A GLOBAL REPORT

REDUCING DISASTER RISK

A CHALLENGE FOR DEVELOPMENT

United Nations Development Programme
Bureau for Crisis Prevention and Recovery
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THE PREPARATION TEAM FOR
REDUCING DISASTER RISK: A CHALLENGE FOR DEVELOPMENT
A GLOBAL REPORT

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FOREWORD

Natural disasters exert an enormous toll on development. In doing so, they pose a significant threat to prospects for achieving the Millennium Development Goals in particular, the overarching target of halving extreme poverty by 2015. Annual economic losses associated with such disasters averaged US$ 75.5 billion in the 1960s, US$ 138.4 billion in the 1970s, US$ 213.9 billion in the 1980s and US$ 659.9 billion in the 1990s. The majority of these losses are concentrated in the developed world and fail to adequately capture the impact of the disaster on the poor who often bear the greatest cost in terms of lives and livelihoods, and rebuilding their shattered communities and infrastructure. Today, 85 percent of the people exposed to earthquakes, tropical cyclones, floods and droughts live in countries having either medium or low human development.

This Report is premised on the belief that in many countries the process of development itself has a huge impact — both positive and negative — on disaster risk. It shows how countries that face similar patterns of natural hazards — from floods to droughts — often experience widely differing impacts when disasters occur. The impact depends in large part on the kind of development choices they have made previously. As countries become more prosperous, for example, they are often better able to afford the investments needed to build houses more likely to withstand earthquakes. At the same time, the rush for growth can trigger haphazard urban development that increases risks of large-scale fatalities during such a disaster. The same is true in many other areas. While humanitarian action to mitigate the impact of disasters will always be vitally important, the global community is facing a critical challenge: How to better anticipate — and then manage and reduce — disaster risk by integrating the potential threat into its planning and policies.

To help frame such efforts, this Report introduces a pioneering Disaster Risk Index (DRI) that measures the relative vulnerability of countries to three key natural hazards — earthquake, tropical cyclone and flood — identifies development factors that contribute to risk, and shows in quantitative terms, just how the effects of disasters can be either reduced or exacerbated by policy choices. Our hope is that the index will both help generate renewed interest in this critical development issue and help bring together stakeholders around more careful and coherent planning to mitigate the impact of future disasters.

Mark Malloch Brown
Administrator
United Nations Development Programme

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UNDP is the UN's global development network, advocating for change and connecting countries to knowledge, experience and resources to help people build a better life.

Today, disaster reduction is a key component of UNDP efforts in crisis prevention and recovery. UNDP first allocated core resources for disaster preparedness in 1989, with an approved policy framework aimed 'to stimulate the interest and actions needed to create comprehensive disaster preparedness plans, strategies and structures and to promote disaster mitigation activities within the context of development planning and implementation'. The United Nations General Assembly has transferred to UNDP, the responsibilities of the Emergency Relief Coordinator for operational activities concerning natural disaster mitigation, prevention and preparedness. Furthermore, the UNDP Bureau for Crisis Prevention and Recovery (BCPR) has made considerable progress in developing an implementation framework that adds value to ongoing activities in disaster reduction.

UNDP plays an active and central role in the implementation of the International Strategy for Disaster Reduction (ISDR). This publication, *Reducing Disaster Risk: A Challenge for Development,* and the global review of disaster risk reduction, *Living with Risk,* published by the ISDR Secretariat, are two complementary and coordinated initiatives. They are aimed at assisting countries and international organisations to enable communities to become resilient to natural hazards and related technological and environmental disasters so economic, environmental, human and social losses can be reduced. UNDP and the ISDR Secretariat are currently working towards a framework of joint reporting on disaster risk reduction.

While much has been achieved, much remains to be done if disaster loss is not to jeopardise the achievement of the Millennium Development Goals. The humanitarian community has made progress in mitigating the losses and suffering associated with disasters through improved response preparedness and early warning. However, humanitarian actions do not address the development processes that are shaping disaster risk in the first place. The development community generally continues to view disasters as exceptional natural events that interrupt *normal* development and that can be managed through humanitarian actions.

The linkages between development and disaster risk are not difficult to visualize. Any development activity has the potential to either increase or reduce disaster risk. When a school or a health centre is destroyed in an earthquake, we have to remember that this same school or health centre was once a development project, whether funded from national budgets or external development assistance.

When we decided to produce a global report on development and disaster risk, we wanted to highlight these *development choices.* Disaster risk is not inevitable, but on the contrary can be managed and reduced through appropriate development actions. This is the message we want to convey in this Report to our programme countries, our donors, our partners in the United Nations system, regional and international organisations, civil society and the private sector. A great deal of support was provided in preparation of this publication, known as the *World Vulnerability Report* when the process began in 2000, and we acknowledge many generous contributions.

Contributors

The technical production of the Report was made by the following team: Mark Pelling (editor), Andrew Maskrey, Pablo Ruiz and Lisa Hall. Yasemin Aysan was responsible for the overall coordination of the Report in its first stages, with critical support from Ben Wisner and Haris Sanahuja.

The preparation of the Disaster Risk Index (DRI) was originally conceived during the meeting of a Group of Experts in 2000 and commissioned to the United Nations Environment Programme (UNEP) Global Resource Information Database (GRID) in Geneva. Main scientific collaborators include Hy Dao, Pascal Peduzzi, Christian Herold and Frédéric Mouton. Maxx Dilley and Haris Sanahuja provided key guidance in concepts and definitions. We would like also to thank those whose work has directly or indirectly contributed to the success of this research, such as Brad Lyon and his colleagues from the International Research Institute (IRI) for Climate Prediction at Columbia University for his methodology on determining physical drought. Regina Below and Debarati Guha-Sapir for EM-DAT databases and Bruce Harper, Greg Holland and Nanette Lombarda for input on tropical cyclones. This work also benefited from the contributions of Stephane Kluser, Antonio Martin-Diaz, Ola Nordbeck, Damien Rochette, Thao Ton-That and Bernard Widmer.

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Advisory Panel and Consultation Process

The Report underwent a long consultation process. An advisory panel made up of international experts and UNDP specialists in disaster reduction provided guidance and advice in the finalization of the Report. The panel included Andrew Maskrey (chair), Angeles Arenas, Mihir Bhatt, Thomas Brennan, Omar Dario Cardona, Maxx Dilley, Ailsa Holloway, Kamal Kishore, Allan Lavell, Kenneth Westgate, Ben Wisner and Jennifer Worrell. Additional inputs were received from Terry Jeggle.

The Report benefited from the discussions of the Working Group on Risk, Vulnerability and Impact Assessment of the International Strategy for Disaster Reduction (ISDR). A large number of consultations around the conception and preparation of the different components of the DRI were realized in 2002.

The Report was shared with a large number of UN organisations involved in disaster reduction: the Food and Agricultural Organization (FAO), International Labour Organization (ILO), the United Nations Centre for Regional Development (UNCRD), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), the United Nations Human Settlements Programme (UN Habitat), the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), the World Food Programme (WFP) and World Meteorological Organization (WMO). The Report was also shared with the Inter-American Development Bank (IDB), the International Federation of Red Cross and Red Crescent Societies (IFRC), the Organization of American States (OAS), the ProVention Consortium and the World Bank (WB). Their comments, suggestions and views have been extremely useful during the drafting of the final version of this Report.

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This Report would not have been possible without the many instrumental contributors. We hope that this common effort towards reducing disaster risk will make an important contribution to our main challenge, the achievement of the Millennium Development Goals.

Julia Taft
Assistant Administrator and Director
Bureau for Crisis Prevention and Recovery

ABBREVIATIONS

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
ADRC	Asian Disaster Reduction Center
AfDB	African Development Bank
AGR_{EMP}	Percentage of labour force in agricultural sector
AOML	Atlantic Oceanographic and Meteorological Laboratory
AUDMP	Asian Urban Disaster Mitigation Program
BCC	Baroda Citizens Council
BCPR	Bureau for Crisis Prevention and Recovery
CDB	Caribbean Development Bank
CDC	Centers for Disease Control and Prevention
CDERA	Caribbean Disaster Emergency Response Agency
CDIAC	Carbon Dioxide Information Analysis Center
CDMP	Caribbean Disaster Mitigation Project
CDMS	Comprehensive Disaster Management Strategy
CEPREDENAC	Coordination Center for the Prevention of Natural Disasters in Central America
CGIAR	Consultative Group on International Agricultural Research
CIESIN	Center for International Earth Science Information Network
CMA	Cape Town Metropolitan Area
CMAP	CPC Merged Analysis of Precipitation
CNSS	Council of the National Seismic System
COPECO	National Commission for Contingencies
CPC	Climate Prediction Center

