 'fat-tailed' distributions.[32] This problem is fundamental to all considerations around the measurement of the mean number of fatalities from a few years of observations or around whether it is possible to identify a trend in disaster data over time. Additionally, there is a challenge involved in separating outcomes that are a result of DRR schemes being put in place and those that relate to changes in hazard.

2.1 Introduction

As shown in Box 4, on 'The challenge of measuring progress from observed disaster loss data', it is not possible to set a baseline and measure progress in terms of reducing disaster fatalities and losses based on observed data over a 15-year period. Data on mortalities and economic losses from floods for various countries from the Dartmouth Flood Observatory [33] demonstrate there are too few events and/or extreme events to measure the true mean of disaster observations and hence to monitor progress over a period of 15 years. We studied data from Bangladesh, China, India, Mozambique, the Philippines and Taiwan and found only that the volatility of the losses significantly exceeds any evidence of an underlying trend. Section 4 details a method that could be used to develop a baseline and measure progress without dependency on the loss data collected from actual events.

2.1.1 What can global-level data, based on numbers of deaths and economic losses, be used for?

We explore historical global disaster loss data to assess which hazards have the greatest impact on a global scale. Global disaster data highlight considerable variations between countries in terms of losses (mortality and economic) depending on their hazard exposure, past events and level of economic development. Global data can be used to highlight countries most affected in terms of number of deaths over the past few decades. However, this ranking can be very sensitive to whether major catastrophes have or have not occurred in that country, in the sample period, and hence the countries with the highest losses may not completely overlap with those identified as being at highest risk.

2.1.2 What can country-level data, based on numbers of deaths and economic losses, be used for?

We explore the extent to which we can use historical data to identify a potential range of realistic targets in DRR on a country basis. Challenges with using historical data to isolate historical changes in DRR effectiveness include the following:

- The nature of the hazard greatly affects the size of the losses.
- Historical data are incomplete, particularly for developing countries (more so for economic loss than for mortality – hence we focus on mortality losses in our country-level analyses).
- To make mortality numbers comparable between countries, the number of deaths needs to be normalised by the population affected. This is a challenge since the number of people living in the area affected by a disaster is not recorded. Assumptions have to be made, using either the country's population (although the disaster often does not extend across the whole country) or a relative proportion of the population living in the area of impact.

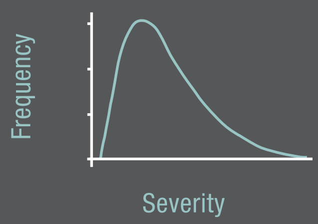
Our analyses show we cannot rely on apparent trends identified at a country level using raw historical data, as they may be a function of the incomplete sampling of the full underlying distribution of event losses. Indeed,

32 See, for example, http://www.cvgs.k12.va.us:81/digstats/main/descriptv/d_skewd.html

33 http://www.dartmouth.edu/~floods/Archives/index.html

BOX 4: THE CHALLENGE OF MEASURING PROGRESS FROM OBSERVED DISASTER LOSS DATA

What is the challenge with skewed datasets? Natural catastrophes show right -skewed and (and often highly skewed) loss distributions, which are dominated by the impact of high-severity and low-frequency events. For natural catastrophes, this means there is unlikely to be a sufficient number of events occurring in a particular country or region or even globally to make statistically significant comparisons between two time periods (such as decades) of observation. This is a fundamental problem at the heart of what can be derived from employing statistics on disaster losses. There is no simple way of manipulating the data to avoid the problem.



While we can suspect an underlying distribution is right-skewed, the overall shape of the distribution will not be known – especially from only a few years or decades of data, as the dataset will not include all possible eventualities. An example of this is Haiti, where from 1900 to 2009 earthquakes killed fewer than 10 people, but then in the 2010 earthquake an estimated 222,570 people were killed. This indicates a severely skewed distribution where there is the possibility for large losses that occur only rarely but that greatly affect the underlying average, over some period. The mean earthquake fatality rate in Haiti between 1900 and 2000 was less than 0.1 fatalities per year. After 2010, the mean fatality rate since 1900 was more than 1,000 a year. The addition of a single year has raised the measured mean by a factor greater than 10,000.

Most decadal samples from a highly right-skewed distribution will not include extremes therefore the averages derived from them will tend to understate the true average. However, when an extreme does occur in a sample period, it may dramatically increase the average for that period. An example from the US highlights that, even for relatively frequent natural catastrophes such as tornadoes, 30 years of data can still be misleading. Between 1980 and 2010, annual tornado fatalities ranged from 15 to 130, with an average of 55. These fatality statistics reflect the sum of many separate tornado outbreaks across a season. The annual number of fatalities appeared stable, with averages for the 1980s, 1990s and 2000s of 52, 58 and 56, respectively. Then, in 2011, 562 people were killed by tornadoes – 10 times more than the previous mean. Clearly, the underlying distribution of annual fatalities is more skewed than the pre-2011 data might have implied. While it may be tempting to think the largest losses are part of a distribution that is different to that the smaller events relate to, instead the large and small observations should be considered to form part of a single skewed distribution. Risk modelling suggests there is the potential for thousands of fatalities in a single tornado strike (e.g. when an intense tornado hits a sports stadium) and so the tail of this distribution has yet to be fully sampled.

When measuring natural catastrophe mortality data from relatively short time periods (such as decades), the statistical sample is very unlikely to be representative of the whole distribution. Therefore, if comparing two periods in which there is a difference in the measured average, one cannot be confident that the data are revealing a true trend rather than that this is a problem of incomplete sampling. All that is revealed is whether or not an extreme event occurred in the time sample.

Measuring country progress from observed disaster loss data (even normalised by the number of people exposed) on the timescale of the SDGs would therefore be misleading for natural disasters. In Sections 4 and 5, we propose how DRR progress could be measured to avoid these issues.

data on the impacts of natural disasters have been recorded since 1900 but are patchy in the early period because of a lack of information and communication, which led to underreporting. It is assumed that data recorded since 1980 offer a more complete overview on natural disasters for the entire world.

In order to understand the magnitude of DRR that could be achievable over 15 years, based on prior historical experience, we must focus on countries known to have had high risk of disasters before applying an improved DRR strategy monitored through comprehensive data extending over a long period of time (ideally more than 15 years in order to achieve a greater sampling of the skewed event distribution). Another way of measuring demonstrable improvements in DRR is to find similar events (by size, location etc.) separated in time, for which it becomes possible to show what has changed around economic losses and mortalities over the intervening period.

2.2 Evidence from investigating disaster mortality and losses at global level and by country income group

The study of trends and patterns of natural disasters in time and space is becoming a common interest in the debate around DRR. Global analyses make it possible to give an overview of the evolution of disaster impacts through time and bring out the fact that DRR has to be one of the main concerns for the future as it influences many other fields.

Regional and economic variations are important influences on the impact of natural disasters. We opted to analyse mortality and economic losses according to ranked national income level, as people's vulnerability and countries' capacity to face disaster depend significantly on the national economy.

Figure 5: Global trends in disaster events and death tolls, 1980-2013

SOURCE: ADAPTED FROM WWW.EMDAT.BE

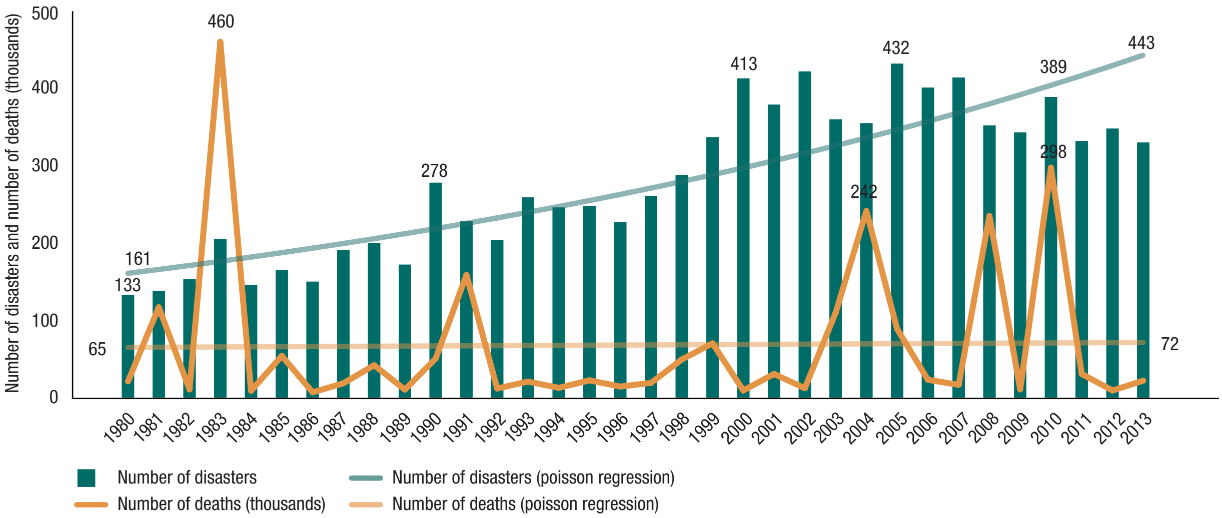
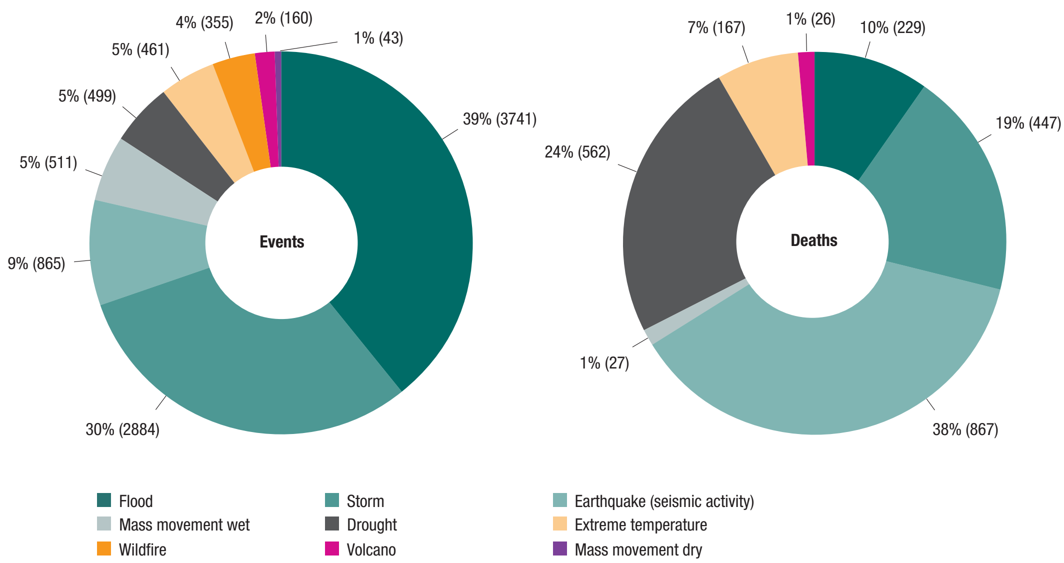


Figure 6: Share of deaths and number of events by disaster type at global level, 1980-2013

SOURCE: ADAPTED FROM WWW.EMDAT.BE



Patterns of disaster type also vary by country and region, and can be linked: low GDP and development in a country in an arid region could be related to the difficulty of conducting agricultural activity because of a lack of resources but also the occurrence of frequent droughts and extreme temperatures. This section considers the importance of developing DRR policies to respond to the relationship between natural disasters and development.

The Poisson regression shows an increase in the number of reported disaster events in the past few years compared with two decades ago (Figure 5).

A Poisson regression curve also shows that mortality has slowly increased since 1980 too, however, disaster mortality data are dominated by the years in which a small number of high-mortality catastrophes occurred (3 major events that killed more than 100,000 people have occurred since 2000). Given the high volatility of the data, it is not possible to clearly identify a persistent trend over the period. This volatility reflects decadal variability in the occurrence of extremes. For example, between 1965 and 2004 there were no earthquakes worldwide with magnitudes above Mw8.4, and hence there were no high-mortality regional tsunami catastrophes like that of the Mw9.2 2004 Indian Ocean earthquake.

The share of each disaster type worldwide has not changed significantly over time (Figure 6). Storms and floods represent a very large proportion of all disasters, particularly in Asia. Floods have historically affected many people but generated low mortality numbers. More recently, there appears to have been an increase in flood reports and flood mortalities, from flash floods and acute riverine and coastal floods. Along with floods, the impacts of storms have also been higher in South and South-East Asia, where they have hit communities unprepared for tropical cyclone storm surges.

While there are fewer significant earthquakes than there are floods or storms, these dominate when it comes to mortality, with nearly 40% of all deaths. This profile is similar to that of droughts, which also occur infrequently but take up a substantial share of the death toll (24%). Despite the efficiency of existing early warning systems for droughts, associated mortality has remained persistently high. Monitoring droughts and their impacts presents specific challenges. First, the spatial extent of a drought is hard to measure. Second, the human impact of droughts, in particular mortality, poses challenges in relation to tracking comprehensive data, as deaths often owe to malnutrition, disease and displacement in fragile populations.

At the global level, projections related to natural disasters are hazardous enterprises. Numerous factors will change substantially in the future and affect the impact natural disasters have on populations, making prediction complex and uncertain. Inevitably given the high volatility of the data there is a wide range of uncertainty in how any such statistical forecast can be projected (see Figure 7, which demonstrates the volatility of observed data).

Figure 7: Global disaster-related mortality rate (per million global population), 1980-2013)

SOURCE: ADAPTED FROM WWW.EMDAT.BE

NOTE: THE 'X' AXIS HAS BEEN EXTENDED TO 2030 TO HIGHLIGHT THE PERIOD COVERED BY 2015 AGREEMENTS AND TO ACCENTUATE THE LIKELIHOOD OF ANNUAL VARIATIONS CONTINUING.

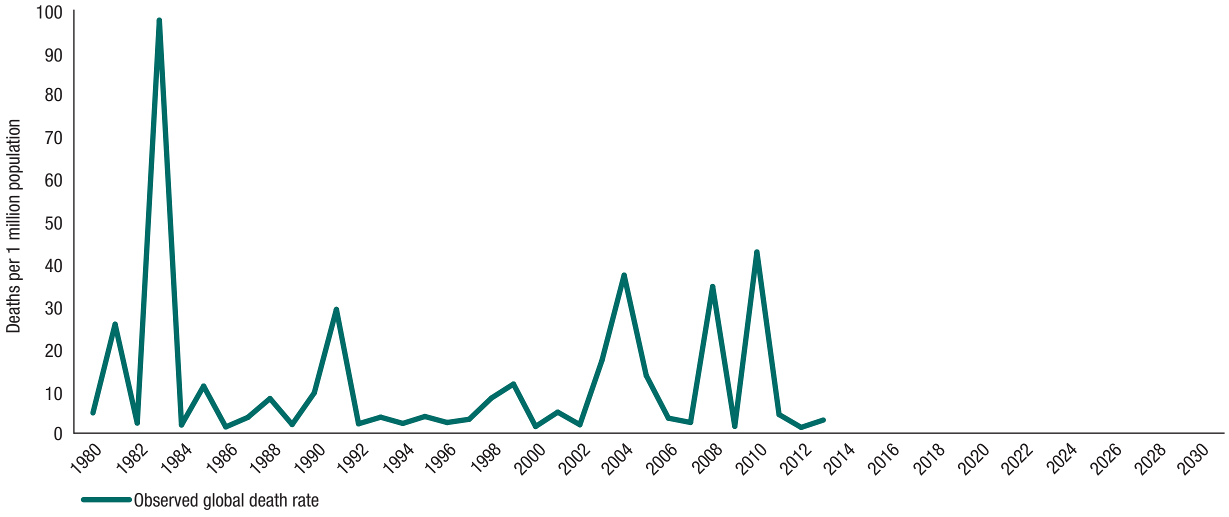
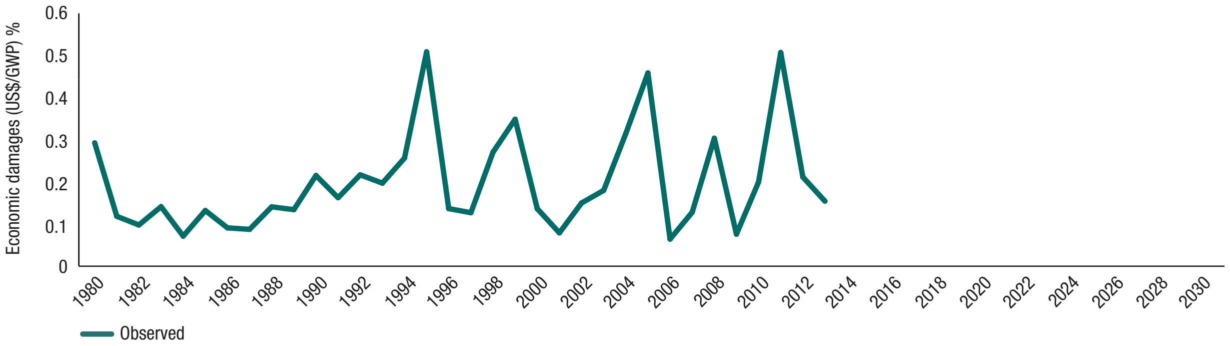


Figure 8: Global economic losses related to gross world product (%), 1980-2013

SOURCE: ADAPTED FROM WWW.EMDAT.BE

NOTE: THE 'X' AXIS HAS BEEN EXTENDED TO 2030 TO HIGHLIGHT THE PERIOD COVERED BY 2015 AGREEMENTS AND TO ILLUSTRATE THE LIKELIHOOD OF ANNUAL VARIATIONS CONTINUING.



2.2.1 Global economic losses

Data on global economic disaster losses in US dollars since 1980, based on 2013 US dollar values adjusted by unit of GDP, show an increase to the present day (see Figure 8). When projecting the trend forward to 2030, potential economic losses would be 161% higher in 2030 than they were in 1980. Again given the volatility of the data there is a wide range of uncertainty in how any such statistical forecast can be projected. Strong conclusions also cannot be drawn from these economic loss data, however, as it is not easy to disentangle the impact of US dollar inflation, exchange rates and losses that result from the disaster event itself. It should also be noted that only 36% of events recorded from 1980 to 2013 in the CRED database contain data on economic losses. Further, a small number of mega-disasters that dominate the level of global economic losses in any one year greatly influence the historic record of economic losses. In the future, more reports on direct and indirect economic damages, using a standardised assessment method, even for small events, would be desirable. Modelling could also help provide estimates of economic losses where data are missing. Further work is required to produce a reliable record of economic disaster losses, adjusted for inflation and for country GDP.

Figure 9 and Figure 10 show the mortality trend over time, while still based on volatile data, is different for the different income groups. Only for the low-income group has the Poisson regression of the number of deaths decreased over time. This is mainly because two major droughts occurred in Africa at the beginning of 1980s and since then, no drought has reach the same level of impact, inducing the decrease. The reason for the small increase in mortality for the three other income groups (lower-middle, upper-middle and high-income) appears to be explained by the occurrence of one or a small number of years of high-mortality disasters towards the second half of the record.

2.2.2 High-income (gross national income per capita $12,616 or more)

For high-income countries (Figure 11), heat waves have had the biggest impact in terms of disaster casualties, whereas storms, floods and earthquakes have dominated with respect to economic loss. Economic losses are mainly accounted by violent storms, the destruction potential of which is clearly high and contributes nearly half of the total losses wealthy countries incur.

Note that economic losses are not reported for every event. For the high-income group 49% of events have recorded data on economic losses. Note: Drought is not a significant source of damage or mortality in high-income countries. Extreme temperature events (cold waves and heat waves) are much more important. For the three other income groups, droughts will be taken into account as a major type of disaster.

2.2.3 Upper-middle-income (gross national income per capita $4,086-12,615)

In upper-middle-income countries (Figure 12), the balance of economic losses is not so different to that in high-income countries, although floods make a major contribution (46%) and storms a more minor one (16%). In contrast, the picture on mortality is completely different, with earthquakes dominating.

The upper-middle-income countries take up a high proportion of geophysical disasters when measured in terms of deaths and economic losses. Many are rapidly developing countries, such as Iran, Romania and Turkey. Nearly two-thirds of all deaths and a quarter of economic losses in this group relate to earthquakes. Typically, earthquakes, if they occur in urban and periurban zones, bring with them high rates of mortality, which is further aggravated if the shock occurs at night. Better research into precise risk factors that determine earthquake mortality would help improve preparedness and prevention at local level. Note that for the upper-middle-income group 36% of events have recorded data on economic losses.