CPI	Corruption Perceptions Index
CRED	Centre for Research on the Epidemiology of Disasters
DAC	Development Assistance Committee
DFID	Department for International Development of the United Kingdom
DiMP	Disaster Mitigation for Sustainable Livelihoods Programme of the University of Cape Town
DMFC	Disaster Mitigation Facility for the Caribbean
DPC	Direction de la Protection Civile
DRI	Disaster Risk Index
ECHO	European Community Humanitarian Office
ECLAC	Economic Commission for Latin America and the Caribbean
EM-DAT	EM-DAT: The OFDA/CRED International Disaster Database
ENSO	El Niño/Southern Oscillation
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GDP_{AGR}	Percentage of agriculture's dependency for GDP
GDP_{CAP}	Gross Domestic Product per capita
GEO	Global Environment Outlook
GIS	Geographical Information System
GLASOD	Human Induced Soil Degradation
GLIDE	Global Identifier Number
GRAVITY	Global Risk and Vulnerability Index Trend per Year
GRID	Global Resource Information Database
GTZ	German Technical Co-operation
HDI	Human Development Index
HDR	Human Development Report
HIPC	Heavily Indebted Poor Countries
HPI	Human Poverty Index
IDB	Inter-American Development Bank
IDNDR	International Decade for Natural Disaster Reduction
IFI	International financial institution
IFRC	International Federation of the Red Cross and Red Crescent Societies
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
ILO	International Labour Organization
IMF	International Monetary Fund
IRI	International Research Institute for Climate Prediction
ISDR	International Strategy for Disaster Reduction
IUCN	World Conservation Union
LA RED	Network for Social Studies on Disaster Prevention in Latin America
LDC	Least Developed Country

MANDISA	Monitoring, Mapping and Analysis of Disaster Incidents in South Africa
MDGs	Millennium Development Goals
NCEP	National Center for Environmental Prediction
NCGIA	National Center for Geographic Information and Analysis
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
OAS	Organization of American States
OCHA	Office for the Coordination of Humanitarian Affairs
ODS	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OECS	Organization of Eastern Caribbean States
PADF	Pan American Development Foundation
PAHO	Pan American Health Organization
PhExp	Physical Exposure (if not specified, for drought)
PPP	Purchasing Power Parity
PRSP	Poverty Reduction Strategy Paper
SADC	The Southern African Development Community
SIDS	Small Island Developing States
SNPMAD	Sistema Nacional para la Prevención, Mitigación y Atención de Desastres
SOPAC	South Pacific Applied Geoscience Commission
$U5_{MORT}$	Under five years old mortality rate
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNCRD	United Nations Centre for Regional Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP/GRID	United Nations Environment Programme, Global Resource Information Database
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNHABITAT	United Nations Human Settlements Programme
USAID/OFDA	United States Agency for International Development, Office of U.S. Foreign Disaster Assistance
USGS	United States Geological Survey
WAT_{RUR}	Percentage of population having access to improved water supply in rural area
WAT_{TOT}	Percentage of population having access to improved water supply
WAT_{URB}	Percentage of population having access to improved water supply in urban area
WB	World Bank
WFP	World Food Programme
WMO	World Meteorological Organization
WRI	World Resources Institute
WTO	World Trade Organization
ZENEB	Zentrum für Naturrisiken und Entwicklung (Center for Nature Risks and Development)

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EXECUTIVE SUMMARY

Some 75 percent of the world's population live in areas affected at least once by earthquake, tropical cyclone, flood or drought between 1980 and 2000.

The consequences of such widespread exposure to natural hazard for human development is only now beginning to be identified. *Reducing Disaster Risk: A Challenge for Development* plays a role in this learning process.

Natural disaster risk is intimately connected to processes of human development. Disasters put development at risk. At the same time, the development choices made by individuals, communities and nations can generate new disaster risk. But this need not be the case. Human development can also contribute to a serious reduction in disaster risk.

This Report shows that billions of people in more than 100 countries are periodically exposed to at least one event of earthquake, tropical cyclone, flood or drought. As a result of disasters triggered by these natural hazards, more than 184 deaths per day are recorded in different parts of the world.

This Report demonstrates that development processes intervene in the translation of physical exposure into natural disaster events. This is demonstrated by the observation that while only 11 percent of the people exposed to natural hazards live in countries classified as low human development, they account for more than 53 percent of total recorded deaths.

The Report argues that disaster risk is not inevitable and offers examples of good practice in disaster risk reduction that can be built into ongoing development planning policy. These examples are summarised in this Executive Summary.

1 Development at Risk

Meeting the Millennium Development Goals (MDGs) is severely challenged in many countries by losses from disasters. The destruction of infrastructure and the erosion of livelihoods are direct outcomes of disaster. But disaster losses interact with and can also aggravate other financial, political, health and environmental shocks. Such disaster losses may setback social investments aiming to ameliorate poverty and hunger, provide access to education, health services, safe housing, drinking water and sanitation, or to protect the environment as well as the economic investments that provide employment and income.

A considerable incentive for rethinking disaster risk comes from the goals laid out in the Millennium Declaration.

The MDGs direct development planning towards priority goals. Each of these goals interacts with disaster risk. These goals will potentially contribute to a reduction of human vulnerability to natural hazard. But it is the processes undertaken in meeting each goal that will determine the extent to which disaster risk is reduced. This implies a two-way relationship between the kind of development planning that can lead to the achievement of the MDGs and the development processes that are currently associated with an accumulation of disaster risk.

The primary responsibility for achieving MDGs lies with individual countries. New windows for environmental sustainability have been discussed at the World Summit on Sustainable Development, held in Johannesburg, South Africa in 2002. For example, Poverty Reduction Strategy Papers need to take disaster risk and environmental sustainability into account. Bringing disasters and development together also requires a better integration between the humanitarian and development communities.

How can development increase disaster risk?

There are many examples of the drive for economic growth and social improvement generating new disaster risks. Rapid urbanisation is an example. The growth of informal settlements and inner city slums, whether fuelled by international migration or internal migration from smaller urban settlements or the countryside, has led to the growth of unstable living environments. These settlements are often located in ravines, on steep slopes, along flood plains or adjacent to noxious or dangerous industrial or transport facilities.

Rural livelihoods are put at risk by the local impacts of global climate change or environmental degradation. Coping capacity for some people has been undermined by the need to compete in a globalising economy, which at present rewards productive specialisation and intensification over diversity and sustainability.

Can development planning incorporate disaster risk?

The frequency with which some countries experience natural disaster should certainly place disaster risk at the forefront of development planners' minds. This agenda differentiates between two types of disaster risk management. *Prospective disaster risk management* should be integrated into sustainable development planning. Development programmes and projects need to be reviewed for their potential to reduce or aggravate vulnerability and hazard. *Compensatory disaster risk management* (such as disaster preparedness and response) stands alongside development planning and is focused on the amelioration of existing vulnerability and reduction of natural hazard that has accumulated through past development pathways. Compensatory policy is necessary to reduce contemporary risk, but prospective policy is required for medium- to long-term disaster risk reduction.

Bringing disaster risk reduction and development concerns closer together requires three steps:

a. The collection of basic data on disaster risk and the development of planning tools to track the relationship between development policy and disaster risk.
b. The collection and dissemination of best practice in development planning and policy that reduce disaster risk.
c. The galvanising of political will to reorient both the development and disaster management sectors.

2 International Patterns of Risk

UNDP has begun development of a Disaster Risk Index (DRI) in order to improve understanding of the relationship between development and disaster risk.

The findings of the DRI project, presented in this Report, enable the measurement and comparison of relative levels of physical exposure to hazard, vulnerability and risk between countries and the identification of vulnerability indicators.

Four natural hazard types (earthquake, tropical cyclone, flood and drought), responsible for 94 percent of deaths triggered by natural disaster were examined and the populations exposed and the relative vulnerability of countries to each hazard were calculated.

In the last two decades, more than 1.5 million people have been killed by natural disasters.
Human deaths are the most reliable measure of human loss and are the indicator used in this Report. However, as with any economic data, this reveals only the tip of the iceberg in terms of development losses and human suffering. Worldwide, for every person killed, about 3,000 people are exposed to natural hazards.

In global terms and for the four hazard types assessed, disaster risk was found to be considerably lower in high-income countries than in medium- and low-income countries. Countries classified as high human development countries represent 15 percent of the exposed population, but only 1.8 percent of the deaths.

Earthquake: About 130 million people were found to be exposed on average every year to earthquake risk as defined in this Report. High relative vulnerability (people killed/exposed) was found in countries such as the Islamic Republic of Iran, Afghanistan and India. Other medium development countries with sizeable urban populations, such as Turkey and the Russian Federation, were also found to have high relative vulnerability, as well as countries such as Armenia and Guinea that had experienced an exceptional event in the reporting period.

Tropical cyclone: Up to 119 million people were found to be exposed on average every year to tropical cyclone hazard and some people experienced an average of more than four events every year. High relative vulnerability was found in Bangladesh, Honduras and Nicaragua, all of which had experienced a catastrophic disaster during the reporting period. Other countries with substantial populations located on coastal plains were found to be highly vulnerable, for example India, Philippines and Viet Nam. Small Island Developing States (SIDS) represent a high-risk group of countries. But comparing within this group pulls out differences, for example, between the relatively high vulnerability of Haiti and the lower vulnerability of Cuba and Mauritius.

Flood: About 196 million people in more than 90 countries were found to be exposed on average every year to catastrophic flooding. Many more people are exposed to minor or localised flood hazards that can have a cumulative dampening impact on development, but do not cause major human losses in single events. They were not included in this assessment. High vulnerability was identified in a wide range of countries and is likely to be aggravated by global climate change. In Venezuela, high vulnerability was due to a single catastrophic event. Other countries with high vulnerability to floods included Somalia, Morocco and Yemen.

Drought: Around 220 million people were found to be exposed annually to drought and African states were indicated as having the highest vulnerability to drought. Methodological challenges prevent any firm country-specific findings being presented for this hazard. The assessment strongly reinforced field study evidence that the translation of drought into famine is mediated by armed conflict, internal displacement, HIV/AIDS, poor governance and economic crisis.

For each hazard type, smaller countries had consistently higher relative exposure to hazard and in the case of tropical cyclones, this was translated into high relative vulnerability.

What are the development factors and underlying processes that configure disaster risks?
The analysis of socio-economic variables, available with international coverage, and recorded disaster impacts, enabled some initial associations between specific development conditions and processes with disaster risk. This work was undertaken for earthquake, tropical cyclone and flood hazard.

Earthquake: Countries with high urban growth rates and high physical exposure were associated with high levels of risk.

Tropical cyclone: Countries with a high percentage of arable land and high physical exposure were associated with high levels of risk.

Flood: Countries with low Gross Domestic Product (GDP) per capita, low local density of population and high physical exposure were associated with high levels of risk.

These findings had very high degrees of statistical significance and highlight the importance of urbanisation and rural livelihoods as development contexts that shape disaster risk. Consequently, further analysis was structured around these two development factors.

If disaster risks are to be managed and reduced, change in development policy and planning is required at the national level.
More effort should be given to the collection of sub-national disaster data. This will help build datasets and indicators with a national level of observation and a local scale of resolution that can enable the visualisation of complex patterns of local risk. For example, the accumulation of risk over time, in specific locations, and when catastrophic hazard events trigger multiple secondary hazards and numerous small-scale disasters. This kind of information is important for factoring disaster risk considerations into development policy at the national level. Locally specific data can also highlight the ways in which natural and man-made hazards (such as house fires) interact, allowing further refinement of policy.

A multi-hazard DRI is an achievable task.
The multi-hazard model is built from the socio-economic variables associated with individual hazards. The multi-hazard DRI is innovative in breaking away from a hazard-centred analysis of risk to one that has integrated analysis of risk that draws on vulnerability factors. There is scope in the model for the better integration of vulnerability variables (such as armed conflict) and hazards (such as volcanoes and landslides) as data becomes available. Future work should also seek to incorporate an assessment of the extent to which national policy has included risk reduction and the impacts of such policy on disaster risk. Finally, it is hoped that the global multi-hazard DRI will pave the way for national level studies that combine disaster and socio-economic information.

3 Development: Working to Reduce Risk?

For many people across the globe, development does not appear to be working. The increasing number and intensity of disasters with a natural trigger are one way in which this crisis is manifest.

Two key variables were associated with disaster risk in the DRI: *urbanisation* and *rural livelihoods*. For each, a critical dynamic pressure likely to shape the future characteristics of these variables was also examined. For urbanisation, we analysed *economic globalisation*, and for rural livelihoods, we analysed *global climate change*. In addition, a number of additional important development pressures — violence and armed conflict, the changing epidemiology of disease (HIV/AIDS), governance and social capital — did not have datasets of the necessary coverage and quality to be included in the DRI at the time of its calculation, and so are included to provide a stronger qualitative analysis.

During this decade, population increase will occur most rapidly in urban areas in the countries of Africa, Asia and Latin America and the Caribbean, with more than half of the world population becoming urban by 2007.
The average size of the world's 100 largest cities increased from 2.1 million in 1950 to 5.1 million in 1990. The complexity and sheer scale of humanity concentrated into large cities creates a new intensity of risk and risk-causing factors, but it is in small- and medium-sized towns that the majority of the urban population live. Smaller cities contribute less pollution to global climate change, but show high levels of internal environmental pollution and risk. Therefore, urbanisation is a real challenge for planning and for the ability of the market to provide basic needs that can allow development without creating preventable disaster risks.

Urbanisation does not necessarily have to lead to increasing disaster risk and can actually, if managed properly, help reduce it.
There are a number of factors that contribute to the configuration of risk in cities. First, history is important. For example; where cities have been founded in or expanded into hazardous locations. Second, the urbanisation process leads to the concentration of populations in risk-prone cities, and risk-prone locations within cities. This is true in megacities and in rapidly expanding small- and medium-sized urban centres. When populations expand faster than the capacity of urban authorities or the private sector to supply housing or basic infrastructure, risk in informal settlements can accumulate quickly. Third, in cities with transient or migrant populations, social and economic networks tend to be loose. Many people, especially minority or groups of low social status, can become socially excluded and politically marginalised, leading to a lack of access to resources and increased vulnerability. The

urban poor are often forced to make difficult decisions about risk. Living in hazardous locations is sometimes 'chosen' if it provides access to work, for example; in the city centre.

Urbanisation can also modify hazard patterns. Through process of urban expansion, cities transform their surrounding environment and generate new risks. The urbanisation of watersheds can modify hydraulic regimes and destabilize slopes, increasing flood and landslide hazard.

As centres of cultural value expressed through the man-made environment, cities are also sites where the collective quality of life can be undermined if historic buildings are lost to disaster.

Urbanisation also has the power to radically shape disaster risks at the regional scale. Major investments in infrastructure and productive facilities, the development of new urban areas and trade corridors, and the unplanned urbanisation of new regions are all examples of modalities through which urbanisation can shape risk in broad territorial areas.

Urbanisation is affected by dynamic pressures, such as economic globalisation.
Globalisation and the growing interconnectedness of global society means that catastrophic events in one place have the potential to affect lives and public policies in distant locations. At the same time, globalisation also has the power to shape new local economic relationships and subsequent geographies of risk. Given that the decisions that generate such conditions (such as free trade agreements) are taken at the international level and without detailed knowledge and data of the territories potentially affected, it is uncommon that existing risk patterns are taken into account.

Economic globalisation can provide opportunities for the enhancement of livelihoods and the quality of life for those people and places benefiting from new investments. To prevent these investments from creating large inequalities and further polarising the world into those who are at risk and those who are not, the opportunities and benefits of globalisation need to be shared much more widely. The introduction of Poverty Reduction Strategy Papers as coherent guidelines for national development planning offers a tool for enhancing the place of equity for poverty and vulnerability reduction in development. Working to reduce inequality and vulnerability within the context of a globalising economy requires strong international, national and local governance.

Rural livelihoods: About 70 percent of the world's poor live in rural areas.
There is great variety in the structure of rural economies and societies and their interaction with the environment. However, there are recurrent themes that characterise how development shapes risk in the countryside. Rural poverty is one of the key factors that shapes risk to hazards such as a flooding or drought. The rural poor, who are most at risk, are often no longer subsistence peasants. Instead, rural dwellers depend on complex livelihood strategies, including seasonal migration or inputs from remittances sent from relatives living in cities or overseas. These new survival strategies are reconfiguring risk in the countryside.

Often the poorest in rural areas occupy the most marginal lands and this forces people to rely on precarious and highly vulnerable livelihoods in areas prone to drought, flooding and other hazards. Local ecological and environmental change as a consequence of agricultural practices can itself create risk. For example, deforestation to make way for agricultural production often leads to soil erosion, loss of nutrients and eventually, the marginality of agriculture. In some circumstances, these processes can lead directly to the generation of new patterns of flood, drought, fire or landslide hazard.

For the majority of rural communities connected to the global economy, livelihoods are vulnerable to fluctuations in world commodity prices. When low commodity prices coincide with natural hazards, rural livelihoods come under high stress. However, those rural communities isolated from the wider market are not necessarily any less at risk. Instead, the pathways through which risk is configured are different. In particular, isolation tends to limit choices for any coping strategy.

Rural livelihoods are affected by dynamic pressures such as global climate change.
Global climate change brings with it long-term shifts in mean weather conditions and the possibility of the increasing frequency and severity of extreme weather events — the latter is perhaps more threatening to

agricultural livelihoods. Taken together, the effects of climate change increase uncertainty and the complexity of risk for everyone, including landless labourers, small-scale farmers, wealthy agriculturists and people whose livelihoods serve the rural economy.

While the developed nations of the world produce the majority of greenhouse gases, the burden of impact will be more severe on developing countries. They have larger vulnerable populations, national economies dependent on agricultural production and are less equipped to deal with extreme weather events.

The lack of capacity to manage and adapt to climate-related risks is already a central development issue in many developing countries, particularly in Small Island Development States. The lack of capacity to manage risks associated with current climate variability will likely also inhibit countries from adapting to the future complexity and uncertainty of global climate change.

Finally, where the dynamics of global climate change and economic globalisation are seen to interact, the shifting nature of hazard and disaster risk becomes even more apparent and hard to predict.