Figure 9: Trends in disaster-related deaths, using the Poisson regression, by income group, 1980-2013

SOURCE: ADAPTED FROM WWW.EMDAT.BE

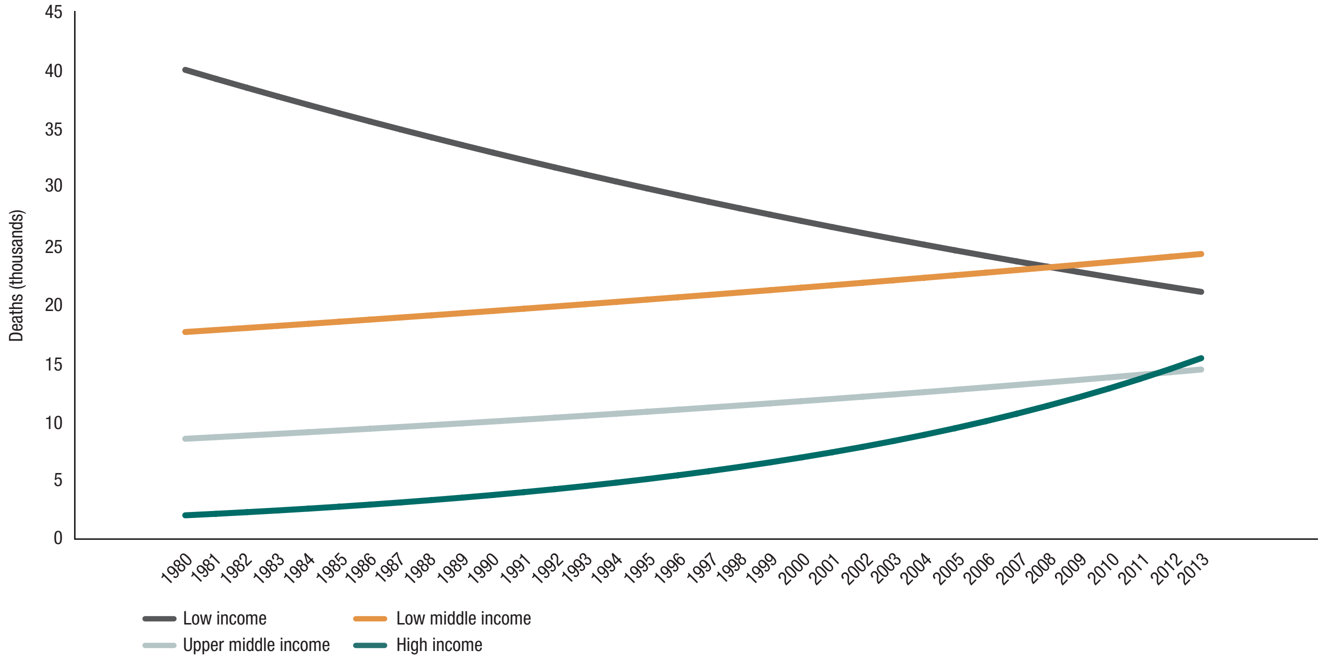


Figure 10: Mortality for different income groups, 1980-2013

SOURCE: ADAPTED FROM WWW.EMDAT.BE

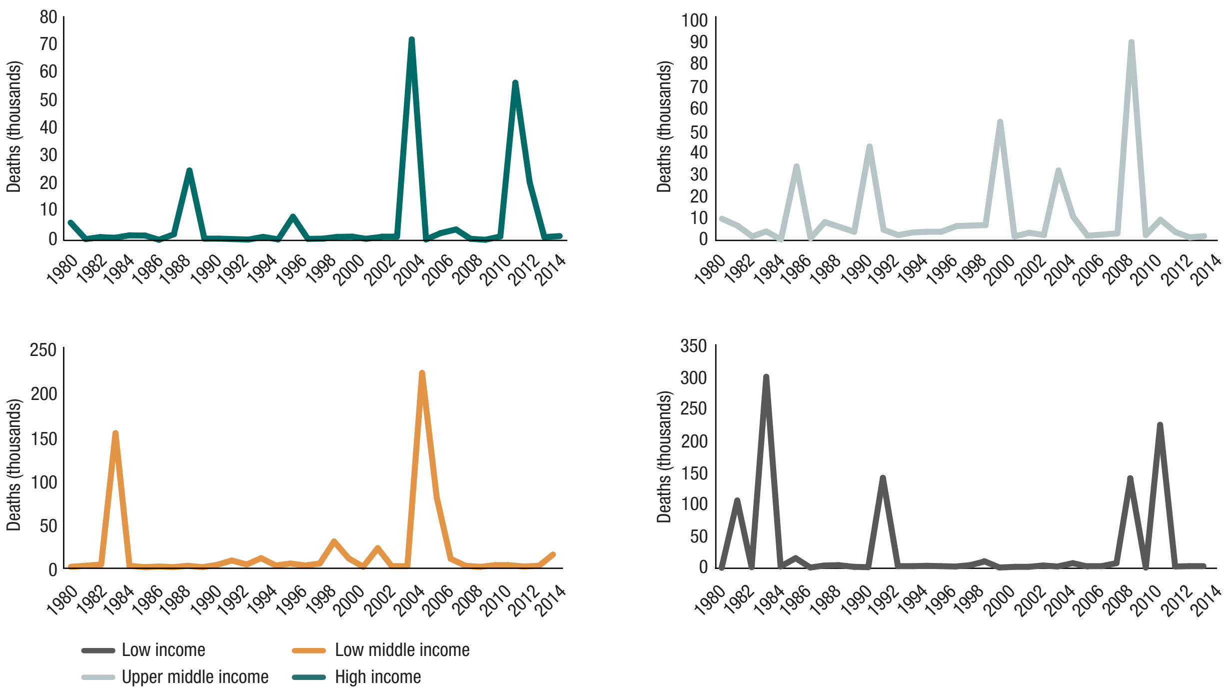


Figure 11: Percentage share (absolute numbers) by disaster type, high-income countries, 1980-2013

SOURCE: WWW.EMDAT.BE

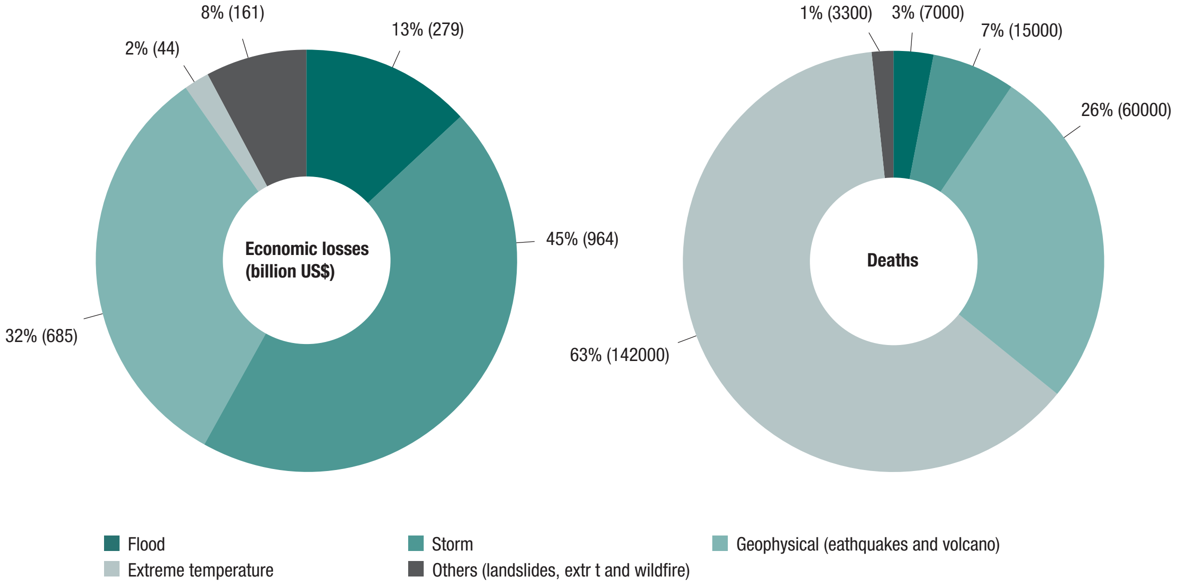
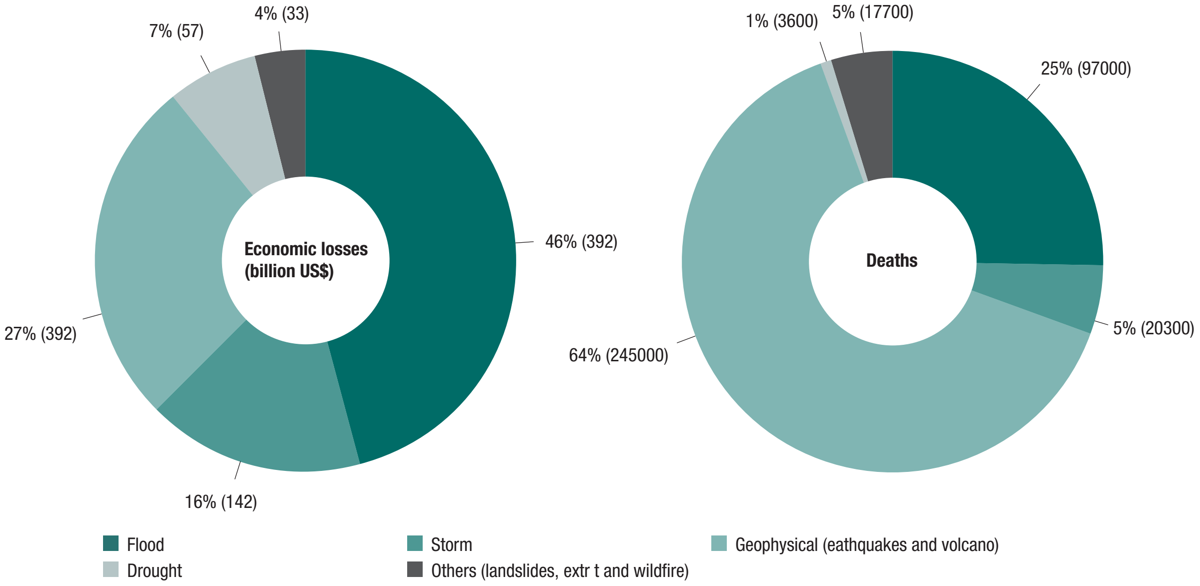


Figure 12: Percentage share (absolute numbers) by disaster type, upper-middle-income countries, 1980-2013

SOURCE: WWW.EMDAT.BE



2.2.4 Lower-middle-income (gross national income per capita $1,036-4,085)

For lower-middle-income countries (Figure 13), again the balance of economic losses is comparable with that seen in upper-middle-income countries (Figure 12) and high-income countries (Figure 11). Storms and drought are now found to be much more significant factors in terms of disaster mortality, although earthquakes still contribute almost half of fatalities. Lower-middle-income countries include highly seismic countries such as Indonesia, Pakistan and the Philippines, as well as the Central American states.

Note that for the lower-middle-income group 34% of events have recorded data on economic losses.

2.2.5 Low-income (gross national income per capita $1,035 or less)

In low-income countries (Figure 14), economic losses are driven principally by floods, although it could be argued that the economic assessment of drought losses is incomplete and difficult to assess. The largest source of disaster-related deaths today is droughts. This may be for many reasons, including the vast geographical scope of such disasters, high levels of rural poverty and poor countries' reliance on agriculture without support infrastructure.

In the poorest countries, droughts, storms and earthquakes together account for 95% of all deaths. Most deaths owed to two droughts, which occurred between 1983 and 1985 in Sudan and Ethiopia and killed 150,000 and 300,000 persons, respectively. Droughts are problematic for mortality reporting since most people die from secondary causes and not as a direct result of the drought. Better accounting for drought-related deaths should be put in place and linked to early warning systems and response mechanisms.

Low-income countries clearly bear the greatest burden in terms of disaster impact, not necessarily because of the frequency of events but because of their human impact. Economic losses are particularly badly reported for this group of countries, since human lives, which form their greatest loss, remain unaccounted for in the monetisation of losses. For the low-income group 15% of events have recorded data on economic losses. Efforts are underway to test different methodologies to calculate values of lives appropriate for low-income countries, which will make it possible to provide an economic value for society as a result of lives lost.

Figure 13: Percentage share (absolute numbers) by disaster type, middle-income countries, 1980-2013

SOURCE: WWW.EMDAT.BE

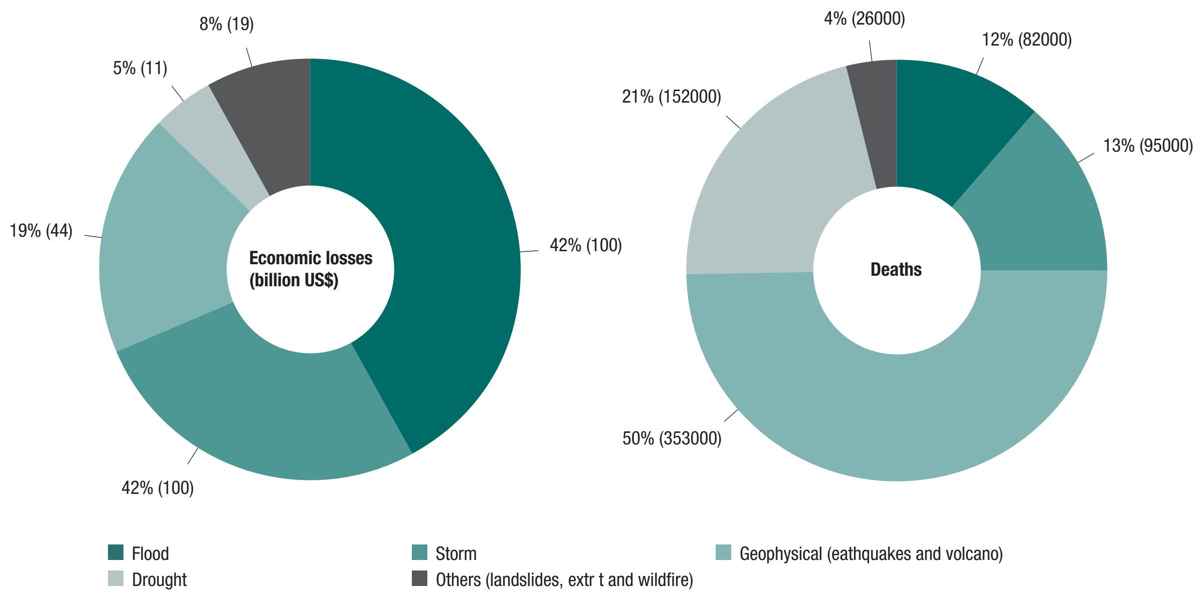
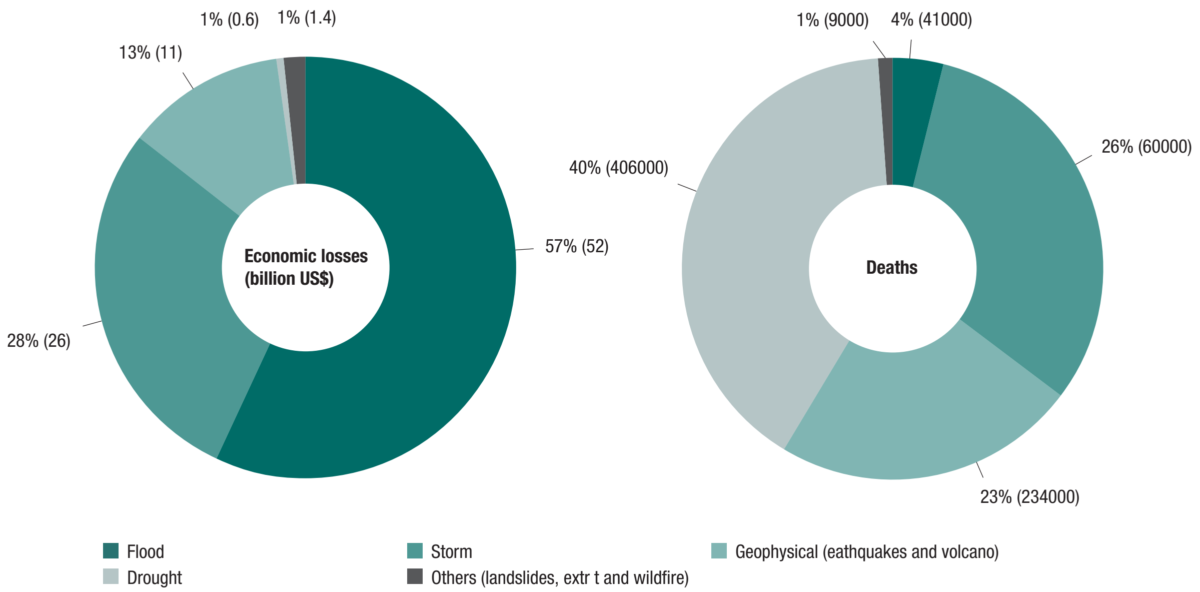


Figure 14: Percentage share (absolute numbers) by disaster type, low-income countries, 1980-2013

SOURCE: WWW.EMDAT.BE



2.2.6 Summary

Comparing the causes of disaster deaths by income group highlights what can be expected to change in a country as it develops. For the poorest countries, the focus is initially on avoiding disaster types for which good forecasting could prevent large-scale loss of life, such as droughts and many floods. However, reductions in earthquake casualties typically require larger amounts of investment, good governance around setting and policing building codes and a strong pool of engineering skills. This typically means more advanced levels of investment, which are available only when a country has reached higher income levels or makes a political decision to prioritise earthquake risk reduction.

The above analysis underlines an important perspective on disaster impact, one that relates to economic groups rather than geographical locations. It provides statistical support to the concept of linking poverty and disaster losses. To be able to transform this understanding of the relationship between economic settings and disaster losses, there is an urgent need for more detailed and in-depth global analyses to distinguish economic factors that determine losses in different countries. In this report, we present only the start of such an analysis.

The differences in the impacts of disasters between the four economic groups of countries need further detailed analysis to make it possible to identify the specific causes. For example, fewer deaths from hydro-meteorological extremes may owe to many factors, for example the geographical location of specific countries determining their exposure to extreme climate characteristics.

2.3 Evidence from national historical disaster loss data to investigate disaster risk reduction progress

As outlined at the beginning of Section 2 (‘What can country-level data, based on numbers of deaths and economic losses, be used for?’), there are challenges involved in using country-level historical data to isolate changes in DRR effectiveness: the nature of the hazard greatly affects the results; historical data have gaps and may cover a short time period (compared with the return period of the extreme events); and it is hard to standardise rules around normalising for population.

Finding suitable country-level historical datasets to demonstrate improvements in DRR is difficult. Some hazard types (in particular earthquakes) have low rates of activity but high volatility, which makes it impossible to demonstrate true mean values from a few decades of data. For many countries, available information on fatalities or disaster impacts may not be complete or accurate pre-1980. Despite skewed distribution and data challenges, we have attempted to investigate trends for more frequent hazards, such as floods and wind events.

We can also explore the use of disaster pairs – events that are very similar to one another and separated only in time – from which it is possible to identify improvements in disaster management over the intervening period. It is also possible to find the range of variability in outcomes that exists for similar events affecting cities comprising a wide range of building stock.

2.3.1 Disaster risk reduction in Japan

Japanese data provide one of the best demonstrations of what can be achieved in terms of decadal reductions in disaster risks. A major DRR campaign was instituted in 1960 after catastrophic storm surge floods caused more than 5,000 deaths. The Disaster Countermeasure Basic Act, implemented in 1961, legislated a change from a reactive to a proactive approach to disasters in the country. Regional disaster prevention plans were enforced, including forecasting systems, flood defences, warning criteria, rescue systems and emergency communications. There was large-scale construction of multi-purpose dams for both flood control and water supply, allied with programmes of river channel capacity expansion, increased retention capacity to mitigate increased run-off from urban development and the production of publically available flood hazard maps to inform development.