If development is to be advanced in countries affected by climate risks and if development is not to aggravate climate change risk, an integrated approach to local climate risk reduction needs to be promoted. Successful risk reduction approaches already practiced by the disaster risk community should be mainstreamed into national strategies and programmes.

Violence and armed conflict, disease, governance and social capital are also important factors of risk.

These themes have not been included in the analysis of vulnerability factors in the DRI exercise because of statistical constraints, but the themes are no less important.

During the 1990s, a total of 53 major armed conflicts resulted in 3.9 million deaths. The analysis undertaken in the DRI suggests that armed conflict and governance are factors that can turn low rainfall episodes, for example, into famine events. This is particularly the case in complex emergencies. At the turn of the 21st century, some countries suffered episodes of drought, earthquake or volcanic eruption on top of years of armed conflict, causing a particularly acute humanitarian crisis. Little or no attention has been paid to the potential of disaster management as a tool for conflict prevention initiatives, in spite of some encouraging experiences.

Epidemic diseases can be seen as disasters in their own right. They also interact with human vulnerability and natural disasters. There is a great deal of variation in the relationships between disease, disaster and development. Hazard events such as flooding or temperature increase in highland areas can extend the range of vector-born diseases, such as malaria. HIV/AIDS and other diseases can exacerbate the disaster risks brought on by climate change, urbanisation, marginalisation and war. With HIV/AIDS, the able-bodied, adult workforce who would normally engage in disaster-coping activities is too weak from the disease. Or they are already dead, leaving households composed of the elderly and very young, who often lack labour capacity or knowledge.

Governance for disaster risk reduction has economic, political and administrative elements:

- Economic governance includes the decision-making process that affects a country's economic activities and its relationships with other economies.
- Political governance is the process of decision-making to formulate policies including national disaster reduction policy and planning.
- Administrative governance is the system of policy implementation and requires the existence of well functioning organisations at the central and local levels. In the case of disaster risk reduction, it requires functioning enforcement of building codes, land-use planning, environmental risk and human vulnerability monitoring and safety standards.

There is more to good governance than reorganising the public sector or redividing the responsibilities between different tiers of government. While governments bear the primary responsibility with regard to the right to safety and security, they cannot and should not shoulder these tasks alone. At national and international levels, civil society is playing an ever more active role in forming policies to address risk. The private sector also has a role to play in moving towards sustainable development that incorporates an awareness of disaster risk — a role that could be enhanced.

This Report offers a number of case studies for good practice in governance for disaster risk reduction. Over the last decade, the number of regional organisations addressing risk management issues has grown. In addition to developing their own expertise and policy initiatives, regional organisations can provide continuity to help maintain national level progress in development and disaster risk management.

At the national level, mainstreaming disaster risk reduction with development policy is a key challenge. The need for strong intervention following a disaster is recognised. The challenge now is to increase the focus on disaster risk reduction as a central element of ongoing development policy. A more integrated approach calls for collaboration between government agencies responsible for land-use planning, development planning, agricultural and environmental planning and education as well as those organisations responsible for disaster management.

This approach requires decentralised disaster risk planning strategies that can empower communities and open the window for local participation. The most vulnerable in society are also often those most excluded from community decision-making and in many cases this includes women. Enabling participation in these circumstances requires a long-term commitment to social development as part of vulnerability reduction programmes.

The importance of a gendered perspective on risk and the opportunities raised by risk reduction for a gender-sensitive approach to development can be seen from encouraging experiences of civil society groups active in risk reduction and disaster recovery.

Within reforms, legislation often remains a critical element in ensuring a solid ground for other focal areas, such as institutional systems, sound planning and coordination, local participation and effective policy implementation. But the road of legal reform is not easy and not always sufficient to facilitate change. Legislation can set standards and boundaries for action, for example, by defining building codes or training requirements and basic responsibilities for key actors in risk management. But legislation on its own cannot induce people to follow these rules. Monitoring and enforcement are needed.

In recent years the concept of *social capital* has provided additional insights into the ways in which individuals, communities and groups mobilise to deal with disasters. Social capital refers to those stocks of social trust, norms and networks that people derive from membership in different types of social collectives. Social capital, measured by levels of trust, cooperation and reciprocity in a social group, plays the most important role in shaping actual resilience to disaster shocks and stress. Local level community response remains the most important factor enabling people to reduce and cope with the risks associated with disaster. But community ties can be eroded by long-term or extreme social stress.

The appropriateness of policies for enhancing the positive contribution of civil society depends on developmental context. For many countries in Africa, Latin America and Asia that have undergone structural adjustment and participatory development, the challenge may not be so much the creation of a non-governmental sector as its coordination.

4 Conclusions and Recommendations

This Report supports six emerging agendas within disaster risk reduction. These are summarised here.

1. **Appropriate governance is fundamental if risk considerations are to be factored into development planning and if existing risks are to be successfully mitigated.** Development needs to be regulated in terms of its impact on disaster risk. Perhaps the greatest challenges for mainstreaming disaster risk into development planning are political will and geographical equity. These are problems shared through environmental management and environmental impact assessment. How to attribute responsibility for disaster risk experienced in one location that has been caused by actions in another location? Justifying expenditure in risk reduction will become easier as valuation techniques (including the DRI) that are available for indicating the positive contribution of risk reduction investments in development become more refined.

2. **Factoring risk into disaster recovery and reconstruction.** Development appraisal and decision making tools, and monitoring programmes that incorporate disaster risk management are needed to mainstream prospective disaster risk management. The argument made for mainstreaming disaster

risk management is doubly important during reconstruction following disaster events.

3. **Integrated climate risk management.** Building on capacities that deal with existing disaster risk is an effective way to generate capacity to deal with future climate change risk.

4. **Managing the multifaceted nature of risk.** Natural hazard is one among many potential threats to life and livelihood. Often those people and communities most vulnerable to natural hazards are also vulnerable to other sources of hazard. For many, livelihood strategies are all about the playing off of risks from multiple hazards sources — economic, social, political, environmental. Disaster risk reduction policy has to take this into account and look for opportunities for building generic as well as disaster risk specific capacities.

5. **Compensatory risk management.** In addition to reworking the disaster-development relationship, which this Report hopes to make a contribution towards, a legacy of risk accumulation exists today and there is a need to improve disaster preparedness and response.

6. **Addressing gaps in knowledge for disaster risk assessment.** A first step towards more concerted and coordinated global action on disaster risk reduction must be a clear understanding of the depth and extent of hazard, vulnerability and disaster loss.

Specific recommendations towards this end are to:

a. Enhance global indexing of risk and vulnerability, enabling more and better intercountry and inter-regional comparisons.
b. Support national and subregional risk indexing to enable the production of information for national decision makers.
c. Develop a multi-tiered system of disaster reporting.
d. Support context driven risk assessment.

Chapter 1
DEVELOPMENT AT RISK

1.1 Natural Disaster as a Cause and Product of Failed Development

Natural disaster is intimately connected to the processes of human development. Disasters triggered by natural hazards put development gains at risk. At the same time, the development choices made by individuals, communities and nations can pave the way for unequal distributions of disaster risk.

Meeting the Millennium Development Goals (MDGs) is extremely challenged in many communities and countries by losses from disasters triggered by natural hazards. The destruction of infrastructure, the erosion of livelihoods, damage to the integrity of ecosystems and architectural heritage, injury, illness and death are direct outcomes of disaster. But disaster losses interact with and can also aggravate other stresses and shocks such as a financial crisis, a political or social conflict, disease (especially HIV/AIDS), and environmental degradation. And such disaster losses may set back social investments aiming to ameliorate poverty and hunger, provide access to education, health services, safe housing, drinking water and sanitation, or to protect the environment as well as economic investments that provide employment and income.

At the same time, it has been clearly demonstrated how disaster risk accumulates historically through inappropriate development interventions. Every health centre or school that collapses in an earthquake and every road or bridge that is washed away in a flood began as development activities. Urbanisation and the concentration of people in hazard prone areas and unsafe buildings, increases in poverty that reduce the human capacity to absorb and recover from the impact of a hazard, and environmental degradation that magnifies hazards such as floods and droughts, are only a few examples of how development can lead to disaster risk.

The relationship of development and disaster risk can be seen by a quick review of data produced by this Report. About 75 percent of the world's population live in areas affected at least once between 1980 and 2000 by earthquake, tropical cyclones, flood or drought. As a result of disasters triggered by these natural hazards, more than 184 deaths per day were recorded in different parts of the world. Deaths indicate only the tip of the iceberg in terms of losses in the quality of life, livelihoods and economic development, and are unevenly distributed around the world. While only 11 percent of the people exposed to natural hazards live in low human development countries, they account for more than 53 percent of total recorded deaths. Development status and disaster risk are clearly closely linked.

Appropriate development policies that reduce disaster risk can therefore make an important contribution toward the achievement of the MDGs by reducing losses and protecting existing development gains as well as avoiding the generation of new risks. The reduction of disaster risk and sustainable human development are therefore mutually supportive goals that also contribute to the reduction of poverty, the empowerment of marginalised social groups and gender equality. Disaster risk reduction can make a particularly critical difference for highly vulnerable populations, for example those living in small island developing states or societies weakened by armed conflict and HIV/AIDS.

Disasters are still usually perceived as exceptional natural events that interrupt normal human development and require humanitarian actions to mitigate loss. While this Report acknowledges the increasing impact of natural disasters on development, its focus is on how development itself shapes disaster risk. This Report demonstrates that countries with similar patterns of natural hazard have widely varying levels of disaster risk and that these risks have been shaped through development paths and processes. The key message of this Report is that disaster risk is not inevitable, but on the contrary, can be managed and reduced through appropriate development policy and actions.

Through publishing this Report, UNDP thus seeks to demonstrate through quantitative analysis and documented evidence that disaster risk is an *unresolved problem of development* and to identify and promote development policy alternatives that contribute to reducing disaster risk.

The Report addresses four key questions:

- How are disaster risks and human vulnerability to natural hazards distributed globally between countries?
- What are the development factors and underlying processes that configure disaster risks and what are the linkages between disaster risk and development?
- How can appropriate development policy and practice contribute to the reduction of disaster risks?
- How can disaster risk assessment be enhanced in order to inform development policy and practice?

The **Disaster Risk Index** (DRI), which is presented as the centrepiece of this Report, is a first step in addressing these questions. The DRI provides the first global assessment of disaster risk factors through a country-by-country comparison of human vulnerability and exposure to three critical natural hazards: earthquake, tropical cyclones and flooding, and the identification of development factors that contribute to risk. Volcanic eruption is important internationally, but lacks sufficient data for analysis at this time (see Technical Annex). Similarly, the development of a drought DRI revealed a series of unresolved methodological and conceptual challenges, which imply that its results do not yet have the required degree of confidence. Nevertheless, the exploration of these challenges in itself provides important insights into drought risk and vulnerability and is presented in the Report as a work in progress. Reliance on internationally available data and the use of human deaths as a proxy for disaster losses meant that certain types of disasters were excluded from the model. An example of this is fire, which can cause widespread damage with few deaths.

DRI builds on UNDP experience with the Human Development Index (HDI). Just as with the HDI, this first report on DRI should be seen as an initial step towards measuring global disaster risks. Its value is as much in flagging data needs to support decision making at the sub-national, national and international levels, as it is in contributing to the process of mapping international patterns of disaster risk.

1.2 Outline of the Report

Chapter 1 is divided into three sections. The first section presents the objective of the Report in advocating for the importance of disaster risk as a component in meeting the MDGs. The second section contextualises the Report by offering definitions of terms and commenting on links with similar projects being undertaken by other international agencies. The third section outlines a conceptual framework for the Report and maps out the relationship between disaster risk and human development.

Chapter 2 reviews the findings of the DRI. This is a first step in achieving a worldwide accounting tool for development and disaster risk status. In addition to starting the process of mapping global patterns of risk and vulnerability, this exercise flags key gaps in knowledge and indicates the national mechanisms needed to enhance data collection.

Chapter 3 explores the development processes that contribute to the configuration of disaster risk, as identified in the DRI. It also allows for the examination of pressures known to shape risk that could not be included in the DRI through lack of international data. Perhaps most important of these is the overarching role of governance. The second role of Chapter 3 is to present examples of good practice in disaster risk reduction projects undertaken within a developmental approach. This material supports a growing number of accounts of best practice including recent reviews undertaken by the International Strategy for Disaster Reduction (ISDR), The International Federation of Red Cross and Red Crescent Societies (IFRC) and The Department for International Development (DFID).[1]

Chapter 4 returns to the key needs identified in Chapter 1 for disaster risk reduction to be appropriately mainstreamed into development policy. Building on these arguments and informed by the evidence presented in Chapters 2 and 3, key policy recommendations are advocated.

The Technical Appendix sets out in detail the methodology used to identify vulnerability factors and model national levels of disaster risk in the DRI. Progress made on the modelling of a multi-hazard DRI is also reported.

The conceptual framework of disaster risk used in the Report is outlined in Chapter 2. At the same time, a formal glossary of terms is presented at the end of the Report. However, it is helpful to outline five key terms here.

Natural disaster is understood to be an outcome of natural hazard and human vulnerability coming together, the coping capacity of society influences the extent and severity of damages received.

Natural hazards are natural processes or phenomena occurring in the biosphere that may constitute a damaging event and that in turn may be modified by human activities, such as environmental degradation and urbanisation

Human vulnerability is a condition or process resulting from physical, social, economic and environmental factors, which determine the likelihood and scale of damage from the impact of a given hazard. Human vulnerability includes within it the vulnerability of social and economic systems, health status, physical infrastructure and environmental assets. It is possible to look at these subsets of vulnerable systems in isolation, but here we are concerned with the broad picture of human vulnerability.

Coping capacity is the manner in which people and organisations use existing resources reactively, to limit losses during a disaster event. To this can be added *adaptive capacity,* which points to the possibility for society to redirect its activities proactively, to shape development in a way that minimises the production of disaster risk.

1.3 Disaster Losses are Increasing

Over the last quarter century, the number of reported natural disasters and their impact on human and economic development worldwide has been increasing yearly. Existing records, while less reliable before 1980, can be traced back to 1900. This longer time period also shows a relentless upward movement in the number of disasters and their human and economic impacts.[2]

It is troubling that disaster risk and impacts have been increasing during a period of global economic growth.

At best this suggests that a greater proportion of economic surplus could be better distributed to alleviate the growing risk of disaster. At worst is the possibility that development paths are themselves exacerbating the problem; increasing hazards (for example through environmental degradation and global climate change), human vulnerability (through income poverty and political marginalisation) or both.

Measuring disaster loss is itself a major conceptual and methodological challenge. On the one hand, it is necessary to define what losses can really be attributed to disasters, as opposed to other kinds of development loss. On the other hand, a major obstacle to describing and analysing disaster loss and its impact on development is the lack of reliable data and information on all levels. This is perhaps one reason why policymakers have been slow to act on the link between disaster and development.

The question of how many disasters occur and the losses that they represent can only be answered in relation to a given level of observation and resolution. Disaster losses occur on all levels, from individual household losses associated with everyday environmental hazards to losses due to exceptional catastrophic events, such as major earthquakes and cyclones that can affect entire regions. Seen from a local perspective, all these losses would be relevant and important. From a global perspective, most local level disasters are effectively invisible.

BOX 1.1 THE ECONOMIC IMPACT OF DISASTERS

Disaster losses are conventionally categorised as:

- **Direct costs** — physical damage, including that to productive capital and stocks (industrial plants, standing crops, inventories, etc.), economic infrastructure (roads, electricity supplies, etc.) and social infrastructure (homes, schools, etc.).
- **Indirect costs** — downstream disruption to the flow of goods and services — e.g., lower output from damaged or destroyed assets and infrastructure and the loss of earnings as income-generating opportunities are disrupted. Disruption of the provision of basic services, such as telecommunications or water supply, for instance, can have far-reaching implications. Indirect costs also include the costs of both medical expenses and lost productivity arising from the increased incidence of disease, injury and death. However, gross indirect costs are also partly offset by the positive downstream effects of the rehabilitation and reconstruction efforts, such as increased activity in the construction industry.
- **Secondary effects** — short- and long-term impacts of a disaster on the overall economy and socio-economic conditions — e.g. fiscal and monetary performance, levels of household and national indebtedness, the distribution of income and scale and incidence of poverty, the effects of relocating or restructuring elements of the economy or workforce.

Reported data on the cost of disasters relate predominantly to direct costs. Figures on the true cost of indirect and secondary impacts may not be available for several years after a disaster event, if at all. The passage of time is necessary to reveal the actual pace of recovery and precise nature of indirect and secondary effects.

Ongoing research suggests that the secondary effects of disasters can have significant impacts on long-term human and economic development.[3] Most obviously, disasters affect the pace and nature of capital accumulation. The possibility of future disasters can also be a disincentive for investors. In examining the longer-term impact of disasters, it is also important to recognise that a disaster is not a one time event but, rather, one of a series of successive events, with a gradual cumulative impact on long-term development.

Source: Benson (2002)[4]

Global databases of disaster loss are maintained by reinsurance companies, such as Munich Reinsurance Group and Swiss Reinsurance as well as by the Centre for Research on the Epidemiology of Disasters (CRED), an independent academic institution. Only the latter is in the public domain and therefore accessible for analytical purposes. EM-DAT: The OFDA/CRED International Disaster Database, or EM-DAT as it will be referred to in this Report, reports losses associated with large scale and many medium-scale disaster events, but does not include losses associated with small-scale events or those medium-scale events not reported internationally.

While data on human mortality is relatively robust, data on economic loss and livelihood erosion is generally not considered to be complete or reliable at this stage. While the reinsurance companies give more emphasis to economic loss, given their focus on insured losses, this is unlikely to provide a clear picture of livelihood losses, particularly in developing countries.