Data sources from Japan (the Fire and Disaster Management Agency (FDMA), the Japan Meteorological Agency (JMA), Japanese Official Chronological Scientific Tables and the General Insurance Association of Japan (GIAJ)) provide detailed data on disaster losses from 1945. In this study, we use data from 68 years, which include more than 65 typhoons and 70 floods (caused by heavy precipitation not related to a typhoon). We assess trends in mortality (normalised by population) and houses destroyed (a proxy for economic loss) for typhoons and flooding separately. A discussion on the variation in hazards over this time is important to understand whether hazard variations alone can explain apparent trends in losses. The most striking feature of the disaster data is how the annual number of deaths caused by typhoons drops significantly after the 1960s. Several typhoons in the 1940s and 1950s caused more than 1,000 deaths, for example Typhoon Vera in 1959, which resulted in about 5,000 deaths. However, since 1960 there has not been a single typhoon that has caused more than 320 deaths. Although we cannot be confident of the degree to which the 1950s was 'unlucky' in terms of the intensity and location of typhoon landfalls or the ensuing period of the 1960s represented a low period of activity, the magnitude of the reduction in fatalities indicates that overall it was a consequence of the major investments in DRR.

Figure 15: Annual typhoon mortality rate (normalised by population) and number of typhoons in Japan, 1945-2009

SOURCES: JMA AND FDMA DATA.

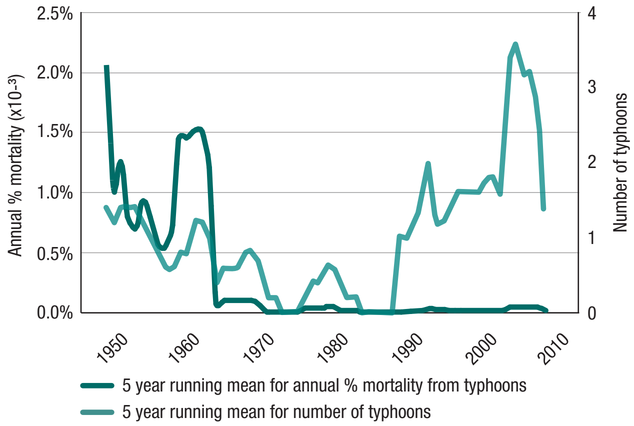
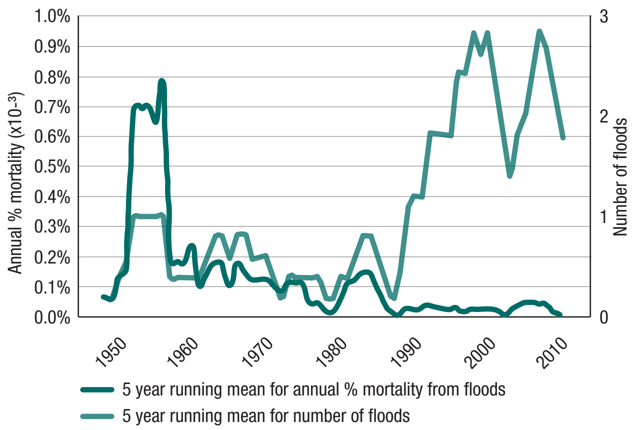


Figure 16: Annual flood mortality rate (normalised by population) and number of floods in Japan, 1945-2011

SOURCES: JMA AND FDMA DATA.



There is a similar fall in the number of deaths for flooding, although the downward trend appears to start earlier. Three flooding events in 1953 dominated flood deaths in the 1950s, causing over 2,500 deaths in total. An event in 1957 also resulted in over 700 deaths, but since then there have been no single flood disasters resulting in more than 450 deaths. The period of the 1950s was an active period of typhoons in and around Japan, as has been the period since 1990. Therefore, the proportion of the reduction in deaths in the 1960s and 1970s that owes purely to DRR policies is up for debate. However, there is no suggestion that hazards are responsible for changes in non-typhoon-related flood outcomes. Therefore, while it is not possible to exactly separate out the DRR component of the reduction in disaster impacts, the Japanese experience highlights the order of magnitude of potential reduction that can be achieved in a rapidly growing economy.

2.3.2 Decadal mortality reduction over time

For typhoons, looking at Figure 17, the change in average annual mortality rate has been rapid, with a reduction from 1.1 per 100,000 people in the 1950s to 0.08 per 100,000 people in the 1960s. The 1950s was clearly a period of intense and damaging typhoon activity, which reduced during the 1960s, so this reduction cannot simply be linked with the implementation of DRR policies in 1961. However, the persistence of low mortalities even when typhoon activity picked up again after 1990 highlights that, longer term, a significant part of this reduction does represent the results of active intervention.

For floods, as Figure 18 shows, from the 1950s to the 1960s there was also a significant 66% decrease in mortality, with a further 58% reduction between the 1960s and the 1970s. There is no suggestion that there has been any significant decadal variability in precipitation in Japan, so these reductions do appear to reflect principally improvements in flood DRR.

2.3.3 Using houses as a proxy for economic losses

Structural flood control measures also led to a significant decrease in the number of houses inundated (and hence a proxy for normalised economic losses). Over the period 1950-1990, the population of Japan and the number of dwelling units increased by around 55%, so normalising the number of houses flooded by population would only serve to exaggerate the reduction.

However, in comparing statistics on properties flooded and people killed, after the 1960s and 1970s the policy around evacuations appears to have become weakened. From 1951 onwards, there is a general decrease in deaths per 10,000 houses

Figure 17: Average annual mortality rate (normalised by population) due to typhoons in Japan, 1951-2010

SOURCES: JMA AND FDMA

NOTE: INCLUDING CONFIRMED DEAD AND MISSING.

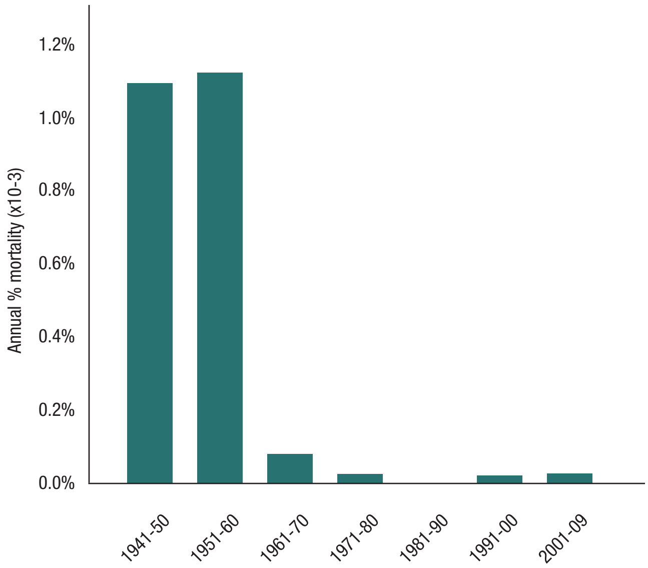


Figure 18: Average annual mortality rate (normalised by population) due to precipitation floods in Japan, 1951-2010

SOURCES: JMA AND FDMA

NOTE: INCLUDING CONFIRMED DEAD AND MISSING.

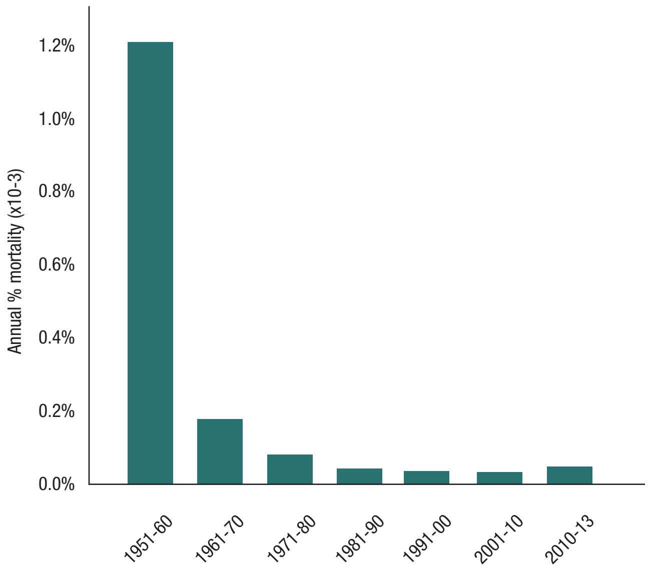


Figure 19: Number of houses in Japan inundated by either typhoon or precipitation floods, 1945-2011

SOURCES: JMA AND FDMA DATA.

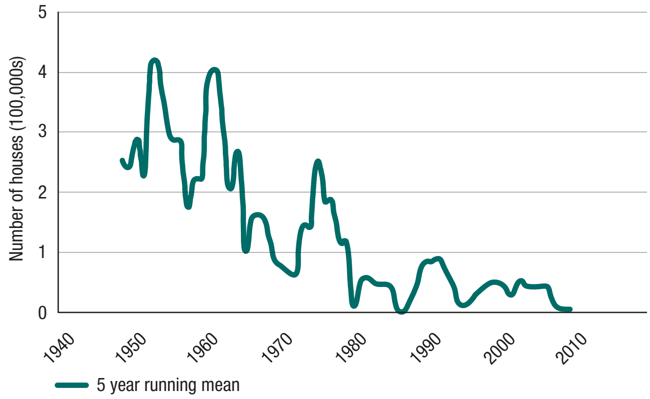
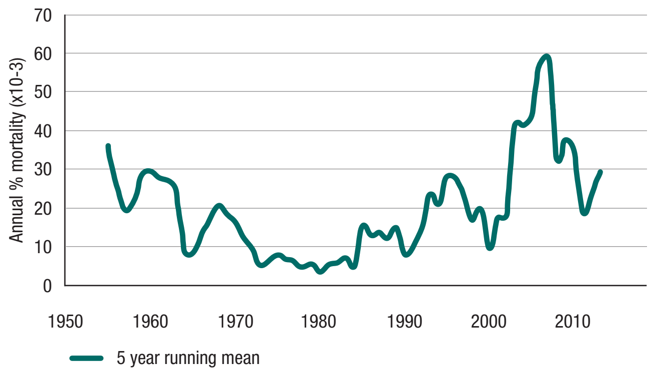


Figure 20: Number of deaths (per 10,000 houses inundated) due to typhoons in Japan, 1951-2013

SOURCES: JMA AND FDMA DATA.



inundated by typhoons, but this has risen by a factor close to 3 since the early 1980s (data not available for non-typhoon floods). This suggests that, initially, the focus was on saving lives, principally through evacuations. Over time, the number of houses inundated also reduced, because of programmes of river management and the construction of many flood defences. However, it appears that, since the 1980s, trusting the ubiquitous flood defences, people may have become less observant of the need to evacuate when they are warned of an oncoming disaster.

2.4 Evidence from 'disaster pairs'

Even where the occurrence of significant disasters is so volatile that one or two extreme outliers skew any trends, it may still be possible to identify changes in exposure and vulnerability, by exploring time-separated pairs of disasters that are as similar as possible in their hazard. Our focus is on mortality, as economic losses include various complicating factors when comparing over time.

Ideally, time-separated disaster pairs should be the same strength and size, occur in the same location and straddle a time period over which there have been significant changes in the population or building stock, levels of protection provided or policies and implementation of evacuations. Inevitably, as these precise circumstances are near impossible to achieve, we first need to distinguish differences in the event from variations in the outcome.

It is possible to find examples of both good and bad practice. Bad practice highlights that significant increases in loss of life occur when DRR is not taken into consideration and, hence, a DRR target is crucial. Earthquake pairs in Turkey, spanning the final three decades of the 20th century, and a comparison between the impact of the flooding from 1965 Hurricane Betsy and 2005 Katrina in New Orleans, indicate rises in vulnerability. In the following section, we report where there have been significant improvements in order to assess what can be achieved when there has been a focus on DRR.

2.4.1 Chile earthquakes

The 1906 Mw8.2 earthquake was situated on the subduction zone plate boundary directly adjacent to the city of Valparaíso and, based on its size, is estimated to have broken about 200 km of the plate boundary (Okal, 2005). There was no tsunami. The 2010 Mw8.8 earthquake ruptured 550 km of the subduction zone plate boundary, at the same depth range, overlapping about two-thirds of the 1906 rupture area (Lay et al., 2010) and having an equivalent geographical distribution of onshore shaking. The earthquake was, however, accompanied by a significant tsunami, which contributed around one-third of the casualties.

TABLE 3: COMPARISON BETWEEN 1906 AND 2010 CHILE EARTHQUAKES

Date	Size	Population	Deaths	Deaths/Urban Population
1906 Valparaiso, Chile	Mw8.2, 200km rupture	Urban: 160,000 Valparaiso (National: 3.4 Million)*	3886	0.024
2010 Concepcion, Chile	Mw8.8, 550km rupture	Urban: 945,000 Concepcion (National: 16.7 Million)*	525	0.00056

SOURCES: FOR 1906 – USGS, 2012A; FOR 2010 – EERI, 2010.

NOTE: * THE POPULATION RATIO IS SIMILAR (AROUND FIVE) FOR THE NATIONAL POPULATION COMPARED WITH THE URBAN POPULATION, SO THE REDUCTION IN FATALITIES IS THE SAME ORDER OF MAGNITUDE EMPLOYING EITHER THE URBAN OR THE NATIONAL POPULATION. HERE WE USE URBAN POPULATION AS AN APPROXIMATION OF THE NUMBER OF PEOPLE EXPOSED.

Even though there are differences in rupture length, both earthquakes hit a principal coastal concentration of urban population (the city of Valparaíso in 1906 and that of Concepción in 2010). In spite of a greater magnitude, a larger area strongly affected and a tsunami, the ratio of deaths to urban population for the 2010 earthquake was much lower than that in 1906.

The 2010 earthquake happened very early in the morning, whereas the 1906 earthquake happened in the middle of a winter evening. In neither earthquake was there a preceding shock that brought people out of the buildings (as was the case in both the 1835 and the 1960 Chile earthquakes.) The principal difference in mortality rate between these two earthquakes can be attributed to the application of a strong building code, which has delivered improvements in both building type and construction quality.

2.4.2 Bangladesh cyclones and storm surge

The 1970 Bhola Cyclone reached Cat 3 intensity, with peak winds of 130 mph and a central pressure of 966 mb on 11 November. The storm made landfall the following day in the centre of the Bangladesh coast, arriving around high tide on the evening of 12 November. The only warning given was a 'great danger signal' broadcast on East Pakistan Radio, but this meant little to the people of the delta. Although 90% of people along the coast recognised a cyclone was coming, only 1% sought refuge in fortified structures. The storm surge reached 10 m elevation in the Ganges delta and at Chittagong reached 4 m above average sea level, 1.2 m above high tide. The surge flood affected over 3.6 million people and, of 77,000 onshore fishermen, 46,000 were killed. A total of 85% of homes in the areas were destroyed or severely damaged. The lowest estimated death toll was put at 224,000. Half the deaths were of children under 10, who formed one-third of the population (Frank and Husain, 1971).

The 1991 Bangladesh cyclone moved north-north-east across the Bay of Bengal, reaching Cat 5 intensity (160 mph windspeed) before weakening back to Cat 4 just before landfall, late on 29 April. The storm made landfall a short distance south of Chittagong in south-east Bangladesh (population 2.27 million) and then rapidly weakened over land. It is estimated 2 million people evacuated into designated cyclone shelters. However, many others did not know where to evacuate to or chose to stay. The total number of homes destroyed was put at 1 million, leaving around 10 million homeless. An estimated 138,000 died, with the highest mortality among children and the elderly (Bern at al., 1993).

The 2007 Sidr cyclone had a northerly track and reached sustained winds of 160 mph, making it Cat 5 equivalent. The storm made landfall on 15 November, weakening quickly after landfall. The cities of Patuakhali, Barguna and Jhalokati districts were affected by a storm surge greater than 5 m. A total of 1,800 multipurpose disaster shelters had been built along the coast and 40,000 Red Crescent volunteers were sent to order residents to evacuate into the special shelters and evacuated at least 600,000; a total of 2 million people evacuated to emergency shelters. This is the same number as was estimated for the 1991 cyclone, even though one might infer, from the number of houses destroyed, the storm affected a smaller exposed population. Hence, the percentage of those who were at risk and who evacuated increased. The reported number of deaths was 3,447, (although Save the Children estimates it at between 5,000 and 10,000) (GFDRR, 2008). However, even using the highest estimate of deaths, deaths/houses destroyed was an order of magnitude lower in 1991 than it was in 2007.

In Table 4, we use houses destroyed as a rough proxy for population subjected to the full force of the cyclone. It is important to attempt to normalise the numbers by population exposed, so we can try to make comparisons, since the events affected different areas and numbers of people.

The ratio of the numbers killed divided by the number of properties destroyed then indicates what proportion of the affected population failed to evacuate.

Relative to the numbers of houses 'destroyed' by the wind and surge, the reduction in mortality rates over the whole 40-year period is greater than 100-fold – as also noted by the World Health Organization (WHO) (Haque et al., 2011).

TABLE 4: COMPARISONS BETWEEN MAJOR CYCLONES IN BANGLADESH

Date	Size	Houses destroyed	Evacuated	Deaths	Deaths/Houses Destroyed
1970 Bhola Cyclone	Cat 3; 4-10m surge	400,000	0	300,000	0.75
1991 Bangladesh cyclone (BOB 01)	Cat 4; 5-8m surge	780,000	2,000,000	138,000	0.18
2007 Sidr	Cat 5; >5m surge	564,000	2,000,000	3,447	0.006

SOURCES: 1970 CYCLONE – FRANK AND HUSAIN, 1971; 1991 CYLONE – NOAA, N.D.; 2007 CYCLONE – GOVERNMENT OF BANGLADESH, 2008.

TABLE 5: COMPARISON OF MAJOR EARTHQUAKES IN THE VICINITY OF CITIES

Urban Earthquakes	Size	PGA (g)	Time of day	Urban Population	Deaths	Deaths/ Urban Population
2010 Port au Prince, Haiti	Mw7.0	0.5	Early evening	3,000,000	200,000	0.067
2011 Christchurch, NZ	Mw6.3	2.2	Day time	341,500	185	0.00054
2003 Bam, Iran	Mw6.6	0.8	Night time	74,000	26,000	0.35
1995 Kobe, Japan	Mw6.8	0.8	Early morning	1,520,000	6,434	0.0042
1994 Northridge, US	Mw6.7	1.8	Early morning	3,000,000	57	0.000019

SOURCES: 2010 PORT AU PRINCE, HAITI – DANIELL ET AL., 2013; 2011 CHRISTCHURCH, NZ – NEW ZEALAND POLICE, 2012; 2003 BAM, IRAN – USGS, 2010; 1995 KOBE, JAPAN – USGS, 2012B; 1994 NORTHRIDGE, US – PEEK-ASA ET AL., 1998.

2.4.3 Comparison of similar nearfield major (Mw6.3-7.0) earthquakes located in the vicinity of cities

The significance of building construction for earthquake fatalities is highlighted by the widely diverging impacts of major earthquakes located close to large urban centres. Inevitably, neither the earthquakes themselves nor the geographic disposition of the cities are identical, but these events have enough in common to make useful comparisons. When considering earthquake fatalities, we should be mindful of the time of day the earthquake strikes because this will affect where people are situated relative to their buildings. Where dwellings are built out of unreinforced mud, brick or stone, the highest fatality rates will tend to be at night. Where dwellings are built out of wood, as in California or New Zealand, fatalities may be higher in the daytime as offices and highways may be more dangerous than houses.

The five earthquakes considered are similar-sized, shallow earthquakes, all occurring since 1994, and ranged from Mw6.3 to Mw7.0 in magnitude. All of these earthquakes occurred next to, or under, cities.

In Table 5 we report the urban population, with the simplification that this is the population exposed to the earthquake, and use this to normalise the number of deaths.

The range of variation in fatality rates in these earthquakes is striking, from 35% in Bam to 6.7%% in Port au Prince, 0.42% in Kobe, 0.05% in Christchurch and 0.002% in Northridge. The fatalities in Northridge would likely have been higher if the earthquake had occurred during the day and in Christchurch would probably have been lower if the earthquake had occurred at night (such that the expected earthquake fatality rate of these two cities is likely to be very similar). In spite of this, these examples illustrate four orders of magnitude difference in the fatality rate experienced in similar-sized moderate magnitude earthquakes, principally because of the construction characteristics of the urban buildings in each city.

Looking at measured peak ground accelerations (PGAs) (one metric of the strength of ground shaking) rather than magnitude, a higher measured PGA (i.e. Northridge and Christchurch) does not necessarily correlate with a higher mortality rate (i.e. Bam and Port au Prince). (However, there will also be lower density of recorders in cities in Iran or Haiti.) This again demonstrates how construction type, construction quality and adoption and enforcement of building regulations are crucial to protect the population. New Zealand banned unreinforced masonry (URM) in 1976; this is still the prevalent construction type in Port au Prince. URM, or poorly built concrete construction (as in Haiti and Iran), causes significantly higher fatalities than wood or well-designed and well-constructed reinforced concrete buildings (as in New Zealand or the US). While other factors, such as local geology (whether alluvium or bedrock), liquefaction potential and height of buildings, also play a role, the most significant factor is building construction.