Comprehensive economic assessments of disaster loss have been carried out by the Economic Commission for Latin America and the Caribbean (ECLAC), the World Bank and other regional and international bodies following major natural disasters. Such assessments, nonetheless, constitute snapshots in time and do not capture accumulative economic loss at either the national or global levels. At the same time, there is likely an underestimation of the impact of disaster on livelihood sustainability and the erosive pressure disasters can exert on social capital. In particular, the contribution to livelihood failure, household collapse and poverty of slow-onset and small-scale disasters is likely to have been played down through lack of data.

Detailed national databases of disaster loss are available in some countries, but do not provide complete global or even regional coverage at this stage. At the same time, national databases show similar deficiencies as the global databases regarding the reporting of economic loss and livelihood erosion.

1.3.1 Economic loss as an indicator of disaster impact

Economic losses are often reported with reference to only the direct losses from infrastructure and assets destroyed during large-scale disasters. They seldom take into account the economic implications of reduced levels of production linked to damage in productive assets or infrastructure that in turn limit access to raw materials, energy, labour or markets (see Box 1.1 on previous page).

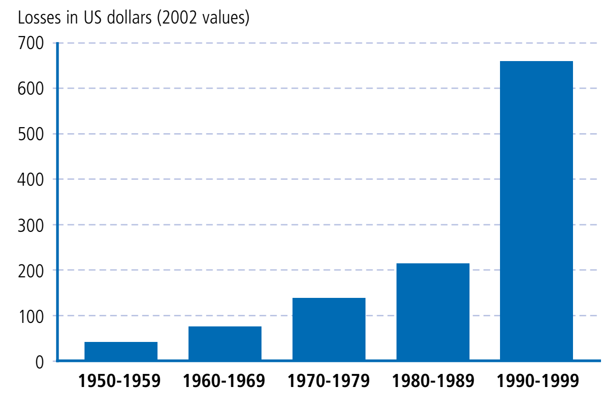
In absolute terms, the recorded economic cost of disasters has been increasing over decades (see Figure 1.1). According to Munich Re, real annual economic losses in 2002 averaged US$ 75.5 billion in the 1960s, US$ 138.4 billion in the 1970s, US$ 213.9 billion in the 1980s and US$ 659.9 billion in the 1990s.[5]

Munich Re estimates that global economic losses for the most recent ten years (1992-2002) were 7.3 times greater than the 1960s. The *World Disasters Report 2002* assesses the annual average estimated damage due to natural disasters at US$ 69 billion. Two-thirds of these losses were reported from high human development countries.

Figure 1.2 shows economic loss by World Region for disaster events triggered by a natural hazard between 1991 and 2000. The unequal distribution of impacts is clear. In Europe and America, losses are shown to be higher than in Africa, but this is a reflection on the value of infrastructure and assets at risk, not impact on development potential. In less developed regions of the world, low losses reflect a deficit of infrastructure and economic assets rather than a low impact on development. And even a small economic loss may be critically important in the case of countries with a very low GDP. What economic loss data cannot show is the variable capacity of people and businesses from different regions to protect themselves from economic loss, for example, through insurance or government aid. Africa's much smaller economic losses may be more significant in terms of slowing progress in human development.

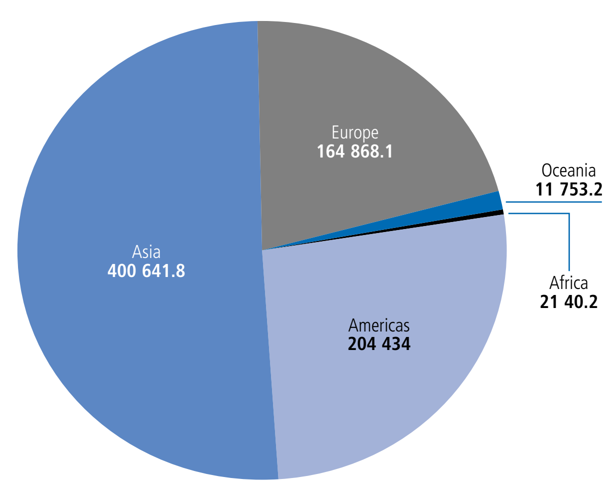
The use of economic loss as an indicator of disaster impact on development varies for different natural hazards. For example, earthquakes often appear to trigger the most expensive disasters, but losses are concentrated. Individual floods may not record large losses, but total human impact may be higher. Asian

FIGURE 1.1 ECONOMIC LOSSES DUE TO NATURAL DISASTERS FROM 1950 TO 2000



Source: Munich Re

FIGURE 1.2 TOTAL AMOUNT OF DISASTER DAMAGE BETWEEN 1991 AND 2000 IN MILLIONS OF US DOLLARS (2000 VALUES)



Source: EM-DAT: The OFDA/CRED International Disaster Database

countries experience the greatest collective economic losses to disaster, with flood being a common hazard in this region and human development may be even more at risk here than these data suggest.

1.3.2 Human loss as an indicator of disaster impact

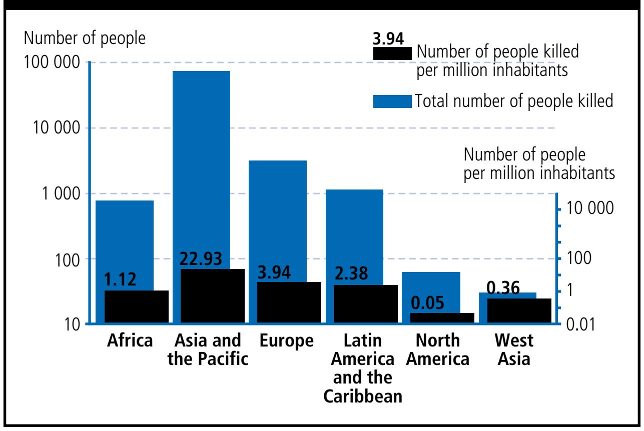
In the last two decades, more than one and a half million people have been killed by natural disasters. The total number of people affected each year has doubled over the last decade.

Human deaths are the most reliable measure of human loss and are the indicator used in this Report. However, as with economic data, this reveals only the tip of the iceberg in terms of development losses and human suffering. Worldwide, for every person killed, around 3,000 people are exposed to natural hazards.[6] This scale of impact fits more intuitively with the order of magnitude one might expect from disaster. But even here the ways in which people are identified as being affected is partial. Estimates are based on assessments of the number of people experiencing damage to livelihoods or to a dwelling, or interruption of basic services. But these are difficult data to collect in a post-disaster period, particularly if there is not an accurate pre-disaster baseline. More difficult still is factoring in longer term impacts, such as the consequences of the death or incapacitation of a primary income earner on a household or extended family, the consequences of migration or resettlement, or the number of people experiencing secondary health and educational impacts.

Data from EM-DAT[7] reveals that in examining human deaths to disasters with a natural trigger by world region (Figures 1.3 – 1.6), a common thread is seen across hazard types. The Asia-Pacific region experiences the greatest impacts both in terms of total lives lost and when lives lost are calculated as a proportion of regional population, due to earthquakes, tropical cyclones and floods. The exception to this comes from the high concentration of deaths associated with drought in Africa. Drought events are often part of a bigger picture that can include armed conflict, extremes of poverty and epidemic disease with death touching only the surface of livelihood disruption and human suffering. The erosion of development gains under such circumstances are clear.

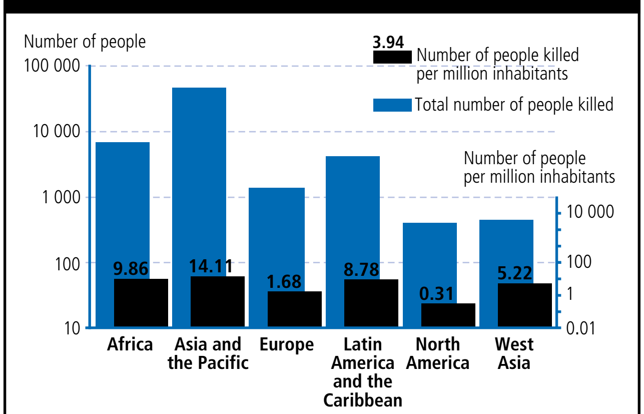
The concept that humanitarian emergencies associated with drought can only be fully understood by considering the role played by armed conflict, extreme poverty and epidemic disease is a useful entry point for rethinking the disaster-development relationship. If disasters apparently triggered by drought are often more

FIGURE 1.3 TOTAL REGIONAL MORTALITY, EARTHQUAKES, 1990–1999



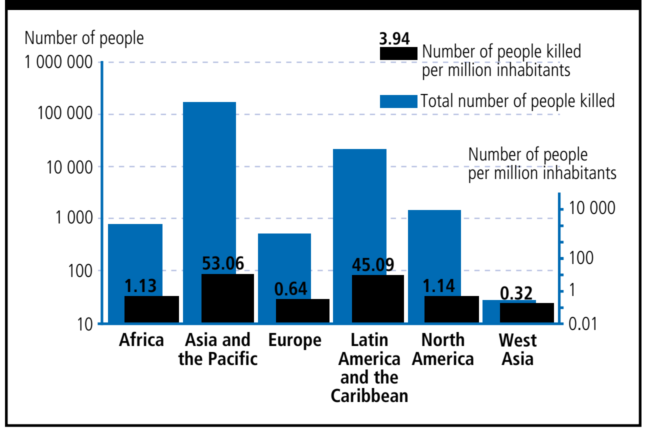
Source: EM-DAT: The OFDA/CRED International Disaster Database