2.4.4 Summary

In Bangladesh, the event pairs suggest significant (over 100-fold or 99%) reductions in cyclone storm surge fatalities from the 1970s to 2010, principally because of policies on evacuation and the construction of elevated concrete cyclone shelters. The most rapid reductions in disaster fatalities over a few years can be achieved for forecastable and hence 'evacuable' hazards, like tropical cyclone storm surges and river floods.

For unforecast hazards, such as earthquakes, there is still a large potential to reduce mortality rates, although replacing building stock inevitably takes longer and is more expensive than developing an effective evacuation plan. The potential to achieve significant reductions in earthquake fatalities is revealed by the four orders of magnitude range in fatality rates since 1990 found among similar-sized major earthquakes in the vicinity of cities. Chile is a highly earthquake-afflicted country that has transformed its building stock through the 20th Century from among the worst to the very best (Cruz, 2009), and has reduced earthquake fatality rates (relative to national population) by a factor close to 40 (98%).

2.5 Recommendations on suitable disaster targets

There are a number of key factors to consider when making recommendations on suitable targets for disaster reduction. These include hazard type, exposure, funding and mitigation measures (both those in place and those available). We discuss these here, followed by some recommendations.

For any country, the key determinant of what can be achieved around improved DRR will be the pre-existing state of disaster management, allied with the particular hazards facing that territory, the extent of the people and building stock exposed to the hazards and the available funding (based on internal revenues or funding received for DRR).

Both the levels of hazard and the innate resilience of the building stock, for example, can be widely variable. While one might assume some correlation between the resilience of traditional buildings to the hazard climate, this is often not the case, in particular when extreme events are rare. For example, traditional buildings in towns in seismically active central Iran, which are constructed out of mud and do not use wood, are lethal in earthquake shaking. Countries in which there is widespread availability of timber, such as the US and Japan, tend to construct houses relatively resistant to earthquake shaking but at the same time more susceptible to being damaged by strong winds. In traditional houses in Japan, a heavy tiled roof is added to the structure to improve wind resistance, but this makes the building more prone to collapse and killing its occupants in an earthquake – as happened quite widely in the city of Kobe in 1995.

The widespread adoption of concrete as a building medium through the 20th century, in particular in low- and middle-income countries, where it has been adopted without engineers, has often meant risk of earthquake fatalities has risen beyond that of the original indigenous construction methods. In Haiti, following earthquakes in the 18th century, URM buildings were banned after they were observed to be deadly. However, these lessons from previous centuries became forgotten and, as timber was depleted on the island, the prevalence of URM and non-engineered concrete construction became widespread in the late 20th century, with thousands killed in 2010.

As countries develop, typically after a particularly severe catastrophe, they embark on regional or national development policies focused around DRR. This is evident from the Japanese experience with typhoon and flood losses since 1960 and from the US experience with hurricane storm surge floods after 1950. These programmes, appropriately, focus on fatality reduction more than limiting economic losses. They may be more or less successful according to the degree to which they develop a realistic and comprehensive understanding of their hazards and vulnerabilities. However, after investing in a significant programme of DRR, inevitably the potential for further targeted reductions in disaster mortality or economic losses will be reduced or may be considered not worth further investment.

Therefore, in assessing potential national targets for DRR and in order to achieve a global target, a starting point is to rank a country's own pre-existing state with respect to its underlying hazard climate, exposure and current DRR. This could be done using current datasets such as those found in the World Risk Index[25].

2.5.1 Mortality versus economic loss reductions

For those hazards that can be forecast and for which people can evacuate, it is possible to make much larger and more rapid reductions in disaster mortality than in economic losses. For example, in Japan between 1960 and 1989, and using decadal averages before and after this period, while typhoon fatalities reduced at least 50-fold, the number of properties flooded as a result of typhoons reduced by only at least 8-fold as a result of improved flood management and flood defences.[26] In Bangladesh for cyclone storm surges, improvements have been made in early warning, evacuations and infrastructure, which have significantly reduced fatality rates – by a factor even in excess of 100. However, from these cyclone storm surges there is no evidence to suggest material reductions in the numbers of properties flooded or in direct economic losses (except as they relate to reductions in fatalities).

From the use of catastrophe models, designed to capture both direct building damages and mortality rates, we find that, in a high earthquake hazard zone, if one was to model the impact of replacing all URM wall construction buildings by the latest building code-compliant steel frame or built-to-code reinforced concrete construction, deaths could be reduced significantly (by factors that can range beyond x100). Reductions could also be made from retrofitting existing houses. However, the reduction in economic loss achieved through such building replacement would be much smaller (for example x4-x6 in one analysis). This highlights the way current building codes are intended to achieve life safety rather than prevent irreversible structural damage.

Countries such as Bangladesh demonstrate that it has been possible to make large reductions in life loss from forecasted hazards that allow for evacuations over a space of one or two decades. The situation in Chile highlights that it is possible to achieve comparable reductions in earthquake mortalities, although over a longer timeframe.

2.5.2 Summary

Data from country case studies demonstrate the following:

- The reduction in disaster fatalities and economic losses available to a country depends on 1) the territory's hazard climate: hazard types, range of severities etc.; 2) the nature of the building stock; 3) the degree to which the country has already undertaken a significant phase of investment in DRR; and 4) the availability of funding.
- Most DRR strategies achieve a significantly smaller reduction in economic losses relative to the impact on mortality rates.
- A more rapid reduction in mortality rates can be achieved for forecast hazards allowing for evacuation than for unforecasted earthquakes.
- Effective evacuations for floods, wind events and storm surges, and replacement of buildings for earthquakes, can achieve the biggest reductions in disaster mortality rates.
- If no work is done to actively manage risks, mortality rates may tend to increase, in particular as a result of unsupervised construction.

If we were attempting to arrive at a realistic global target for DRR in relation to mortality, we would need to balance the proportion of countries that have already achieved strong DRR programmes, and for the rest the degree to which the principal disasters are or are not forecastable. For a headline figure, a global 50% reduction in disaster mortality over the next 15 years (adjusted by exposed population) could reflect the appropriate balance of these factors. This target should then be 'allocated' to countries according to their hazard climate, exposure, pre-existing state of preparedness and available funding. A starting point could be to rank countries using indices such as those of the World Risk Index.

For economic losses, we also need to consider the contribution of different hazards as well as what has already been achieved in a country. Where floods are a principal driver of risk, then improved river flood management and the construction of flood defences can reduce their impact. As shown by the Japanese experience, significant investment in defences can achieve big reductions in the numbers of properties flooded, and in this way also reduce the numbers of deaths and those affected. Elevating buildings takes more economic value out of reach of floods.

For earthquakes, there are fewer options available other than constructing more resilient building types. However, the development of building codes to date has concentrated on improved life safety, not reducing reconstruction costs. For example, it should be possible to walk out of a strongly shaken reinforced concrete building alive because of the way the structure absorbs damage, but the building may still have to be demolished and rebuilt. The experience of the earthquakes in Christchurch, New Zealand, in 2010 and 2011,for example, highlighted that many buildings that superficially appeared undamaged, and in which there were no fatalities, nonetheless were considered total losses, because they had suffered differential subsidence. Therefore, for earthquake-afflicted countries, it remains a challenge to reduce the economic impacts. There are, however, initiatives to introduce 'code-plus' construction standards, aimed at reducing damages as well as saving lives – although these also add extra cost to buildings. Reflecting the balance of earthquake versus storm and flood losses worldwide, it is recommended that the global target for economic loss reduction be set at 20%.

3.

Targets on disasters and poverty

The positioning of a target related to disasters under Goal 1 of the SDGs has raised questions about the relationship between disasters and poverty and the extent to which disasters are responsible for impoverishment. These are explored in detail in Shepherd et al. (2013). This section considers how to set a target that directly links disasters and impoverishment, in order to drive action that sustains people overall escaping from poverty.

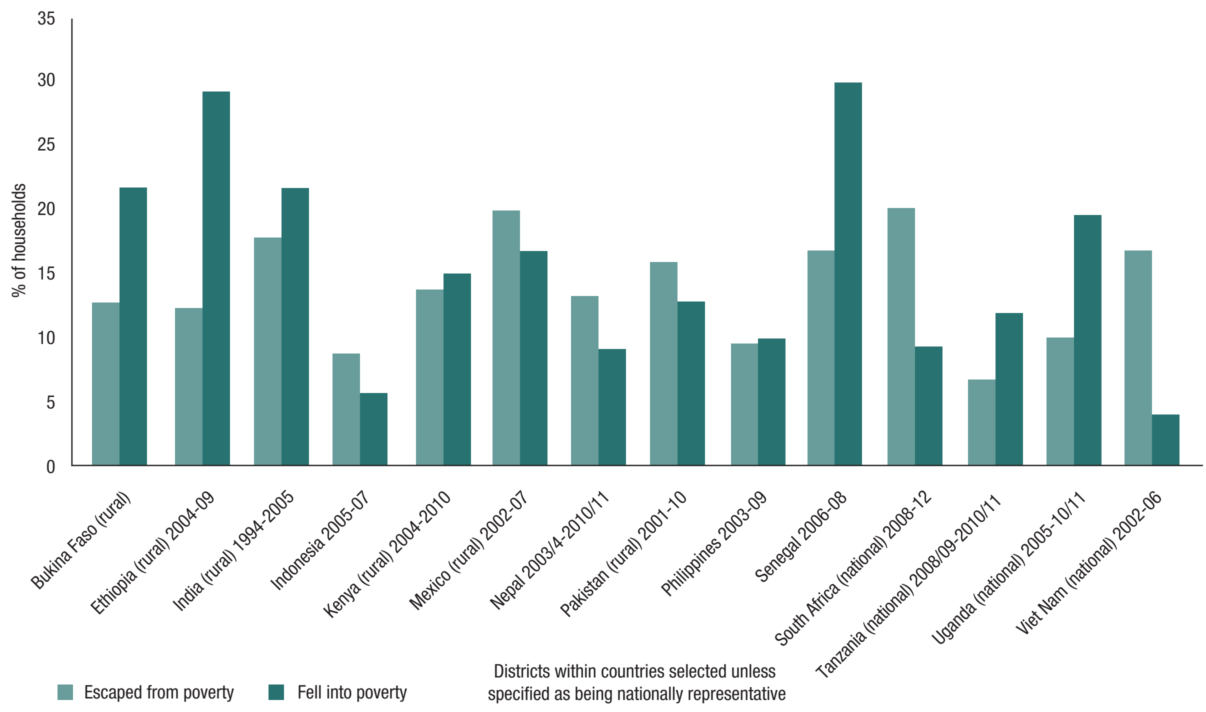
3.1 Introduction: Poverty dynamics

In order to get to zero extreme poverty, it is necessary both to tackle current poverty and to stop future impoverishment – the descent below the poverty line of people currently living out of poverty. Unfortunately, limited availability of nationally representative panel data or household survey data that track households over time means we lack a comprehensive picture of the extent of impoverishment. However, the panel survey data that are available show rates of impoverishment are significant and, in some contexts and over certain periods of time, impoverishment can exceed escapes from poverty (Figure 21 shows illustrative data). Without tackling the drivers of descent into poverty it will not be possible to get to zero and stay there.

This section investigates the different shocks that drive impoverishment, with a particular focus on the role of natural catastrophes. It examines how successful countries have been at stopping impoverishment and proposes a target on reducing impoverishment over the medium term from a range of shocks that households continually face.

Figure 21: Households escaping from and falling into poverty - selected data to highlight impoverishment potential over particular periods of time

SOURCE: ADAPTED FROM SHEPHERD ET AL. (2014).
NOTE: CALCULATIONS USE NATIONAL POVERTY LINES.



3.1.1 The main shocks driving impoverishment

People fall into poverty as a result of shocks, combined with limited resilience (viewed in terms of limited assets and endowments at the level of individuals, households and communities). In addition to natural catastrophes, shocks can be agroclimatic, economic, health-related, legal, political or social (Baulch, 2011). The main shocks driving impoverishment vary from context to context. Natural catastrophes are commonly cited as a major driver of impoverishment along with conflict and insecurity (including theft) and the costs of, and foregone income resulting from, ill health, as well as expenses associated with certain social conventions (including dowry payments, wedding and funeral costs (ibid.)). Table 6 gives the main causes of impoverishment and downward mobility across selected contexts.

TABLE 6: THE MAIN SHOCKS DRIVING DOWNWARDS MOBILITY AND IMPOVERISHMENT OVER TIME

Country and sample	Source	Shocks driving impoverishment
Household panel survey data		
Rural Bangladesh 1987/88-2000 379 households (not nationally representative	Sen (2003) [lxviii]	Main shocks causing deterioration in economic well-being over the last decade as perceived by respondents whose situation deteriorated over the period: - Ill-health (18%) - Natural disaster (15%) - Social ceremonies (3%) According to the EM-DAT database the 1988 flood is the largest natural catastrophe in the country's history by number of people affected. A storm of 1991 and flood in 1998 are the ninth and tenth largest natural catastrophes respectively by the same measure. Percentages are low as shocks are presented as just one driver of impoverishment – others include changes in household demography – though shocks overall are the number one driver.
Rural Ethiopia 1999-2004 1368 sedentary rural households	Dercon et al. (2005) [lxix]	Only two shocks have a statistically significant impact on consumption: Experiencing drought in the last five years (reduces per capita consumption by 20%). More than half the survey households reported to experiencing drought, the most common climatic shock, over the period. Illness of household head (reduces per capita consumption by 9%) The 2003 drought is the largest natural catastrophe in the country's history in terms of number of people affected (EM-DAT database)
Rural India 1975-2006 10 villages 2000 individuals	Dercon et al. (2013) [ixx]	Pest shocks, for households experiencing them between 1984-2000, lowered consumption growth by 12% Experiencing a weather or price shock over the same period did not lead to significant reductions in consumption growth (though pest shocks may be linked to the climate)
Stages of Progress Methodology (qualitative assessment of changes in wealth)		
Uganda 36 Villages 1068 randomly selected households. Assessment of changes in wealth over the last 25 years.	Krishna et al. (2006) [lxxi]	More than 70 per cent of households that fell into poverty cited ill health and healthcare expenses as the most important part of the process leading to their descent. Crop disease important in case of 19% of households which fell into poverty.

Country and sample	Source	Shocks driving impoverishment
Kenya 20 communities 1700 households. Assessment of changes in poverty status since 1978.	Kristjanson et al. (2010) [lxxii]	Major two shocks leading to poverty, cited by households falling into poverty: - Poor health and health related expenses (74%) - Heavy funeral expenses (64%) Environmental factors not mentioned as an important driver of poverty
Life Histories		
Rural Bangladesh 293 life history interviews	Davis (2011) [lxxiii]	Frequencies of causes of decline in people's lives. Percentage of life histories showing this as a main cause: - Illness and injury (75%) - Dowry and marriage (39%) - Death of family member (33%) - Household and property division (22%) - Theft or cheating (20%) - Litigation (19%) - Floods, cyclones or storms (17%) - Crop damage (14%) - Violence, conflict or physical insecurity (14%)

NOTE: THESE STUDIES DO NOT TAKE INTO ACCOUNT THE ROLE POLICIES AND PROGRAMMES MAY HAVE PLAYED IN MINIMISING THE IMPACT OF CERTAIN RISKS (E.G. OF FLOOD RELIEF OR DISASTER RISK MANAGEMENT).

While it is difficult to disentangle the impacts of natural catastrophes on poverty, the balance of evidence does suggest droughts and extreme rainfall volatility increase poverty, along with a wide range of other factors (Karim and Noy, 2013). For instance, in Mexico, a country with a strong disaster management system (Shepherd et al., 2013), between 2000 and 2005 natural hazards (particularly floods and droughts) had significant impacts on poverty incidence and the Human Development Index (HDI). Specifically, they increased food poverty by 3.7% and reduced the HDI by the equivalent of losing on average two years of human development gains over the same period (Rodriguez-Oreggia et al., 2013).

The same shocks can have different impacts on different groups of people. The global increase in the price of staple foods in 2007/08 both increased the poverty headcount and drove people already living in poverty further below the poverty line. The impact of rising prices, though, was not uniform across households: it was net food purchasers, particularly those living near the poverty line in both rural and urban areas, who took particularly hard impacts (Wodon and Zaman, 2009). Natural catastrophes can also increase inequality and socioeconomic differentiation, as the poorest households often experience greater impacts, with wealthier households having greater ability to cope and respond. Following an exceptionally strong typhoon in the Philippines, both high- and low-income households experienced similar levels of loss in the year after. However, the consumption and income of low-income households did not recover over the next few years, in contrast with that of wealthier households (Anttila-Hughes and Hsiang, 2012). In rural Nicaragua, Hurricane Mitch affected the poorest households disproportionately, especially in terms of their ownership of non-productive assets, which were significantly reduced (Jakobsen, 2012). Similarly, panel data from rural Ethiopia, combined with meteorological data, reveal that poor households are more vulnerable to a drop in consumption when rainfall is low compared with the average for the village (Porter, 2008, in Dercon and Porter, 2011).

3.1.2 Impoverishment is often the result of a series of shocks

It is not normally one shock that drives people into poverty, but rather a series of negative events (Krishna, 2010). Qualitative interviews in rural Bangladesh and rural Sindh, Pakistan, highlight how sequences of shocks are important in driving downward mobility (Baulch, 2011). In rural Sindh, the drought of 1999-2002 had especially adverse effects on landless households because a collapse in employment opportunities occurred at the same time as rising food prices (Lohano, 2011). Meanwhile, in rural Ethiopia it is households that are significantly affected by both drought and illness that see the most significant decrease in their levels of per capita expenditure once other factors are accounted for (Dercon and Porter, 2011). In Bangladesh, it is the combined effects of dowry and medical expenses (especially for the elderly) that drive downward mobility. Between 1996/97 and 2006/07, flooding did not have a significant impact on poverty transitions, although 30% of households reported flood-related damage (Quisumbing, 2011).

Work on natural catastrophes highlights how their impacts will vary according to the recurrence time between events (e.g. two bad storms in a row may be worse than two bad storms with a ten-year lag between them (Anttila-Hughes and Sharma, 2014). However, it is not just the sequencing of, and recurrence time between, natural catastrophes that is likely to be important, but also the sequencing and timing of a range of shocks. Households are often able to recover from one blow, but a number of blows in quick succession can have devastating consequences (Krishna, 2010).

3.1.3 Investigating the long-term impacts of shocks

The outcomes of shocks can be measured in terms of their short- and long-term impacts. Further depleting already limited productive assets, or withdrawing children from school in response to a shock, for instance, can have long-term consequences. It is also important to assess both direct and indirect outcomes. This distinction is particularly important when examining sudden-onset natural catastrophes. It may be here that direct impacts (descent into poverty as the result of destruction of business equipment or livestock which are the primary sources of income, for instance) are less significant than indirect impacts (such as fomenting conflict, changing political behaviour or altering household preferences for boys or girls) (Anttila-Hughes and Sharma, 2014). Arguably, just assessing the immediate, direct impacts of a disaster, in terms of lives lost or economic losses, can significantly underplay their impacts (de la Fuente and Dercon, 2008).

The short-term impacts of shocks, including disasters, can last several weeks or months. With effective remedial action (such as food relief or cash transfers) at the household and community levels immediately following a shock, income, losses and declines in consumption can be smoothed and any declines in nutritional status need not be permanent. Limited evidence from the 2007/08 food price crisis suggests its impacts on poverty have largely been short in term. In the long term, negative impacts seem to be much smaller. This may be because rising agricultural wage rates have often offset some of the negative impacts of increased food prices and consumers and producers adjust to higher agricultural prices (Ivanic and Martin, 2011; van Campenhout et al., 2013).

However, there are several reasons why, if responses are not timely and well targeted, the impacts of natural catastrophes, in particular, can become long in term. These are related to the covariance, or widespread nature, of the shock. As natural catastrophes often affect an entire area, they reduce the ability of households to recover when compared with household-level shocks where kinship networks and local groups may be able to help households cope with the shock. In contexts of relatively closed markets, such as remote rural areas, for instance, if many households sell possessions at the same time to cope with a disaster, prices can become depressed and so the coping strategy less effective. Coping strategies that rely on inter-household transfers can also be less viable. For instance, being in a rural financial institution where the majority of deposits are from community members engaged in agriculture may not ensure access to loans after a natural catastrophe, as deposits will likely be withdrawn to face any resulting harvest failure and wider consequences (Skoufias, 2003).

While data on the long-term impact of natural catastrophes and other shocks are limited, there is evidence nonetheless (de la Fuente and Dercon, 2008). For instance, a relatively mild drought in Zimbabwe in 1994/95 lowered the annual growth rates of children aged 12-24 months by between 1.5 cm and 2 cm. Four years after the drought, these children remained shorter than those who were not affected by drought at the same age (Hoddinott and Kinsey, 2001), although children in relatively well-off households had recovered some of this lost growth when compared with those in poor families (Hoddinott, 2006). Lost growth in childhood is then correlated with lower productivity and lifetime earnings as an adult (Hoddinott et al., 2013). There also remain impacts on labour markets, in terms of substantially lower wages, several years after a natural hazard. The 1998 flood in Bangladesh was an event with a 1% probability of occurring. Five years later, agricultural and non-agricultural wages remained 4-7% lower for each one foot deviation from the average flood level in a village (Mueller and Quisumbing, 2011).

TABLE 7: RATES OF IMPOVERISHMENT OVER SELECTED PERIODS OF TIME

Country	Years/ Period of Time	Annual Rate of Impoverishment (%)	Context: Information on Major Covariant Shocks
Ethiopia (rural)	1990-1994	4	
	1999-2004	3.6	Drought Sept 1999 affecting 4.9 million people Drought during 2003 affecting 12.5 million people
	2004-2009	6	Drought start of 2009 affecting 6.2 million people. Steady increase of price in food staples from 2004 - price of maize in 2008 was 130 per cent higher than the 2004-08 average
Kenya (rural)	2004-2007	4.7	Drought July 2004 affecting 2.3 million people. Drought Dec 2005 affecting 3.5 million people
	2007-2010	4.7	Drought July 2008 affecting 3.8 million people. Food Security Steering Group calculated that food price rises over late 2007-mid 2008 would raise the population which is 'food poor' .
South Africa	2008-2010	5	
	2010-2012	4.5	
South Africa (KwaZulu-Natal)	1993-1998	2.2	
	1998-2004	3.2	Drought during 2004 affecting 15 million people
Uganda	1992-1999	1.6	
	2005/06-2009/10	2.8	2008 saw a spike in the prices of most basic commodities. In the short-term this increased the poverty headcount by 2.2%
Nepal	1995/96-2003/04	1.6	Period of civil war
	2003/04-2010/11	1.3	Nepal subject to food price increases of 2007/08
Pakistan (rural Sindh and Punjab)	2001-2004	4.7	
	2004-2010	1.3	Pakistan subject to food price increases of 2007/08
Vietnam	1992-1999	1.8	Drought Dec 1997 affecting 3 million people
	2002-2004	0.25	
	2004-2006	0.25	
Indonesia	2005-2007	2.9	
	2008-2010	2.1	
Philippines	2003-2006	3	
	2006-2009	2.7	Storm Sept 2006 affecting 3.8 million people. Storm June 2008 affecting 4.8 million people

SOURCE FOR FINAL COLUMN: EM-DAT DATABASE – NATIONAL REPORTS ON TOP 10 NATURAL CATASTROPHES BY NUMBER OF PEOPLE AFFECTED (AFFECTED USED TO REFER TO PEOPLE REQUIRING IMMEDIATE ASSISTANCE DURING A PERIOD OF EMERGENCY, I.E. REQUIRING BASIC SURVIVAL NEEDS SUCH AS FOOD, WATER, SHELTER, SANITATION AND IMMEDIATE MEDICAL ASSISTANCE). DISASTER LISTED IF IT AFFECTED ≥ 5% OF POPULATION REPRESENTED BY THE SURVEY. ANNUAL RATE OF IMPOVERISHMENT CALCULATED AS THE PROPORTION OF THE SURVEYED POPULATION FALLING INTO POVERTY BETWEEN THE TWO SURVEY ROUNDS DIVIDED BY THE NUMBER OF YEARS OVER THE SURVEY COVERS.

Long-term impacts can also be felt through children missing out on education.In Côte d'Ivoire, school enrolment declined by 20% in regions experiencing rainfall shocks in 1986/87 compared with those that did not experience a shock (Jensen, 2000). Meanwhile, in Zimbabwe, children affected by a drought in 1982-1984 had completed 0.4 fewer grades of school 13-16 years after the drought compared with those children who did not experience it. This could imply a 14% loss in their lifetime earnings (Alderman et al., 2006).

3.2 Has impoverishment been successfully tackled?

Table 7 presents an assessment of trends in impoverishment over time using three-, or more, wave household panel data or two two-wave panel surveys undertaken across different time periods (Annex 2 gives more information on these surveys and the source of analysis). The aim here is to give an idea of the rate of reduction of impoverishment that is possible in a variety of circumstances. A shortage of data points means it is difficult to identify trends with any certainty, but the table shows that, overall, countries have not been that successful at reducing impoverishment. The table also gives information on major national covariant shocks. The aim in doing this is not to attribute particular rates of impoverishment to these events, but rather to illustrate the context within which countries have been successful, or more usually unsuccessful, at reducing their impoverishment rates.

An exception is Vietnam, which, while having a low annual rate of impoverishment during the 1990s (1.8% over the period 1992-1998), saw a dramatic decline in the 2000s to an annual impoverishment rate of 0.25%. Vietnam is also in the highest tier of disaster risk management system quality for developing countries, meaning it has a portfolio of actions to reduce risk and respond to disasters (Shepherd et al., 2013). In contrast, the Ethiopian Rural Household Survey (ERHS) shows more people fell into poverty between 2004 and 2009 than between 1999 and 2004. This is attributed to the fact that 2009 was a particularly bad year in rural Ethiopia, a year of drought during a period of rising food prices (with most households sampled being net food purchasers) (Dercon et al., 2011).

Specifically in the aftermath of disasters, there are instances where effective programmes and interventions, as well as particular strategies adopted by households, have successfully reduced the impoverishing effects of natural catastrophes, particularly in the medium and long terms. In Ethiopia, for instance, while the 1999-2000 drought had devastating short-term impacts on households, particularly the poorest, this effect was short term, with households actively pursuing strategies to enable them to return to their pre-drought level of wealth by just three years after the event. These strategies include income diversification and so being less reliant on rain-fed agriculture (Little et al., 2006). This finding is echoed, over the short term, in Vietnam, where irrigation provided effective protection against localised droughts between 2004 and 2006. Here, households with no irrigated plots saw their consumption decline by 16% on average in the year of the drought, whereas households with irrigated plots saw just a 3% decline (Thomas et al., 2010).

In terms of effective interventions, in Ethiopia children 6-24 months old experienced about 0.9 cm less growth in communities with substantial crop damage after severe localised droughts, while food aid acted as an effective insurance mechanism in reducing child malnutrition (Yamano et al., 2005). In Bangladesh, meanwhile, Quisumbing (2011) hypothesises that floods did not drive impoverishment between 1997 and 2006 because of an effective emergency response system, including well-targeted food assistance. In contrast, in Vietnam, disaster relief after riverine floods between 2004 and 2006 prevented the erosion of the household asset base (and so had the potential to halt long-term declines into poverty), but was not sufficient to prevent a 17% temporary decline in consumption in the year following the floods. However, households living in less flood-prone were more likely to experience immediate declines in welfare and erosion of their asset base following flooding, presumably because of less established systems for disaster provision in the area (Thomas et al., 2010).

3.3 A proposal for framing a target on impoverishment

Clearly, preventing any impoverishment resulting from natural catastrophes will not be possible, as the impacts in the hours, days and weeks following a disaster can be hard to prevent entirely – even in the wealthiest societies. Given that responses to disasters should occur within weeks if not days, it would be reasonable to look at preventing any post-disaster impoverishment after a period of months or year(s). A target within a poverty eradication context could then be: A shock, such as a disaster, does not increase poverty levels, as measured one/x year(s) after the event.

It is important to note that the proposed target is not a target on disasters alone, but also on causes of impoverishment and downward mobility. This is because, while disasters are an important driver of poverty, it is far from clear that they are the most important one. This target would be under a poverty eradication goal and could be disaggregated according to the major causes of impoverishment:

natural catastrophes, conflict, ill health and price (or broader economic) volatility. However, we have left the period over which poverty levels would be expected to recover to their pre-shock level open to discussion as, after a severe natural hazard, such as an earthquake or a drought, it is likely that more time would realistically be required for people to recover to their pre-shock situation than in the case of a household-level shock.

Because of the variation within countries of incidence of negative events, including natural catastrophes, it would be important to capture subnational variation in this indicator through measurements by region as well as by rural and urban area.

4.

Creating a baseline and monitoring progress on disaster risk reduction

To have effective targets for reducing disaster deaths, and economic, physical and social impacts, it is necessary to define how a baseline should be set as well as how to measure progress. In this section, we propose an approach, which takes into account lessons learnt from the MDGs and HFA.

4.1 Introduction

We have considered various options to create an approach. The options for measuring a baseline and progress are as follows:

1. Employing observed mortality and economic loss data;
2. Using probabilistic catastrophe models for mortality and economic losses;
3. Linking hazard maps with hazard specific resilience data.

In terms of using observed data, as explained in Box 4 (p.14), on 'The challenge of measuring progress from observed disaster loss data', at the start of Section 2, the population of disasters is a 'right-skewed', or fat-tailed, statistical distribution, often dominated by larger but rare events. This provides a significant challenge to how a baseline can be set or progress against the target measured from a decade of national observations. In particular, raw data on disaster occurrences on their own cannot be used to define either a pre-existing baseline or progress in achieving the reduction to the target. Instead, it becomes necessary to find ways of quantifying the level of risk in a country independent of the occurrence of actual loss events. This leads us to consider options 2 and 3.

Risk reflects the compound of the hazard, the exposure and the vulnerability of that exposure to the hazard. Therefore, to measure risk we need to identify how hazard, exposure and vulnerability interrelate. One way of achieving this measure of risk is to employ a catastrophe model (option 2), which contains a large population of synthetic extreme events, each with its respective probabilities (Box 4, p.14).

However, given that catastrophe models are not yet widely available for all countries, and that modelling fatalities is less mature than modelling losses from damage, a simpler way of measuring risk is to use hazard maps linked with detailed exposure and vulnerability data (option 3). For example, we can identify what proportion of buildings in different hazard zones are built to code, or we can assess what proportion of people situated in a flood hazard zone are covered by a comprehensive and well-rehearsed evacuation plan. This methodology is set out in more detail in Section 4.2 and, at a high level, is the recommended approach, given the availability of data, the fact it enables a consistent approach for all countries allows the data collected to be linked to a measurement of risk. However, further studies would need to be carried out, as noted in Section 6, in order to address potential implementation issues. There would also need to be a systematic collation of detailed building exposure data, identification of where there are development needs and a multi-tiered global system for maintaining high-quality updated hazard maps.

4.1.1 Risk mitigation linked to disaster loss experiences

Another reason why data on actual disaster losses may not give a good reflection of the current level of risk is the reactive way the principal actions around DRR tend to follow the occurrence of a major catastrophic loss. Hence, a country that has not suffered a disaster is likely to present a higher risk than an identical country (in terms of hazard climate, geography, economy, population etc.) that has been subject to a recent catastrophe. The occurrence of a major catastrophe can drive significant reductions in the potential for future loss of life and economic impacts. For example, Hurricane Andrew in Florida in 1992 and the 1994 Northridge earthquake in California, both led, within a few years, to substantial enhancements in the building code for their respective states. It typically takes five to ten years for the lessons to be identified and new building codes to come into force. As the proportion of buildings built to the new code expands year by year, the mean vulnerability of the building stock is reduced. Within six years following 2005 Hurricane Katrina, the flood defences around the city of New Orleans had been significantly improved. This marked a step change in raising the resilience of the city to a future hurricane storm surge.

For forecastable hazards, the experience of a poorly forecasted disaster – as with Cyclone Nargis in Myanmar in 2008 or the 1970 storm surge in Bangladesh – can lead to rapid improvements in the level of preparation for a future flood. In Bangladesh, over the following 40 years, actions have included a programme to build cyclone shelters as well as prepare the population for future cyclone warnings. As a result, there has been a very significant reduction in loss of life from cyclones.

BOX 5: THE USE OF HAZARD MAPS AND CATASTROPHE MODELLING IN THE INSURANCE INDUSTRY

Disasters are extremely damaging events but, given their rare and infrequent nature, there is limited information on which to base estimates of either future mean annual losses or losses in rare high-magnitude events. Furthermore, exposure to these events is continually changing as a result of new construction and population increases, especially in high-growth countries. For these reasons, since 1990 the insurance industry has embraced the use of probabilistic catastrophe modelling.

A catastrophe loss model contains a synthetic catalogue of at least 10,000 and up to 100,000 years of extreme events for a particular hazard and region. This could, for example, be Atlantic hurricanes or earthquakes in India. The process to generate the synthetic catalogue is based on the scientific understanding of what determines the structure, severity and geography of the hazard. The events are constructed at high resolution in the form of hazard footprints of the primary hazard (e.g. the spatial distribution of maximum hurricane windspeeds), as well as, where relevant, a secondary accompanying hazard, such as storm surge flooding (mapped as water depths and velocities). Details of properties, including their relevant parameters, such as value, location and construction type, are entered into the model. For each simulated event at that location, precompiled vulnerability functions relate the severity of the hazard to the loss expected for that individual property. These vulnerability functions account for the fact that the damage to a building for a given hazard level will be a function of its characteristics, such as construction type. Based on vulnerability functions linking the hazard to the percentage loss, the loss cost is calculated for each of the simulated events with respect to 'the exposure', which comprises all the buildings, contents or people in a city or country. Then, by multiplying the expected loss from each of the events, with the event's annual probability of occurrence, and summing across all the events that affect the locations inputted, it becomes possible to generate the average annualised loss (along with the standard deviation of that estimate) to the individual property or the portfolio of properties. This then becomes the basis for setting appropriate insurance premiums.

The catastrophe modelling paradigm has principally been used to help insurance entities quantify financial risk and hence the large majority of catastrophe models have been developed for high- and upper-middle-income countries with an active insurance industry. However, there are a number of current programmes to expand the development of catastrophe models into other areas of the world.

Catastrophe models mainly focus on the financial cost of disasters, but have also been developed to model earthquake casualties. To do this requires estimating the probability of building collapse and the distribution of the population within the buildings at two antipodal times of day (such as the middle of the workday and night). The output of such casualty models includes the annualised number of expected fatalities as well as the number of fatalities that can be expected at key 'annual probabilities' or 'average return periods'. The expected annual rate of fatalities is simply the fatalities for each simulated event multiplied by the respective event probability summed across all the stochastic events in the simulation.

A preliminary step in the development of a catastrophe model involves the creation of a probabilistic hazard map. These represent the hazard parameter (e.g. strength of ground shaking, flood depth etc.) expected at each location at a given annual probability or return period (e.g. 1% annual probability or 100-year return period flood map). Hazard maps produced for two or three annual probabilities can be used to provide a good perspective on the distribution of both frequent and rare hazards across a territory. Hazard maps are generally more available than models and already cover most hazard-affected countries.

Although catastrophe models are the optimum method for calculating the estimated loss to properties, they can be relatively complex and expensive to build as they require full modelling of the hazard, vulnerability and exposure. Hazard maps are much cheaper and faster to produce as they only require modelling of the hazard.

Such mechanisms mean the level of preparedness and vulnerability in a region can be linked directly to whether there has been a major catastrophe in recent decades. If the 1970 cyclone had not hit Bangladesh, or Hurricane Katrina had not flooded New Orleans, these investments in risk reduction would not have taken place. Therefore, as a counterfactual, a subsequent catastrophe would cause higher impacts in terms of loss of life or economic damage if the original catastrophe had not occurred. Also, the principal loss event by which one might attempt to characterise the level of risk in a territory becomes the feedback mechanism by which that risk has changed. A territory without a recent major catastrophe is likely to exhibit higher vulnerability than an equally hazardous territory that has suffered such a catastrophe – even though the experience from historical data of catastrophe loss in the two regions suggests the reverse.

For the largest catastrophes, the lessons can even travel outside the affected region. The South Florida building code has been widely adopted in parts of the Caribbean, and lessons from the Northridge earthquake have been implemented in other national building codes. The 'unanticipated' Mw9 earthquake along the Pacific coast of Japan in 2011 has prompted a focus on reviewing where else worldwide such earthquakes could be expected.

On a regional and national level, one can expect that the highest vulnerability to catastrophes will be in locations where there had not been a previous catastrophe for many decades – such as Port au Prince Haiti before 2010 – although data based on observations from the past 100 years might suggest there was no risk. There are a number of urban concentrations around South Asia, where, because there has been no loss for many decades, the current risk will be highest.

On a global level, the higher the levels of loss of life or economic loss over some period, the more one might expect a reduction in these measures in a subsequent period if lessons are learnt and actions are taken. However, there could be certain countries that do not take mitigation measures. In contrast, if several years go past worldwide without a major catastrophe, then vulnerability to future catastrophes is likely to be increasing.

These examples highlight that the focus is often on improving the vulnerability of areas that have had a recent disaster rather than translating knowledge learnt to other areas at risk in different regions and countries. DRR does not currently happen consistently in countries, and therefore examples of rapid risk reduction tend to be reactions to particular catastrophes. In the future, the focus should be on sustaining continuous efforts of risk reduction in areas at risk, even when disasters do not act as timely reminders.

4.1.2 Learning lessons from the Millennium Development Goals and the Hyogo Framework for Action

In order to create a successful monitoring framework, it is key to learn lessons from reviews of both the MDGs and the HFA, in particular because, when the frameworks were established, they were not linked. If DRR targets are to be included in the SDGs, which are the renewal of the MDGs, the SDGs and the post-2015 framework on DRR should be aligned to ensure consistency of efforts, both in development of the frameworks and in the collection of data on a country level.

Millennium Development Goals

While there were no specific DRR targets in the MDGs, it is appropriate to consider the high-level strengths and weaknesses of the monitoring framework and implementation to see what can be learnt. The format of the MDG agenda (that is, the sequence of goals, targets and indicators) is generally considered effective and helped improve policy monitoring and accountability. Additional strengths from the MDG framework and implementation include the following (UNTT, 2012):

- Supported the development of countries' statistical capacity and the use of data in support of development policies;
- Improved statistical system coordination at national and international levels;
- Framework promoted concrete actions to address human development shortfalls and the goals and targets were made explicit in national development policies;
- Facilitated various forms of intra-regional cooperation.

Identified weaknesses of the MDG framework, which should be addressed in future methodologies, are as follows (UNTT, 2012)

- Failure to take into account the initial conditions of the various regions and countries. The framework did not consider the inherent vulnerability of countries to natural catastrophes and the possibility of sudden reversals of years of development gains;
- Some imprecise quantitative targets;
- Failure to account for changing populations;
- Lack of clarity on how to tailor global targets to national situations as well as regional variations;
- Lack of attention to disaggregated data by which to monitor progress among vulnerable groups, qualitative aspects and interdependencies across the MDGs.

Criticism was also made of measurements in the MDGs: the lack of baseline data, reliance on household surveys that are prone to errors in responses and the inaccuracy of trends (Attaran, 2006). Recommendations include leaving greater flexibility to tailor targets to regional, national and subnational realities and to subgroups of the population, for example reflecting different income levels or vulnerabilities.

Hyogo Framework for Action

On the HFA, the main progress made in recent years has been qualitative, grounded in policies, legislation and planning that should help lay the foundation for more quantitatively measurable achievements in the future. There has been a shift from a crisis management approach to one of proactive risk reduction and safety (UNISDR, 2013e). HFA progress reports submitted in 2011 and 2013 highlighted a number of challenges. These include the following:

- The HFA core indicators do not report any outcomes, and countries reported an insufficient level of real implementation against each indicator. As an example, although building codes exist, they are not enforced. Apparent progress in developing policies, laws and institutional frameworks, which are reported, does not necessarily translate into real change.
- The lack of precision in the core indicators leads to widely varying interpretations, understanding and measurement of progress by governments.
- The HFA Monitor, a self-assessment tool, generates results that are subjective and, while this expresses a government's own vision of progress, they cannot be used to benchmark or compare countries. In addition, country comparison is not valid, as countries have very different risk profiles and are at different stages of development.
- The HFA Monitor has provided only limited information on whether development policies or practices are generating new disaster risks or whether countries have policy instruments to strengthen resilience.
- Governments dedicate insufficient financial resources to reduce existing risks or to strengthen the resilience of those most at risk – typically low-income households and communities, small businesses and the informal private sector. Countries report the need for objective tools, such as cost–benefit analysis to make the case for disaster risk education, but most report the absence of such tools as a challenge.