FIGURE 1.4 TOTAL REGIONAL MORTALITY, FLOODS, 1990–1999



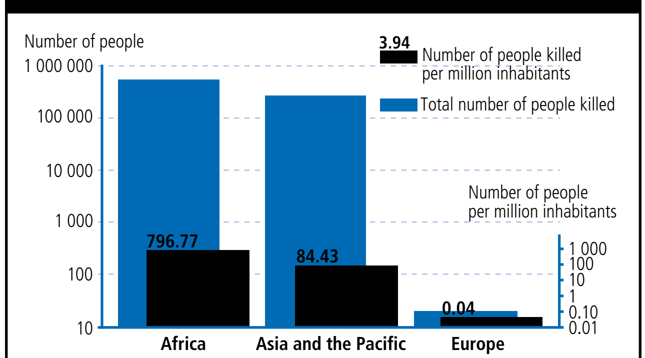
Source: EM-DAT: The OFDA/CRED International Disaster Database

FIGURE 1.5 TOTAL REGIONAL MORTALITY, TROPICAL CYCLONES, 1990–1999



Source: EM-DAT: The OFDA/CRED International Disaster Database

FIGURE 1.6 TOTAL REGIONAL MORTALITY, DROUGHTS, 1980–2000*



* In the case of drought, the period 1980-2000 better represents the regional distribution of deaths.

Source: EM-DAT: The OFDA/CRED International Disaster Database properly thought of as complex emergencies, as much to do with human as environmental processes, why not other disasters associated with tropical cyclones, earthquakes or floods?

Regional losses in Latin America and the Caribbean are dominated by disasters triggered by tropical cyclones and flooding. Africa and West Asia also suffer from high losses from flooding. Europe and North America show lower absolute and relative numbers of deaths to all hazard types, with the highest impact for these regions being registered by Europe's relative losses to earthquakes.

The severe famines associated with drought that unfolded in sub-Saharan Africa in the 1980s are shown by extending drought losses to a time period of 1980-2000.

1.4 Disaster Risk and the Millennium Development Goals: A Framework for Action

A considerable incentive for rethinking disaster risk as an integral part of the development process comes from the aim of achieving the goals laid out in the Millennium Declaration. The Declaration sets forth a road map for human development supported by 191 nations. Eight Millennium Development Goals were agreed upon in 2000, which in turn have been broken down into 18 targets with 48 indicators for progress. Most goals are set for achievement by 2015.[8]

The MDGs contain cross-cutting themes in development and disaster risk policy, each tied to specific targets and indicators for progress. They require international collaboration to be met. All signatory countries now claim to be working toward these goals and donors are providing sharply focused aid packages to support their endeavours.

The risk to development stemming from natural disaster is recognised in the Millennium Declaration in Section IV, entitled "Protecting Our Common Future". Within this section is stated the objective: "to intensify our collective efforts to reduce the number and effects of natural and man-made disasters".[9]

Natural disasters occur when societies or communities are exposed to potentially hazardous events, such as extremes of rainfall, temperature or wind speed or tectonic movements, and when people are unable to absorb the impact or recover from the hazardous impact. While it is commonplace to talk about natural disasters, both vulnerability and hazard are conditioned by human activities. Reducing the number and effects of natural disasters means tackling the development challenges that lead to the accumulation of hazard and human vulnerability that prefigure disaster.

The accumulation of disaster risk and the unequal distribution of disaster impacts prompt a questioning of the development paths that have been taken by countries more or less at risk from disaster. Natural disasters destroy development gains, but development processes themselves play a role in driving disaster risk. To follow the example quoted earlier, when a school built without earthquake resistance collapses during a tremor, is this an example of disaster risk undoing development, or of inappropriate development prefiguring disaster risk?

The MDGs direct development planning towards priority goals. Each of these goals will interact with disaster risk. On the surface, these goals will contribute to a reduction of human vulnerability to natural hazard. But it is the processes undertaken in meeting each goal that will determine the extent to which disaster risk is reduced. Building schools is not enough for a sustainable and long-term development gain, schools exposed to natural hazard must be disaster resistant, and people using them need to prepare for disaster.

This implies a two-way relationship between the kind of development planning that can lead to the achievement of the MDGs and the development processes that are currently associated with an accumulation of disaster risk. Unless disaster risk considerations are factored into all development related to the MDGs, well-meaning efforts to increase social and economic development might inadvertently increase disaster risk. At the same time, the realisation of existing (let alone future) levels of risk will slow down and undermine efforts to achieve the MDGs.

The primary responsibility for achieving MDGs lies with individual countries. To date, 29 countries have published Millennium Development Goal Reports.[10]

BOX 1.2 THE MILLENNIUM DEVELOPMENT GOALS AND DISASTER RISK REDUCTION

The Millennium Declaration contains a statement of values and objectives for the international agenda for the XXI century. Eight Millennium Development Goals, based on the Millennium Declaration, have been approved by the General Assembly as part of a road map for the implementation of the Declaration. These are set out below and each one's relationship with disaster risk is highlighted.

1. Eradicating extreme poverty and hunger

i) To halve the proportion of people whose income is less than one dollar a day
ii) To halve the number of people who suffer from hunger

The DRI proves through statistical analysis a long-held theoretical position that human vulnerability to natural hazards and income poverty are largely co-dependent. At the national level, reducing disaster risk is often contingent upon alleviating poverty and vice versa. Exposure to hazards can play a critical role in places where poverty expresses itself as a lack of entitlement to acquire basic nutritional needs. Hunger reduces individual capacity to cope with disaster stress and shock and disasters can destroy assets leading to hunger. The economic and political underpinnings of hunger, particularly within complex political emergencies, are well documented.[11]

2. Achieving universal primary education

i) To ensure that children everywhere — boys and girls alike — complete a full course of primary education

Educational attainment is a fundamental determinant of human vulnerability and marginalisation. Basic literacy and numeric skills enable individuals to become more engaged in their society. Broadening participation in development decision-making is a central tenet of disaster risk reduction.

The destruction of schools is one very direct way in which disasters can inhibit educational attainment, but perhaps more important is the drain on household resources that slow and sudden-onset disasters inflict. Households frequently have to make difficult decisions on expending resources on survival and coping with poverty, or on investments (such as education and health care) to alleviate human vulnerability and enhance longer-term development prospects. Unfortunately, for the poorest, there is no choice and human vulnerability deepens as resources are targeted towards survival.

3. Promoting gender equality and empowering women

i) Eliminate gender disparities in primary and secondary education, preferably by 2005, and in all levels by 2015.

Facilitating the participation of women and girls in the development process, including efforts to reduce disaster risk, is a key priority. Women across the world play critical roles in the shaping of risks in development. In some contexts, women may be more exposed to and vulnerable to hazards. For example, those with responsibilities in the household may be more exposed to risk due to unsafe building and from local hazards stemming from inadequate basic services or exposure to smoke from cooking fuel. At the same time, women are often more likely than men to participate in communal actions to reduce risk and enhance development. Orienting disaster risk policy so that it builds on the social capital represented by women can enable a more informed development policy. As criticisms of participatory development indicate, achieving such a model will not be easy, but best practice does exist to point the way.

When women face barriers in participating at higher levels of decision-making, this severely limits the skills and knowledge available for sustainable development and risk reduction. Overcoming disparities in access to education is a fundamental component of the disaster risk reduction agenda.

4. Reducing child mortality

i) Reduce infant and under-five mortality rates by two-thirds

Children under five years of age are particularly vulnerable to the impacts of environmental hazards ranging from the everyday risks of inadequate sanitation and drinking water to death and injury following catastrophic events and their aftermath. The loss of care givers and household income earners and the stress of displacement can have especially heavy tolls on the psychological and physical health of children under five years of age. Policies aiming to support sustainable development paths by reducing child mortality need to build in strategies to limit or reduce disaster risk.

5. Improving maternal health

i) Reduce maternal mortality ratios by three-quarters

As environmental hazard stress or shock erodes the savings and capacities of households and families, marginal people within these social groups are most at risk. In many cases it is women and girls or the aged who have least entitlement to household or family assets. Maternal health is a strategic indicator of intra- and inter-household equality. Reducing drains on household assets through risk reduction will contribute to enhancing maternal health. More direct measures through investment in education and health will similarly contribute to household resilience as maternal health indicators improve. Children have already been identified as a high-risk group and maternal health plays a part in shaping the care received by young children.

6. Combating HIV/AIDS, malaria and other diseases

i) Halt and begin to reverse the spread of HIV/AIDS
ii) Halt and begin to reverse the incidence of malaria and other major diseases

The interactions between epidemiological status and human vulnerability to subsequent stresses and shocks are well documented. For example, rural populations affected by HIV/AIDS are less able to cope with the stress of drought because of a shortage of labour. Individuals living with chronic terminal diseases are more susceptible to the physiological stress of hunger. For diseases transmitted through vectors, there is a risk of epidemic following floods or drought, similarly the destruction of drinking water, sanitation and health care infrastructure in catastrophic events can increase the risk of disease.