Hence, for a successful framework, for either the SDGs or the post-2015 framework on DRR, the following should be considered:

- Precise quantitative indicators that report real change, for example changes in building stock or land-use rather than just policy change;
- Non-subjective tools for monitoring progress (e.g. independent evaluations), although countries still cannot be compared owing to differences in their risk profiles;
- Tools to understand whether policies will generate new disaster risks or strengthen resilience;
- The initial conditions of the various regions and countries;
- Population dynamics;
- Reduced reliance on household surveys;
- A clear understanding of how baseline data can be obtained;
- Clarity on how to tailor global targets to national realities, through case studies;
- Population dynamics and further disaggregation of data by vulnerable groups as well as consideration of additional aspects, such as the availability of sufficient funding, which would be useful for reporting.

In the following section, we propose a framework that could address these points. First, however, we must consider definitions and what we propose to measure.

4.2 Establishing a baseline and monitoring progress

4.2.1 Impacts and definitions

To enable global measurement, a number of definitions would need to be agreed. These include:

- The type of disasters being considered in the goals – for example whether natural or man-made disasters (such as dam collapse) – as well as a definition of each so as to clarify the distinction. This will be important, as the impact of disaster types may change. In this report, we focus on natural catastrophes – particularly, though not exclusively, those that have high impact;
- The probability levels employed for how hazard is assessed on a regional level – for example whether the 1 in 100 (1% probability) or 1 in 200 (0.5% probability) level is used to measure flood risk across all countries. When making these decisions, it is important to conduct a full analysis on what is available, and what measurements regulatory bodies use. The use of more than one annual probability for each country would ensure a good perspective on both frequent and rare hazards across a territory.

Additionally, before implementing a method to assess progress on DRR, it will be necessary to agree on these definitions and on the hazards that should be considered at a national level, to ensure consistency in measurement. For collating data among countries, specifically for the SDGs, a consistent method is required for successful implementation. This will require a focus on material disaster types (i.e. those that cause significant losses), such as earthquakes, wind events, droughts and floods.

4.2.2 Proposed methodology for measuring a country's progress in disaster risk reduction

In order to develop a monitoring framework, natural hazards can be divided into three categories, according to the degree and timescale over which they can be forecast:

1. Hazards such as floods, hurricanes and other categories of storm, which are well forecast over a timescale of days to hours and from which it becomes possible to evacuate those at greatest risk;
2. Hazards such as earthquakes, which typically arrive without warning and require well-designed and constructed buildings to reduce loss of life and to limit economic damage;
3. Slow onset hazards such as drought, which can be foreseeable for weeks, even while their duration and intensity may not be predicted. These need action plans in place to provide supplies to the affected region, including contingencies around the severity and duration of the period of reduced rainfall.

Effective DRR policies to reduce either mortality or economic loss depend on the type of hazard the area is at risk from. Some key policies are given below for each type of hazard:

- For 1, building effective defences, land use planning and evacuation planning;
- For 2, by constructing safer buildings and infrastructure, which can better withstand shaking and landslide damage, and by reducing the proportion of people and building value in areas of high hazard;
- For 3, irrigation and the effective planning around the transportation and distribution of food, water and shelter.

First, a country must understand what hazards it is exposed to, and in which regions, and then develop a DRR strategy for each hazard. For the SDGs, the key is to ensure the DRR strategies are effective and to assess progress against a consistent baseline.

As explained in Box 4 (p.14) on 'The challenge of measuring progress from observed disaster loss data', it is not possible to measure progress in DRR at a national level using loss data alone. In order to measure progress, it will be necessary to assess the degree to which protection against risks is provided, even in the absence of a disaster. Here, we suggest a method using hazard maps (rather than catastrophe risk models owing to current coverage, as outlined in Section 5) to measure the status of global risk from natural hazards, for both mortality and economic losses. The data collected on people at risk should be extended, to understand trends by vulnerable groups, such as those below the poverty line.

4.2.3 Mortality

Category 1: Forecast evacuable hazards (e.g. hurricanes, flood, tsunami)

From a hazard map, at some key defined annual probability(ies), the population at risk is identified from all those located in the hazardous areas. For these 'at-risk people', we need to identify what proportion are covered by an effective evacuation plan. The plan should incorporate education, logistics, regular drills, safe evacuation destinations etc. The effectiveness of this plan must be incorporated into the calculation, to ensure the measurement is outcome-orientated (i.e. the plan has been fully communicated and rehearsed and would be effective should a disaster occur). The 'effectiveness factor' would have to be independently assessed, as based on the quality of local governance and accountability mechanisms etc.

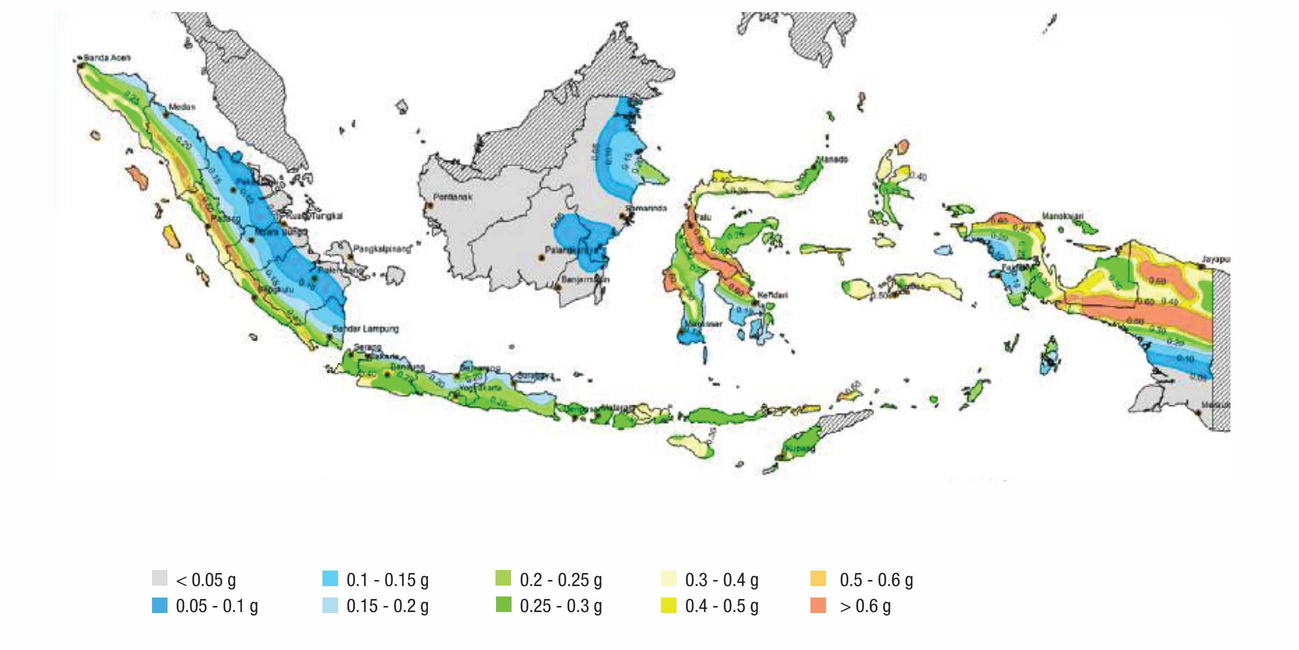
Therefore, calculating the expected fatalities for a certain population requires:

- Hazard maps – to ensure we are tracking both high-frequency and rare events, maps could demonstrate more than one level of hazard annual probability – such as 2%, 0.5% and 0.2% annual probabilities or following regulatory body guidelines:
    - These hazard maps would need to be updated over time to take into consideration any evidence around changes in hazard, including from the building of flood defences and any other mitigation strategies
    - For the purposes of setting a target, percentage reductions should be measured according to the baseline hazard map of 2015. (At the same time, attention should be paid to whether there is evidence for changes in hazard resulting from climate change over the 15-year period, although such changes should not be included in the definition of performance against a target.)
- Number of people in each hazard area on the map who are at risk;
- Number of people covered by an evacuation plan in each hazard area multiplied by an effectiveness factor (based on quality of local governance and accountability mechanisms etc.);
- Percentage of people expected to die who do not evacuate (from historical data or other sources).

Figure 22: Earthquake hazard map, Indonesia, showing different hazard zones

SOURCE: ADAPTED FROM IRSYAM ET AL., 2010.

NOTE: THIS IS AN EXAMPLE OF A PGA HAZARD MAP FOR INDONESIA, FOR A 10% PROBABILITY OF EXCEEDANCE IN A 50-YEAR PERIOD. THE COLOURS SHOW THE LEVEL OF GROUND SHAKING SCIENTISTS EXPECT TO SEE.



To calculate an estimate of **average annual** number of fatalities, we can multiply the annual probability of the particular hazard zone (e.g. 1% annual probability) by the number of expected fatalities calculated from the hazard levels.

Using this procedure, a country could reduce its average annual number of mortalities by either:

- Building and maintaining defences to reduce the area affected by the hazard;
- Expanding the evacuation plan to cover more people; or
- Improving the effectiveness of the evacuation plan (e.g. by improving the effectiveness of accountability mechanisms).

Category 2: Sudden, unforecasted hazards (earthquakes)

For sudden, unforecasted hazards, such as earthquakes, in the absence of the ability to mount an evacuation, fatalities are principally the result of building collapse. Expected fatalities can be determined by estimating how many people are likely to be situated in buildings that are expected to collapse. Different building types (e.g. URM, reinforced concrete etc.) and different levels of construction quality will result in different expected collapse rates at a given severity of ground shaking.

Figure 23: Population at risk by building classification in different hazard zones

NOTE: GRAPH SHOWING POPULATION AT RISK (FOR A HYPOTHETICAL COUNTRY), BY BUILDING TYPE, FROM A SPECIFIC RETURN PERIOD HAZARD. THE CLASSIFICATION OF LEVEL 1-5 WOULD TAKE INTO ACCOUNT CONSTRUCTION TYPE AND QUALITY AS WELL AS BUILDING REGULATIONS AND ENFORCEMENT (E.G. 1 – URM AND 5 – STEEL MOMENT RESISTING FRAME). THIS WOULD THEN NEED TO BE RELATED TO THE NUMBER OF DEATHS EXPECTED FROM THE DIFFERENT SHAKING INTENSITIES AND FOR DIFFERENT BUILDING CLASSIFICATIONS.

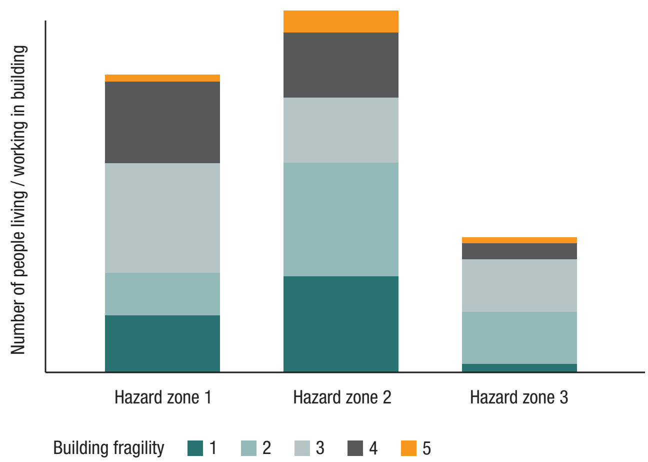


TABLE 8: ILLUSTRATIVE FATALITY RATES BY BUILDING FRAGILITY AND SHAKING INTENSITY

		Building fragility				
		1	2	3	4	5
Shaking (PGA or MMI)	6	0.6	0.5	0.4	0.3	0.2
	7	0.7	0.6	0.5	0.4	0.3
	etc	…	…	…	…	…

SOURCE: RMS INTERNAL MODEL RESULTS

NOTE: TABLE SHOWING ILLUSTRATIVE FATALITY RATES EXPECTED FROM A PARTICULAR BUILDING TYPE AND AMOUNT OF SHAKING (E.G. MEASURED FROM PGA OR THE MODIFIED MERCALLI INTENSITY (MMI) SCALE).

To calculate the expected fatalities from earthquakes in high-hazard areas would require:

- Hazard maps at consistent annual probabilities;
- The number of people at risk in each building classification in each hazard zone (i.e. the coloured areas on the map above), as shown in Figure 23;
- For each building classification within each level of ground shaking, fatality rates applied in a consistent manner to calculate the expected number of fatalities, using a matrix of rates, as demonstrated in Table 8. This could be achieved using fatality rates from an available methodology such as that developed in the USGS PAGER (Prompt Assessment of Global Earthquake for Response) procedure, or as is used in commercial catastrophe models.

Based on the number of people exposed, the building fragilities and the level of shaking, the expected number of fatalities for a particular hazard probability can be calculated. This can be converted into an estimate of **average annual** number of fatalities, as for Category 1, by multiplying the number of fatalities by the hazard probability.

Using this method a country could reduce its average annual number of fatalities by either:

- Replacing the worst performing buildings with built-to-code earthquake-resistant new buildings;
- Improving the quality of existing buildings through retrofitting and enforcement of building codes; or
- Replacing buildings in high-hazard locations with buildings in areas with a lower level of hazard.

Category 3: Well-forecast, non-evacuable hazards (**e.g. drought**)

For these hazards, DRR progress could be monitored by tracking the percentage of people in areas at risk who are covered by an effective action plan. This could consist of effective planning around the transportation and distribution of food, water and shelter. Similarly, drought intensity hazard probability maps would be required to allow the population living and working within each at-risk zone to be identified. Then, for all those people who fall into these hazard areas, we need to know what proportion are covered by an effective action plan.

Calculating the expected fatalities requires:

- Hazard maps at consistent annual probabilities;
- The number of people at risk in each hazard zone;
- The number of people in each hazard zone covered by an action plan multiplied by an effectiveness factor for the action plan to estimate the number of survivors and deaths. The effectiveness factor would have to be independently assessed and could be based on the quality of local governance and accountability mechanisms etc.;
- Expected fatalities for those who are not covered by an action plan.

Using this procedure, a country could reduce its average annual number of mortalities by either:

- Reducing the proportion of people in high-hazard zones;
- Expanding the action plan to cover more people; or
- Improving the effectiveness of the action plan.

4.2.4 Economic loss

For economic loss calculations, it will be necessary to identify details of the building stock, and the building/contents/infrastructure values within each level of hazard on the hazard map, again defined at one or more consistent annual probabilities. The expected annual loss calculated from these values will be only one portion of the total economic loss, which would also include, for example, business and livelihood disruption. The loss from building damage could be scaled to reflect these additional factors.

Category 1 and Category 2 hazards

For these hazards, it is possible to calculate the performance of a country in terms of economic loss by assessing the inventory of building types within those areas expected to be subject to the hazard. Calculating the expected economic loss in a particular hazard zone requires:

- Hazard maps at consistent annual probabilities;
- Economic value in each hazard zone along with the building inventory;
- Vulnerability functions for each building/contents/infrastructure type for each hazard level, relating the expected loss ratio to that hazard level;
- From the expected loss ratios for each exposure type for a particular level of hazard, a calculation of the monetary value of the loss.

Using this framework, a country could reduce its average annual economic loss by:

- Reducing the proportion of value in high-hazard zones;
- Constructing and maintaining flood defences to reduce the value at risk;
- Replacing the worst-performing buildings/infrastructure with new, more resilient buildings/infrastructure; or
- Improving the resilience of existing buildings/infrastructure.

Category 3: Well forecast, non-evacuable hazards (e.g. droughts)

For these hazards, it is possible to measure the performance of a country in terms of economic loss, first by assessing agricultural production per square kilometre within those areas expected to be subject to the hazard. Calculating the expected economic loss in that territory requires:

- Hazard maps;
- Economic value in each hazard zone, for example in terms of agricultural production;
- The percentage of economic value in each hazard zone covered by systems designed to alleviate impacts of drought (e.g. irrigation systems);
- An independent assessment of the efficiency of the system in place, to identify the economic value which can be saved.

The economic loss could then be calculated by first taking the economic value in a particular hazard zone with the percentage degree to which it is at risk at that hazard level. This percentage is then reduced according to the assessed efficacy of the systems designed to alleviate that risk, which would have to be independently assessed. The economic value or loss could be extended to include business interruption, for example to account for areas that are reliant on agricultural supplies.

Using this procedure a country could reduce its average annual economic loss by:

- Reducing the proportion of agriculture grown in high-hazard zones;
- Providing systems to alleviate impacts from the hazard (e.g. irrigation systems for drought);
- Improving the resilience of crops to water shortages; or
- Improving the effectiveness of mitigation strategies.

4.2.5 Aggregating to a global level

To measure progress at a national and global level with respect to DRR, expected fatality rates and economic losses should be tracked over the time period of the goals. This is outlined in the two equations below, where the average annual number of fatalities or loss is calculated by multiplying the expected fatalities (for a particular hazard map) by the probability of that hazard map. This can be summed for different hazard maps, hazard types (Categories 1, 2, 3 as described above) and regions. These are normalised by population or by GDP.

Average annual fatality rate =

$$\frac{\underset{\text{across hazard regions and defined probabilities}}{\Sigma(\text{expected fatalities x probability of hazard})}}{\text{Population}}$$

Average annual economic loss =

$$\frac{\underset{\text{across hazard regions and defined probabilities}}{\Sigma(\text{expected economic loss x probability of hazard})}}{\text{GDP}}$$

4.2.6 Development of a baseline

For each parameter assessed in this procedure, it will be necessary to establish a baseline estimate. In order to develop the baseline, the collation of required data on exposures and vulnerabilities and hazard maps is required. It is suggested that the baseline period be set at the start of the period of assessment for the SDGs and the post-2015 framework on DRR (i.e. 2015). The same methodology outlined above should be used to both develop a baseline and monitor progress over time. For comparison across two different time periods, inflation and exchange rates must be taken into account for economic losses.

4.2.7 Aims, achievements and further work

The aims for a future framework are highlighted in the Section 1: Introdution. These aims would be met by the proposed monitoring framework as follows:

- Precise quantitative indicators are proposed which report real change (e.g. change in building stock rather than just changes in policy), which are as objective as possible and with reduced reliance on household surveys, as recommended to reduce data accuracy.
- The framework can be used to understand whether policies will generate new disaster risks or strengthen resilience.
- Recognition for reducing existing risks is included.
- The initial conditions of the various regions and countries are taken into consideration through the use of hazard maps.
- Population dynamics are taken into account by noting population in hazard areas and normalising by population, and data can be disaggregated, for example according to vulnerable groups, if the data are collected.

Further work is required to standardise the procedure for measuring expected fatalities and economic loss and, following this, pilot country case studies will also be crucial to understand how the methodology would be applied on the ground. Coordination of funding will be key to successfully achieving the target. Further, the improvement in the collection, standardisation and availability of all types of data related to disaster risk is vital for monitoring progress; we explore this in Section 5.

4.3 Impoverishment baselines

Most countries already have extensive systems, procedures and instruments for data collection already in place. For many, the central tools for measuring national progress are nationally representative household surveys, and it is likely that household surveys will do the 'heavy lifting' of data collection for measuring progress towards a post-2015 agenda. These are variously known as and include household income and expenditure surveys, household budget surveys, welfare monitoring surveys and living standards surveys. These are the surveys that are used to calculate official national poverty statistics.

Establishing a baseline for measuring progress towards an impoverishment target would mean ensuring a nationally representative household survey is undertaken relatively close to the outset of the post-2015 agenda. Measuring impoverishment would then involve taking a representative sub-sample of households included in the national household survey and tracking them over the duration of the post-2015 framework – that is, establishing a panel survey. This household panel survey would need to incorporate a shocks module which enables investigation of the impacts of different shocks, including natural catastrophes, and their role in driving impoverishment (see Section 5.4). A consideration when establishing a panel survey is the recurrence time between survey rounds. For instance, should the survey return to the same households every year, or would a longer period between survey rounds be more appropriate? Post-disaster needs assessments and other qualitative data collection approaches could also aim to return to households covered by national household surveys in order to obtain a more detailed picture of the situation of households pre- and post-disaster.

5.

Improving disaster risk reduction data

As outlined in Box 4 (p.14) on 'The challenge of measuring progress from observed disaster loss data', loss data on its own are insufficient either to set a baseline around disaster fatalities and economic losses or to measure progress in a country's DRR.

As an alternative to using observed data on fatalities and economic losses to set baselines and determine progress, metrics on expected disaster fatalities and expected economic losses should be developed, and DRR policies tracked through procedures such as identifying the percentage of the population living or working in buildings of moderate and high susceptibility to collapse in high-hazard earthquake zones (see section 4.2). The long-term aim could be for every country to eventually use full catastrophe models to monitor progress. However, these will take time to develop. Both these methods will require the collection of high-resolution exposure information, including that on building locations and values.

In future, detailed data on disaster losses and the attributes of buildings damaged will be important for testing and improving the methodology for measuring assumed relationships between fatality rates and different building styles or evacuation procedures. The occurrence of particular disasters will also test mitigation strategies. Hence, we will need improvements in disaster loss data collection, including the generation of datasets to assess impacts on the poorest (Sections 5.2 and 5.4). It will be important for the collection of both risk and loss data that there be consistent global definitions and methodology.

5.1 Coverage of hazard maps, models and associated data for assessing annual progress at country level

To measure how national disaster resilience changes over the 15-year timescale of the SDGs, we need a consistent measure of risk. As Section 4 outlines, this can be traced either by employing a simplified risk assessment procedure based on the use of hazard maps, alongside exposure and vulnerability data, or by using a probabilistic catastrophe model framework (ensuring the baseline and progress are measured in a consistent fashion). **At this time, we consider the former procedure a more realistic recommendation, given current catastrophe model coverage.** This section reviews the availability of the tools required for this process, and considers how to focus investments to expand the necessary information to be able to track progress in DRR against the identified national targets.

5.1.1 Hazard maps

A hazard map is hazard-specific, indicating the severity of ground shaking, flood depth or windspeed at a consistent annual probability. While the availability of catastrophe models is relatively sparse for lower- and middle-income countries, hazard maps already exist for many hazards and territories. Sources for hazard maps include national surveys (e.g. European flood zones), commercial catastrophe modelling companies, international agency initiatives (such as the Global Earthquake Model (GEM)), re/insurance companies, independent scientific research and government studies. Overall, hazard maps are more generally available than models. As Section 4.1 details, a method using hazard maps combined with exposure data and vulnerabilities is likely to provide the most efficient, timely and cost-effective way to monitor progress on achieving improved disaster resilience.

Supporting this initiative will require a systematic multi-tiered global system for maintaining updated hazard maps.

5.1.2 Catastrophe models

Catastrophe models are widely used in the insurance industry (as explained in Box 5 on 'The use of catastrophe modelling in the insurance industry') and have principally been developed by commercial modelling companies for high-income and upper-middle-income territories in which there is an insurance industry. These models generally produce financial loss metrics, although a small number of models output expected earthquake fatalities for individual countries/regions (e.g. Japan and California). If demand existed, more such models could be developed.

There are also several initiatives to develop catastrophe models for a broader set of countries. The World Bank has commissioned models for a number of territories that are considering establishing some catastrophe pooling arrangement. The GEM has set out to develop earthquake catastrophe economic loss models to cover the whole globe and is also developing earthquake fatality loss models, expected to be available at the end of 2014. The UNISDR has also had a programme to develop basic catastrophe economic loss modelling capabilities for a wide range of countries and hazards globally, including tropical cyclones, floods, landslides and earthquakes.

Monitoring of the SDGs requires a globally consistent assessment framework. Currently, probabilistic catastrophe modelling of mortality is not extensively available, although there is wider coverage for modelling economic losses. It will be key to determine which hazards are material for global monitoring, in order to prioritise further model development and refinement. Once there are trusted models available for all regions, probabilistic models could be used for monitoring DRR progress. However, it is unlikely this will be achieved in time for the initiation of new monitoring frameworks in 2015.

5.1.3 Exposure data

Whether within catastrophe models or through simpler procedures for measuring risk, the collection of detailed building exposure data will need to be a core task within the work to set and monitor the SDG goals for DRR. For assessing earthquake risk, exposure data collection procedures will need to use some mix of aerial imagery (e.g. to understand locations and building types) validated with onsite inspections, with a focus on those attributes that relate to how building vulnerabilities can be differentiated. Human exposure data (e.g. the number of people living and working in buildings) will also need to be developed for assessing fatalities.

5.2 Improving disaster risk and loss data

There are three recommendations around what is proposed for the collection of disaster risk and loss data.

1. **Clear and measurable definition of each indicator to be collected:** The definition of each indicator (e.g. number of people in an area covered by an effective action plan) needs to be both precise and simple such that all countries are able to follow and adhere to the same global norms.

2. **Transparent methodology to calculate or compile the indicator:** Rigorous methods that describe the calculation of expected economic and human losses should be tested and set out in guidelines to help national and regional bodies compile this information. The guidelines must be workable in all the different situations in terms of resources and capabilities.

3. **Ensure validity and independent quality of data.** All efforts should be made to ensure the accuracy of the data collected and the sustainability of the collection procedures. Moreover, there needs to be a transparent method for data validation. Key at-risk cities should be prioritised in terms of data collection and validation.

Sustaining data norms and standards will require the establishment of guidelines for global, regional and local levels. The procedures would benefit from employing multidisciplinary expertise from relevant fields (such as statistics and the social sciences, among others). The involvement of national and regional scientific and technical expertise will be key to guarantee the quality of the data collected at national level and their sustainability. For example, the affiliation of EM-DAT to a university department has ensured its sustainability, its independence and its credibility.

5.3 Improving data on extensive risks

5.3.1 What is extensive risk?

Extensive risk is defined by UNISDR (2009) as 'The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity, often of a highly localized nature, which can lead to debilitating cumulative disaster impacts.' This refers to events causing 'frequently occurring low-intensity losses', specifically those affecting large numbers of people and damage to infrastructure, though with low mortality and destruction of economic assets (ibid.). The neglect of extensive risk in monitoring frameworks can be attributed in part to the low mortality or loss of economic assets from each event (Browne, 2013).

Extensive risk associated with 'small' hazard events can be the product of socioeconomic processes and repetitive events such as avalanches, flooding, landslides, storms, lower-scale earthquakes and volcanic eruptions (Marulanda et al., 2009). While not typically considered a 'disaster', given the relatively small or moderate size, extensive risk results from the same failures of development and disaster management as in large-scale events. These include poverty, vulnerability, environmental degradation, urbanisation and poor governance.

The Global Assessment Report (UNISDR, 2013b) identifies four underlying drivers of risk that characterise the accumulation of extensive risk: 1) badly planned and managed urban development; 2) the decline of regulatory ecosystem services; 3) low-income households' exclusion from participation in formal markets; and 4) weak governance. Further, UNISDR highlights 'that not only exposure and vulnerability but also hazards are produced through these underlying drivers, extensive risk is endogenous to and pro¬duced by urban and economic development'.

It is key to note that:

- The materiality of intensive and extensive risk, at global and national level, will vary depending on hazards and populations exposed;

- The definition of an extensive risk is currently based on an arbitrary threshold of the number of deaths, losses or people or buildings affected, rather than being related to the hazard. Hence, in these definitions, the same hazard could result in an 'intensive' risk in a developing country (causing many deaths) and an 'extensive' risk in a developed country (causing few deaths).

Governments do not systematically track most extensive disaster losses. Analysis of data from 20,000 local level reports from 20 countries spanning 40 years shows extensive risk accounts for 9.6% of all disaster deaths, 20% of houses destroyed and 54% of houses damaged (UNISDR, 2011). The 2013 Global Assessment Report (UNISDR, 2013b) reports that extensive risk is responsible for 13% of mortality and 42% economic losses of all disasters reported. However, note that the time period of 40 years will not necessarily be adequate to monitor deaths from intensive risks as a fair comparison with extensive risks.

In the insurance industry, the distinction is between:

1. Risk categories with a potential for very large highly correlated losses, such as natural catastrophes, modelled by using a probabilistic catastrophe model;
2. High-frequency low-severity classes of risks, such as household fires, which can be actuarially treated based on historical claims data.

Lessons could be learnt from the insurance industry, in terms of the distinction between different types of risk based on their underlying distributions rather than simply on the size of a particular loss. However, to increase our understanding of low-intensity risks, improved data collection should be made universal, in particular to be able to achieve other SDGs, such as those associated with poverty reduction.

5.3.2 Extensive loss data collection

There are few examples of national databases comprehensively collecting all relevant data on extensive risks (included in UNISDR, 2011).

- The Indonesian Disaster Data and Information Management Database informs national policy, planning and budgets. It records small, localised hazards as opposed to having a singular focus on major disaster events of national significance.
- The Mozambique National Disaster Database has detailed records of agricultural losses (including details on the area and types of crops destroyed). This captures the ways extensive risk impacts agriculture and rural livelihoods.
- Egypt, Jordan, Morocco, Syria and Yemen are cooperating to build a high-resolution database to collect local-level disaster loss data.
- Vietnam's Damage and Needs Assessment initiative has compiled provincial-level risk and disaster data from 1989.
- Regional organisations as well as the national governments in Bolivia, Ecuador, El Salvador and Guatemala have started to institutionalise the systematic recording of locallevel disaster loss data.

5.3.3 Challenges with recording and engaging with extensive risk

Technical deficiencies
A number of technical deficiencies impede the adequate recording of losses from small disasters. First, certain important disaster loss databases (e.g. LaRED: DesInventar, the Canadian Disaster Database, the United States Storm and Hazard Database, DSWD-dromic) rely heavily on news media reports of disasters (CRED, 2009). While the media is drawn to intensive, high-impact disasters, it is less concerned with extensive risk, which does not stand sharply apart from persistent development deficits and affects marginalised sections of society – which is not considered 'newsworthy'. Second, while high-intensity events receive national and international attention, extensive risk is a 'localised' issue dealt with by subnational authorities. This poses particular problems in terms of tracking/gauging and recording losses, as local/ subnational capacity for collecting and managing risk data is severely deficient (CADRI, 2009).

Lack of political incentives
There is emerging evidence that, currently, the political incentives for gauging and responding to extensive risk are missing (Hamdan, 2012). As the preceding section discussed, extensive risk refers to 'persistent hazard conditions of low or moderate intensity'; investing time and money in engaging with these does not reap political benefits in the same way as responding to major, high-intensity events (Hamdan, 2012; UNISDR 2009). This is because extensive risk, rather than being seen as an exigent condition, is 'camouflaged' within persistent development deficits and therefore does not attract public or media attention the same way. Also, even though evidence demonstrates how extensive risk can enhance the impact of intense hazards, often the funds for relief and rehabilitation for big disasters act as a disincentive for action on the small disasters that may precede these. The current international financing architecture for supporting DRR is designed to support ex-post action, drawing attention away from the value of investing ex-ante (where efforts to prevent and manage extensive risk would be supported) (Kellett and Peters, 2014).

Power and empowerment
Closely linked to the issue above is that, in poorly governed contexts with inadequate political accountability mechanisms, issues of extensive risk are overlooked because those who suffer most come from marginalised sections of society (Williams, 2011). While cataclysmic, high-intensity disasters that occur without warning (e.g. earthquakes) have the ability to impact a wider cross-section of society, when it comes to persistent/recurring low-intensity hazards (e.g. waterlogging/flooding), those with more means usually adopt risk reduction pathways (e.g. raising plinths, moving out of exposed territory) (ibid.). This leads to the phenomenon of the 'voiceless' being the main sufferers of extensive risk, which then influences the level of administrative and financial resources devoted to engaging with these (including tracking losses).

5.3.4 Methods and measures of improving an engagement with extensive risk

1. Risk assessments and loss inventories, to understand how significant small disasters are for each country;
2. Communication of the cost and impact of extensive risk/small disasters to mobilise political action where required;
3. Further investigation and communication of the impact of small-scale disasters on development and poverty levels, so the poverty goals can be achieved.

5.4 Improving data on the poverty impacts of disasters

Panel data surveys, or surveys that return to the same households at more than one point in time, provide information on the scale of impoverishment, which households fall below the poverty line, which remain below it and which escape poverty over a particular period. They are therefore a key source of information measuring the impact of natural catastrophes on household consumption (Thomas et al., 2010).

Despite enthusiasm for the use of new data collection methods, including crowdsourcing and modern technologies, it is clear that the main workhorse of data collection – the humble household survey – must not be overlooked. Household surveys currently yield the data needed to monitor over half of the MDGs and will remain central to measuring progress post-2015 (Samman, 2013). Currently, progress is measured largely through nationally representative repeated cross-sectional surveys, including household budget surveys, income and expenditure surveys, living standards surveys and welfare monitoring surveys. These surveys do not return to the same households over time, but rather provide a one-shot snapshot of household welfare. The next time the survey is conducted the sample is redrawn and a new sample of households are visited. Establishing nationally representative panel surveys through tracking over time a sub-sample of households included in national cross-sectional surveys could add important insights into the nature of progress post-2015. A common concern with panel data is cost, discussed in Box 6.

For this report, we analysed nationally representative panel data to investigate further the role of environmental events in driving reductions in consumption, where possible by taking into account the effect of transfers and relief systems in buffering against the impacts of natural hazards (following the approach of van de Walle, 2002. See Annex 2 for the full results). This analysis, from South Africa, Tanzania and Uganda, revealed that self-reported environmental events, while they did often contribute to reducing consumption, did not lead to significant reductions in consumption for households over the periods studied (see Table 9). This could be a function partly of using consumption as the dependent variable for certain shocks, which may lead to increased expenditure (on funeral expenses after the death of a household member, for instance) and so higher levels of consumption. These results are consistent with empirical findings from developed and transition economies where shocks usually have negative medium-term impacts but not long-term effects (Lokshin and Ravallion, 2006; Ravallion and Lokshin, 2005).

This analysis highlights the data challenges in investigating the impacts of natural catastrophes on poverty and human development. One of the limitations of the approach adopted above is that it uses self-reported information on environmental

BOX 6: CONSIDERATIONS WHEN DEVELOPING NATIONAL PANEL DATA

A good starting point for estimating the costs of a panel is the costs of cross-sectional surveys of equivalent sample sizes and with similar survey instruments. Some factors, though, may increase the cost of a panel survey relative to a cross-sectional survey:

- Migration will remove some of the economies of scale (in terms of interviewer travelling time) associated with the original clustered sample design.
- High response rates are critical for the long-term viability of a panel, and these depend in part on survey effort and survey costs. This may require additional costs for interviewer training, multiple visits and refusal conversion.
- Panel maintenance may require year-around activities to ensure movers can be tracked. Some form of participation fee could also be needed.

For a couple of reasons, though, after the first panel wave panel survey costs may be reduced. Once a panel is established, less effort is required to revisit the vast majority of respondents, leading to lower costs. This includes the possibility of feeding forward information from the past wave, so reducing interview duration.

However, panel data are not a substitute for nationally representative cross-sectional surveys: unless households are added to maintain the representativeness of the panel, over time they will no longer be representative of the population.

SOURCE: BUCK ET AL. (1995); HODDINOTT AND QUISUMBING (2003).

TABLE 9: POVERTY DYNAMICS AND SELF-REPORTED NATURAL CATASTROPHES

	Time period	Disasters occurring during this period	Finding	Further information
Uganda National Panel Survey Nationally representative	2005/06 to 2009/10	July 2008 drought affecting 1.1 million people. August 2007 flood affecting 718,045 people. (Top two natural catastrophes in terms of number people affected in Uganda)	The self-reported incidence of natural catastrophes (drought, floods or erosion) was not significant in driving reductions in household consumption. Drought, irregular rains and erosion reduced consumption but not significantly so.	Unable to take into account the role of government transfers in potentially buffering against the impacts of environmental events.
South Africa's National Income Dynamics Study Nationally representative	2008 to 2010 and 2010 to 2012	Jan 2011 flood affecting 200,000 people. Oct 2012 flood affecting 125,000 people. (6th and 7th biggest natural catastrophes in terms of number of people affected)	No specific environmental shocks variables. Crop and livestock loss associated with increased consumption.	Serious limitations of shocks module when looking at environmental events because of the way shocks are coded.
Tanzania's National Panel Survey Nationally representative	2008/09 to 2010/11	August 2011 drought affecting 1 million people. (5th largest natural disaster in terms of number of people affected)	Self-reported severe water shortages significantly reduce consumption. Droughts and floods (coded together) reduce consumption but not significantly.	No disaggregation of different environmental events.

SOURCE: THIRD COLUMN EM-DAT DATABASE NATIONAL REPORTS ON TOP 10 NATURAL CATASTROPHES BY NUMBER OF PEOPLE AFFECTED (AFFECTED USED TO REFER TO PEOPLE REQUIRING IMMEDIATE ASSISTANCE DURING A PERIOD OF EMERGENCY, I.E. REQUIRING BASIC SURVIVAL NEEDS SUCH AS FOOD, WATER, SHELTER, SANITATION AND IMMEDIATE MEDICAL ASSISTANCE).

events, which can lead to recall and reporting errors. In particular, if the survey asks about shocks occurring over a previous period that is more than 12 months, then reporting is likely to be unreliable (Heltberg et al., 2013). However, reporting periods of less than 12 months are unlikely to pick up the sequences of events that are important in driving impoverishment (Baulch, 2011). One way around this could be to use the community-level questionnaire, typically collected alongside the household survey, to cross-check the incidence of particular environmental events (Quisumbing, 2003). A community questionnaire, which is a structured questionnaire collected through interviews with key informants and community members, can also be designed to collect a history of local covariant shocks, so covering a longer timespan than can typically accurately be collected at the household-level (Hoddinott and Quisumbing, 2011).

Another limitation in using household surveys to investigate the role of natural catastrophes on poverty dynamics relates to the questions posed in existing shocks modules. It can be very difficult for questionnaire surveys to code shocks accurately. Ideally, the environmental event should be classified as a shock. However, typically, an environmental event drives a range of other shocks, including loss of crops, employment and livestock, all of which themselves can be classified as shocks (Baulch, 2011). One shortcoming of South Africa's National Income Dynamics Study is that it does not code environmental events as separate shocks, but rather the shocks module concentrates on a range of events that may, or may not, be outcomes of natural hazards (including major crop failure and widespread death and/or disease of livestock). There is scope for standardising and improving shocks modules in household and community surveys (cross-sectional as well as panel) to increase the options of using them to investigate the role of natural catastrophes in household welfare dynamics. Table 10 is one proposal on ways to classify shocks in household surveys, although the precise types of shocks that it is relevant to include will vary according to context.

TABLE 10: A PROPOSAL FOR THE CLASSIFICATION OF SHOCKS IN HOUSEHOLD SURVEYS

Has there been a weather or environmental shock?	Drought Heatwave Too much rain or flood Earthquake Volcanic eruption Landslides Erosion Windstorm Frost and hailstorm Wildfire Pests or diseases that affected crops before they were harvested Pests or diseases that led to storage losses Pests or diseases that affected livestock
Has there been war, civil conflict, banditry, crime?	Destruction, confiscation or theft of Tools or inputs for production Theft of cash Theft of stored crops Destruction or theft of housing Destruction or theft of consumer goods Death of working adult household members Death of other household member Disablement of working adult household members Disablement of other household member Conscription, abduction or draft of working adult household members
Have there been negative political, social or legal events?	Confiscation of land Confiscation of other assets Land reform Resettlement, villagisation or forced migration Bans on migration Forced labour Forced contributions or arbitrary taxation Imprisonment for political reasons Discrimination for social or ethnic reasons Discrimination for political reasons Contract dispute or default affecting access to land Contract dispute or default affecting to other inputs Contract dispute or default affecting sale of products
Have there been any economic shocks?	Lack of financing/capital Lack of access to inputs Increase in input prices Decrease in output prices Lack of demand or inability to sell agricultural products Lack of demand or inability to sell non-agricultural products Unemployment/job loss
Have there been any other events or shocks?	Death of husband Death of wife Other death (specify) Illness of husband Illness of wife Other illness (specify) Divorce Abandonment Disputes with extended family members regarding land Disputes with extended family members regarding other assets
Other shocks not covered above	

SOURCE: HODDINOTT AND QUISUMBING (2003).

Important information to cover on these shocks includes the following:

- Timing of the three worst shocks of each type of shock;
- Outcomes of the shock – in terms of loss of assets or income or reduced consumption;
- Degree of covariance of the shock (how many households were affected);
- Coping strategy used;
- Post-shock credit and assistance.

In summary, much of the evidence that demonstrates a significant impact of natural hazards on reducing household consumption and broader measures of human development combines panel data analysis with meteorological and other data on the incidence of particular natural hazards. However, even when this is the case, the short timespan of much panel data can lead to a disproportionate acceptance of the hypothesis that environmental events do not lead to significant reductions in household welfare. Panel data covering a longer time period would be more likely to be able to pick up any resulting longer-term declines in welfare (Thomas et al., 2010). This would point to the importance of establishing a baseline now where households could be tracked for post-disaster needs assessment through a combination of quantitative household surveys and qualitative methods.
The combination of qualitative and quantitative approaches can overcome the shortcomings of household surveys in enabling examination of the questions of how and why people fall into poverty. In particular, qualitative approaches are able to investigate the sequence and timing of shocks that drive people into poverty and the ways people manage and cope with these shocks, and so can inform the design of policies and programmes to tackle poverty and manage natural catastrophes.

6.

Ten recommendations to establish a global system for monitoring progress on disaster risk reduction

The following propositions, based on assessments in this report, focus on agreeing common targets and indicators for DRR and establishing national and global monitoring systems to track progress:

1. **Given the short timeframe from now to 2030, assessing trends in observed disaster losses might give a false impression of success if countries or regions are lucky in avoiding severe disaster events in the period.** A target set on DRR should combine the targets with a methodology that assesses levels of disaster risk. Only then can we adequately track progress in reducing disaster risk.

2. **Such targets should be included in both the SDGs and the post-2015 framework on DRR using identical language.** A single set of goals, targets and indicators spanning the two would clarify priorities, increase logic and coherence and minimise the amount of work required to develop monitoring and reporting capacity. Indicators could monitor inputs and outputs, such as presence of plans or legislation, number of people covered by effective early warning systems and/or school and health facilities built to hazard-resistant building codes, linked to the hazard risk in the area.

3. **It is important to establish clear, numerical targets at a global scale to act as eye-catching, awareness-raising components of the SDGs and the post-2015 framework on DRR, and also to help direct actions. Space should also be created for the differentiation and self-determination of targets at national level.** Differences between countries in terms of potential to reduce risks, given previous actions and exposure to certain types of hazards, means one-size-fits-all targets – like halving disaster deaths – are not appropriate for all. Instead, countries should be encouraged to establish their own levels, in light of the global target, and select from a basket of indicators, and then register these as part of the reporting process. This is likely to promote greater ownership and relevance. However, this would need to be independently reviewed and guidance given based on the country profile (hazard risk, possible mitigation methods, economic band, exposure at risk).

4. **A disasters data revolution is needed, involving the systematic collection of data on disaster risk and disaster losses across countries to enable the establishment of national and global trends.** This revolution can happen only if DRR targets and indicators are included in the SDGs and are treated as part of a much wider movement to improve the quality and availability of data on sustainable development. Without such data, no country can truly know if it is becoming more or less resilient to the impacts of hazards. Disaster risk data can be used to monitor progress over time, whereas disaster loss data improve our understanding of the risk and how best to provide mitigation measures, and also feed hazard maps and models.

5. **A monitoring methodology for tracking national progress on DRR must focus on the use of detailed disaster risk information,** including high-resolution data on national building inventories, population data (including by socioeconomic group), mapped hazard data and DRR plans. This makes it possible to measure levels of disaster risk using the real experience of disaster losses to validate findings. While there has been progress, investment will be needed to set up a technical support programme in this regard.

6. **Upgrades to poverty data should involve modules on shocks.** Where countries start more comprehensive, regular monitoring of poverty dynamics, potentially by extending household surveys, such poverty surveys or other data collection methods should incorporate modules or questions about the impact of disaster events on income poverty and other dimensions of human development, such as health or school attendance.

7. **To increase simplicity, logic and integration, the SDGs and the post-2015 framework on DRR should include DRR targets with the same start and end point (e.g. targets set from 2015 to 2030), and reporting periods should be synchronous.** Any mismatch of timeframes or regularity of reporting periods will increase countries' workload and stretch their capacity to monitor progress.

8. **Tracking progress on disaster losses and risks requires data to be normalised for key variables, like population or GDP, to allow for comparisons between time periods. It also requires the establishment of a baseline against which progress can be assessed.** As a record of losses from only a few decades typically under-samples the impact of the most extreme disasters, the baseline should be based principally on the assessed level of risk (of losses) in that country, based on the use of proxies indicative of casualties and economic losses. The methodology to define the baseline must be consistent with how progress is measured.

9. **The institutional architecture for delivering a global monitoring system needs to involve multiple groups at different scales, each serving a distinct function.** While responsibility for monitoring progress on DRR lies with national governments, a facilitating body at international level, such as UNISDR, is needed to collect data and help strengthen national and local monitoring capacity. Such a body would need to involve national statistical offices and other relevant governmental bodies in order to collect the required data, including census data. Regional technical agencies

could support this, as could the scientific community (supplying data to establish risk profiles), technology companies (supplying satellite data to approximate building coverage, for example) and other groups (providing data on disaster losses). The institutional architecture should span the post-2015 framework on DRR and the SDGs so as not to create duplication.

10. **While governments will continue to self-report progress, it is vital that independent groups at all levels can contribute to the overall framework for monitoring progress on DRR. This will help with transparency and accuracy.** The original framework for monitoring progress on the HFA – the HFA Monitor – has suffered from being a self-reporting platform: global and regional institutions have been unable to check claims or accurately compare reports between countries. An independent international technical group has an important role to play in helping guide standards (e.g. in definitions or methods for risk assessments), assess data quality and transparency and support other potential processes of accountability, including country-to-country peer review.

In order to successfully implement a global monitoring system, additional studies will be needed, particularly in the following areas:

- Further development of the indicator methodology:
  - Detailed analysis of the availability of all relevant data sources on current disaster activity, risk information and hazard maps;
  - Investigation and communication of what indicator data would need to be collected, and hazard maps created in order to set the original baseline as well as to monitor progress towards the target;
- Specific country case studies to investigate practical implementation linked to the above indicator methodology development, cost–benefit analyses of actions and refinement of the framework as required;
- Understanding of the availability of the necessary funding to achieve the targets on a country basis;
- Exploration of how global targets should be differentiated by country, according to exposure, hazards and national income level

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Technical annex 1: Country classification per income (gross national income per capita)

TABLE A1: HIGH-INCOME ECONOMIES ($12,746 OR MORE)

Andorra	French Polynesia	Norway
Antigua and Barbuda	Germany	Oman
Aruba	Greece	Poland
Australia	Greenland	Portugal
Austria	Guam	Puerto Rico
Bahamas, The	Hong Kong Special Administrative Region, China	Qatar
Bahrain	Iceland	Russian Federation
Barbados	Ireland	San Marino
Belgium	Isle of Man	Saudi Arabia
Bermuda	Israel	Singapore
Brunei Darussalam	Italy	Sint Maarten
Canada	Japan	Slovak Republic
Cayman Islands	Korea, Republic of	Slovenia
Channel Islands	Kuwait	Spain
Chile	Latvia	St Kitts and Nevis
Croatia	Liechtenstein	St Martin
Curaçao	Lithuania	Sweden
Cyprus	Luxembourg	Switzerland
Czech Republic	Macao Special Administrative Region, China	Trinidad and Tobago
Denmark	Malta	Turks and Caicos Islands
Estonia	Monaco	United Arab Emirates
Equatorial Guinea	Netherlands	United Kingdom
Faeroe Islands	New Caledonia	United States
Finland	New Zealand	Uruguay
France	Northern Mariana Islands	Virgin Islands (US)

SOURCE: HTTP://DATA.WORLDBANK.ORG/ABOUT/COUNTRY-CLASSIFICATIONS/COUNTRY-AND-LENDING-GROUPS#LOWER_MIDDLE_INCOME

TABLE A2: UPPER-MIDDLE-INCOME ECONOMIES ($4,126-12,745)

Angola	Fiji	Palau
Albania	Gabon	Panama
Algeria	Grenada	Peru
American Samoa	Hungary	Romania
Argentina	Iran, Islamic Republic of	Serbia
Azerbaijan	Iraq	Seychelles
Belarus	Jamaica	South Africa
Belize	Jordan	St Lucia
Bosnia and Herzegovina	Kazakhstan	St Vincent and the Grenadines
Botswana	Lebanon	Suriname
Brazil	Libya	Thailand
Bulgaria	Macedonia, Former Yugoslav Republic of	Tonga
China	Malaysia	Tunisia
Colombia	Maldives	Turkey
Costa Rica	Marshall Islands	Turkmenistan
Cuba	Mauritius	Tuvalu
Dominica	Mexico	Venezuela, Bolivarian Republic of
Dominican Republic	Montenegro	
Ecuador	Namibia	

SOURCE: HTTP://DATA.WORLDBANK.ORG/ABOUT/COUNTRY-CLASSIFICATIONS/COUNTRY-AND-LENDING-GROUPS#LOWER_MIDDLE_INCOME

TABLE A3: LOWER-MIDDLE-INCOME ECONOMIES ($1,046-4,125)

Bhutan	Kiribati	São Tomé and Príncipe
Bolivia	Kosovo	Senegal
Cameroon	Lao People's Democratic Republic	Solomon Islands
Cabo Verde	Lesotho	Sri Lanka
Congo, Republic of	Mauritania	Sudan
Côte d'Ivoire	Micronesia, Federal States of	Swaziland
Djibouti	Moldova	Syrian Arab Republic
Egypt, Arab Republic of	Mongolia	Timor-Leste
El Salvador	Morocco	Ukraine
Georgia	Nicaragua	Uzbekistan
Ghana	Nigeria	Vanuatu
Guatemala	Pakistan	Vietnam
Guyana	Papua New Guinea	West Bank and Gaza
Honduras	Paraguay	Yemen, Republic of
Indonesia	Philippines	Zambia

SOURCE: HTTP://DATA.WORLDBANK.ORG/ABOUT/COUNTRY-CLASSIFICATIONS/COUNTRY-AND-LENDING-GROUPS#LOWER_MIDDLE_INCOME

TABLE A4: LOW-INCOME ECONOMIES ($1,045 OR LESS)

Afghanistan	Gambia, The	Myanmar
Bangladesh	Guinea	Nepal
Benin	Guinea-Bissau	Niger
Burkina Faso	Haiti	Rwanda
Burundi	Kenya	Sierra Leone
Cambodia	Korea, Democratic Republic of	Somalia
Central African Republic	Kyrgyz Republic	South Sudan
Chad	Liberia	Tajikistan
Comoros	Madagascar	Tanzania
Congo, Democratic Republic of	Malawi	Togo
Eritrea	Mali	Uganda
Ethiopia	Mozambique	Zimbabwe

SOURCE: HTTP://DATA.WORLDBANK.ORG/ABOUT/COUNTRY-CLASSIFICATIONS/COUNTRY-AND-LENDING-GROUPS#LOWER_MIDDLE_INCOME

Technical annex 2: The relationship between shocks and household impoverishment

TABLE A5: SHOCKS AND IMPOVERISHMENT IN TANZANIA

Tanzania National Panel Survey (2008/09-2010/11)	Total consumption	Total consumption net all government transfers	Total consumption net marginal propensity to consume (MPC) * government transfers
Droughts or floods	-0.044	-0.045	-0.044
	(0.257)	(0.244)	(0.254)
Crop disease or pests	-0.012	-0.010	-0.012
	(0.752)	(0.788)	(0.761)
Livestock died or stolen	-0.096***	-0.096***	-0.096***
	(0.008)	(0.008)	(0.008)
Severe water shortage	-0.071**	-0.072**	-0.071**
	(0.044)	(0.041)	(0.043)
Household head in agriculture	-0.311***	-0.314***	-0.312***
	(0.000)	(0.000)	(0.000)
Logarithm of total household size	0.272***	0.273***	0.272***
	(0.000)	(0.000)	(0.000)
Female household head	-0.029	-0.029	-0.029
	(0.549)	(0.543)	(0.548)
Logarithm of household head age	0.208	0.202	0.207
	(0.185)	(0.198)	(0.188)
Age of household head squared	-0.000	-0.000	-0.000
	(0.776)	(0.807)	(0.784)

Tanzania National Panel Survey (2008/09-2010/11)	Total consumption	Total consumption net all government transfers	Total consumption net marginal propensity to consume (MPC) * government transfers
Household head completed first 4 years of primary education (D1-D4)	0.276	0.275	0.276
	(0.161)	(0.163)	(0.162)
Household head completed all 8 years of primary education (D4-D8)	0.363*	0.362*	0.363*
	(0.064)	(0.065)	(0.064)
Household head completed secondary schooling (F1-F6; Preform 1; MS+Course; O+-course; A+-course; Diploma)	0.559***	0.559***	0.559***
	(0.005)	(0.005)	(0.005)
Household head completed university education (U1-U5+)	0.495	0.494	0.495
	(0.104)	(0.103)	(0.104)
Children dependency ratio	-0.000	-0.000	-0.000
	(0.341)	(0.331)	(0.338)
Elderly dependency ratio	0.000	0.000	0.000
	(0.873)	(0.927)	(0.887)
Rural cluster	-0.089	-0.081	-0.087
	(0.187)	(0.232)	(0.198)
Total number of rooms in household	0.034***	0.034***	0.034***
	(0.000)	(0.000)	(0.000)
Piped water	0.095**	0.096***	0.095**
	(0.010)	(0.010)	(0.010)
Toilet with flush	0.032	0.032	0.032
	(0.557)	(0.563)	(0.559)
Total land size (acres)	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)
Total number of livestock	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)
Constant	13.562***	13.574***	13.565***
	(0.000)	(0.000)	(0.000)
Observations	1,525	1,525	1,525
R-squared	0.238	0.238	0.238

NOTES: ROBUST PVAL IN PARENTHESES *** P<0.01, ** P<0.05, * P<0.1. CONTROL VARIABLES TAKEN FROM R1 (2008/09). SHOCKS TAKEN FROM R2 (2010/11) AND REPORTED OVER THE PREVIOUS FIVE YEARS.

TABLE A6: RATES OF IMPOVERISHMENT OVER SELECTED PERIODS OF TIME

	2008-2010. Shocks captured over the 24 months before 2008 Control variables from 2008			2010-2012 Shocks captured over the 24 months before 2012 Control variables from 2010		
South Africa National Income Dynamics Study						
	Full consumption	Consumption net all government transfers	Consumption net MPC * government transfers	Full consumption	Consumption net all government transfers	Consumption net MPC * government transfers
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Logarithm of full real household consumption	Logarithm of real household consumption net all transfers	Logarithm of real household consumption net MPC transfers (MPC=0.29)	Logarithm of real household consumption net all transfers	Logarithm of net real household consumption	Logarithm of real household consumption net MPC transfers (MPC=0.285)
Death of a non-residential family member or friend that household depended financially on	0.059	-0.098	0.028	0.089**	0.252***	0.062
	(0.226)	(0.411)	(0.663)	(0.031)	(0.009)	(0.331)
Serious illness or injury of a household member	-0.013	-0.110	-0.013	-0.047**	-0.187***	-0.078**
		(0.297)	(0.612)	(0.035)	(0.001)	(0.019)
Widespread death and/or disease of livestock	0.068**	0.115	0.047	0.097***	0.032	0.014
	(0.015)	(0.292)	(0.194)	(0.001)	(0.654)	(0.754)
Major crop failure	0.010	0.063	0.064	0.121***	0.155**	0.068
	(0.658)	(0.453)	(0.112)	(0.000)	(0.020)	(0.121)
Logarithm of household size	0.172***	0.330***	0.283***	0.145***	0.189***	0.186***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female household head	-0.048*	0.004	-0.055	-0.015	-0.046	-0.059*
	(0.096)	(0.963)	(0.238)	(0.529)	(0.402)	(0.098)
Logarithm of age of household head	0.455***	0.429	0.531***	0.353***	0.264	0.298**
	(0.000)	(0.154)	(0.003)	(0.000)	(0.157)	(0.014)
Age of household head squared	-0.000	-0.000	-0.000**	0.000	-0.000	-0.000
	(0.870)	(0.892)	(0.043)	(0.606)	(0.679)	(0.401)
Household head married	0.124***	0.184**	-0.010	0.187***	0.182***	0.110***
	(0.000)	(0.010)	(0.829)	(0.000)	(0.002)	(0.003)
Household head completed junior primary school	0.084**	0.093	0.160***	0.121***	0.221***	0.180***
	(0.017)	(0.323)	(0.003)	(0.000)	(0.002)	(0.000)
Household head completed senior primary school	0.236***	0.218**	0.209***	0.281***	0.361***	0.292***
	(0.000)	(0.022)	(0.002)	(0.000)	(0.000)	(0.000)

	2008-2010. Shocks captured over the 24 months before 2008 Control variables from 2008			2010-2012 Shocks captured over the 24 months before 2012 Control variables from 2010		
South Africa National Income Dynamics Study						
Household head completed junior high school	0.416***	0.490***	0.449***	0.382***	0.434***	0.370***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Household head completed senior high school	0.810***	0.861***	0.689***	0.734***	0.684***	0.604***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Household head completed higher education	1.096***	1.080***	0.872***	1.155***	1.130***	1.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of children	-0.024	-0.566***	-0.287***	-0.090	-0.385***	-0.244***
	(0.708)	(0.000)	(0.007)	(0.105)	(0.002)	(0.002)
Share of elderly	-0.115	-0.437	-0.107	-0.045	-0.335	-0.320***
	(0.147)	(0.109)	(0.373)	(0.556)	(0.148)	(0.003)
Tropical livestock units	0.014***	0.014	0.010	0.004*	-0.003	0.004
	(0.003)	(0.270)	(0.163)	(0.092)	(0.724)	(0.288)
Household owns house	0.057	-0.085	-0.015	0.009	-0.083	-0.081*
	(0.105)	(0.305)	(0.785)	(0.755)	(0.195)	(0.060)
Household owns computer	0.707***	0.591***	0.503***	0.566***	0.513***	0.464***
	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)
Clean water	0.088**	0.167*	0.134**	0.113***	0.270***	0.177***
	(0.043)	(0.058)	(0.044)	(0.000)	(0.000)	(0.000)
Safe toilet facility	0.246***	-0.006	0.148**	0.255***	0.288***	0.278***
	(0.000)	(0.956)	(0.043)	(0.000)	(0.001)	(0.000)
Electricity	0.089***	0.165**	0.114**	0.068**	0.096	0.086**
	(0.010)	(0.045)	(0.027)	(0.016)	(0.153)	(0.028)
Street light	0.086**	0.174**	0.079	0.113***	0.091	0.039
	(0.030)	(0.049)	(0.180)	(0.001)	(0.219)	(0.417)
Rural cluster	0.006	-0.061	-0.080	0.012	0.005	0.014
	(0.909)	(0.529)	(0.246)	(0.782)	(0.949)	(0.813)
Constant	4.719***	4.194***	4.335***	5.093***	5.155***	5.530***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	6,693	2,482	3,781	7,036	2,948	4,214
R-squared	0.321	0.127	0.158	0.332	0.148	0.185

NOTE: ROBUST PVAL IN PARENTHESES *** P<0.01, ** P<0.05, * P<0.1.

TABLE A7: SHOCKS AND IMPOVERISHMENT IN UGANDA

Uganda National Panel Survey 2005/06-2009/10	
Total consumption	**Total consumption net all government transfers**
Drought or irregular rains	-0.054
	(0.264)
Floods	0.091
	(0.587)
Landslide or erosion	-0.292
	(0.110)
Unusually high level of crop pests or disease	0.043
	(0.715)
Unusually high level of livestock disease	0.062
	(0.460)
Fire (2009)	0.069
	(0.570)
Household size	0.009
	(0.420)
Share of elderly members	-0.199
	(0.417)
Share of children	-0.357**
	(0.035)
Age of household head (log)	0.148*
	(0.051)
Female household head	0.149**
	(0.020)
Years of education of household head	0.192***
	(0.000)
Urban cluster (2009)	0.309***
	(0.002)
Central region	0.525***
	(0.000)
Eastern region	0.093
	(0.197)
Northern region	-0.082
	(0.308)
Western region – omitted category	
Permanent community access road	0.113**
	(0.021)
Value of enterprise equipment (non-agricultural) (log)	0.005
	(0.399)
Value of agricultural equipment (log)	-0.016
	(0.104)
Value of cattle (log)	0.007**
	(0.048)
Area of land owned (log)	0.006
	(0.845)
Household receives remittances	-0.102**
	(0.016)
Household head works in agriculture	-0.319***
	(0.000)
Number of rooms per person (log)	0.498***
	(0.000)
Toilet	0.041
	(0.499)
Protected water	0.069
	(0.167)
Constant	12.316***
	(0.000)
Observations	1,496
R-squared	0.394

ROBUST PVAL IN PARENTHESES, *** P<0.01, ** P<0.05, * P<0.1. SHOCKS VARIABLES REPORTED OVER THE 12 MONTHS BEFORE 2009/10 (ASKED IN R2). CONTROL VARIABLES TAKEN FROM R1 (2005/06).

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