7. Ensuring environmental sustainability

i) Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources
ii) Halve the proportion of people without sustainable safe drinking water
iii) By 2020, achieve a significant improvement in the lives of at least 100 million slum dwellers

Major disasters, or the accumulation of risk from regular and persistent but smaller events, can wipe out any hope of sustainable urban or rural environments. Again, the equation works both ways. Increasing destruction due to landslides, floods and other disasters related to environmental and land-use patterns are a clear signal that massive challenges remain in achieving this MDG. The target of achieving a significant improvement in the lives of at least 100 million slum dwellers by the year 2020 will be impossible without developing policies to confront their currently high risk from earthquake, tropical cyclones, flooding and drought.

8. Developing a global partnership for development

i) Address the least developed countries' special needs and the special needs of landlocked and small island developing states
ii) Deal comprehensively with developing countries' debt problems
iii) Develop decent and productive work for youth
iv) In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries
v) In cooperation with the private sector, make available the benefits of new technologies — especially information and communications technologies

Efforts to enhance sustainable development and reduce human vulnerability to natural hazard are hampered by national debt burdens, terms of international trade, the high price of key drugs, lack of access to new technology and new hazards associated with global climate change.

Difficulties in reaching international agreement on a range of issues, for example at the World Summit on Sustainable Development in Johannesburg in 2002 and the World Trade Organisation meeting at Cancun in 2003, highlight the efforts needed to build a global partnership for development that might contribute to disaster risk reduction.

Examples of progress at the international level include cooperation between states at high risk from natural disaster that has increased their negotiating power. In the case of small island developing states, the Association of Small Island States has been active in climate change talks. Within the machinery of international organisations, the ISDR Task-Force constitutes a good example of global partnership for development and disaster risk reduction.

Source: www.un.org/millenniumgoals

While the MDGs have galvanised international development efforts, progress has been slow and this has direct implications for global levels of disaster risk.[12] The most far-reaching opportunities for disaster risk reduction within the MDGs relate to MDG8 — developing a global partnership for development. This requires that developed countries meet their commitments to trade reform, debt relief and aid. The lack of consensus on international trade, particularly in agriculture that brought the World Trade Organization talks in Cancun in 2003 to a halt, shows the amount of work that still needs to be undertaken in building an international agenda for trade reform. Without such reform, developing countries will have little chance of generating higher economic growth. At the same time, however, because trade reform has such far-reaching implications for patterns of economic, social and territorial development, by definition it will change the distribution of disaster risk. Once again, the two-way relationship between disaster risk and development becomes apparent. Trade reform may stimulate more *risk generating* development, unless disaster risk reduction becomes an integral part of development planning.

Issues of environmental sustainability were discussed in the World Summit on Sustainable Development, held in Johannesburg, South Africa in 2002. The Johannesburg Plan of Implementation encourages public-private sector partnerships in managing environment and development challenges. The ways in which partnerships operate in terms of wealth generation and distribution, stakeholder participation and the environmental impacts of development, will also potentially contribute to the shaping of disaster risk. These need to be critically reviewed in the face of disaster risk, stemming from the ongoing degradation of the natural environment from deforestation, natural resource extraction (including oil), soil loss, biodiversity loss and growing concerns for access to water for drinking and agricultural use.

Alongside the use of the MDGs in focusing development aims, the international community is also changing its way of delivering development support. This too has implications for the shaping of disaster risk and the way in which strategies for enhancing security will need to be framed.[13] In particular, the use of national Poverty Reduction Strategy Papers (PRSPs) to better define priorities for public expenditure and the role of aid within these priorities. This rethinking of aid applies not only to governments, but also to civil society and the private sector.

With disaster risk increasingly recognised as one way in which economic poverty is felt or expressed,[14] PRSPs need to take this into account. They also provide an opportunity to bridge the ministerial and bureaucratic divides that have in the past so often resulted in disaster risk reduction falling in the cracks between development planning and disaster response.

1.5 A Changing Debate: Bringing Disasters and Development Together

A developmentally informed perspective on disasters lies at the intersection of work normally undertaken by two different communities: development planners and disaster risk reduction practitioners. This Report hopes to contribute by catalysing both communities to rethink their responsibilities. It follows previous initiatives that have paved the way for this argument. Important in this regard has been the United Nations International Decade for Natural Disaster Reduction, 1990-1999 (IDNDR).

A number of very large-scale disasters occurred at the end of the IDNDR. The 1997-1998 El Niño led to flooding in East Africa, Latin America, the Caribbean and South and Southeast Asia. It was followed by hurricanes Georges and Mitch hitting Central America and the Caribbean. These events were succeeded by mudslides and debris flows in Venezuela, a cyclone in Orissa, India, and earthquakes in Turkey, El Salvador and Gujarat, India. All this occurred in the four years between 1997 and 2001 and all contributed to a more articulated and serious consideration of the disaster-development relationship.[15]

The declaration of the IDNDR helped raise the profile of discussions surrounding the social and economic causes of disaster risk. In acknowledging this came the realisation that mitigating losses through technological and engineering solutions dealt with the symptoms rather than with the causes of the problem and that reducing disaster risk required a long-term engagement with processes of international development. The major disasters occurring at the end of the 1990s helped to galvanise support for this view.

As the successor to IDNDR in 2000, the UN International Strategy for Disaster Reduction (ISDR) was initiated to foster this agenda by focussing on the processes involved in the awareness, assessment and management of disaster risks. An important tool in the development of this agenda has been the ISDR Secretariat's publication *Living with Risk: A Global Review of Disaster Reduction Initiatives.*[16] The UN commitment to promoting sustainable development and mitigating disaster losses is brought together in this document.

BOX 1.3 THE EVOLUTION OF NATURAL DISASTER AS A DEVELOPMENT CONCERN

Both researchers and practitioners have been providing compelling evidence for many years that natural disasters are something more than just *acts of God.* While this is a broad generalisation of a very complex and heterogeneous process, one can say that until the 1970s a dominant view prevailed that natural disasters were synonymous with natural events such as earthquakes, volcanic eruptions and cyclones. In other words, an earthquake was a disaster *per se.* The magnitude of a disaster was considered to be a function of the magnitude of the hazard. As earthquakes and volcanic eruptions are not avoidable, the emphasis of national governments and the international community was on responding to the events and in the best of cases, preparing for them.

From the 1970s onwards, technical professionals, such as engineers and architects, began to focus on the fact that the same natural hazard had a varying impact on different kinds of structures, such as buildings. The characteristics of a disaster became more associated with its physical impact than with the natural hazard. Interest grew in the design and implementation of ways to mitigate losses through physical and structural measures to reduce hazards (for example, through building levees and flood defences) or to increase the resistance of structures. Unfortunately, the cost of physical mitigation meant that in many countries efforts to reduce risks by these means have been minimal.

Also since the 1970s, but with increasing emphasis in the 1980s and 1990s, researchers from the social sciences and humanities have argued that the impact of a natural hazard depends not only on the physical resistance of a structure, but on the capacity of people to absorb the impact and recover from loss or damage. The focus of attention moved to social and economic vulnerability, with mounting evidence that natural hazards had widely varying impacts on different social groups and on different countries. The causal factors of disaster thus shifted from the natural event towards the development processes that generated different levels of vulnerability. Vulnerability reduction began to be advanced as a key strategy for reducing disaster impact, though this proved elusive to implement.

By the end of the 1990s, it was clear that development processes were not only generating different patterns of vulnerability, but were also altering and magnifying patterns of hazard — an argument that has gained increasing currency as evidence mounts regarding the impact of global climate change. Risk management and reduction has been advanced as an integral paradigm that builds on and incorporates all the previous strategies from the perspective that all development activities have the potential to increase or reduce risks.

In 1997, under the United Nations Programme for Reform, the General Assembly transferred the responsibility for operational activities on natural disaster mitigation, prevention and preparedness to UNDP. Since then, UNDP has made considerable progress in developing capacity building programmes in disaster reduction and recovery. In doing this, UNDP supports the implementation of the ISDR agenda at the national and regional levels. This work is reinforced by partnerships with the Office for Co-ordination of Humanitarian Affairs (OCHA) and other UN agencies and international organisations.

International Financial Institutions (IFIs) such as the World Bank and the regional development banks have also began to engage with issues surrounding the relationship between disaster risk and economic development. Many considerations compelled IFIs to incorporate disaster reduction as a major part of their portfolio of activities. For example, the massive destruction of infrastructure that had been built with international loans from the IFIs, the setbacks to national economies and the mounting evidence that unless disaster reduction was factored into reconstruction, new loans following disasters might simply lead to the *rebuilding* of risk. The ProVention Consortium, launched by the World Bank as a global partnership of governments, international organisations, academic institutions, the private sector and civil society, has been active in promoting research and disseminating best practices in many aspects of disaster risk management.

Members of international civil society also have been instrumental in moving the agenda of managing disasters on from mitigation and preparedness, towards a deeper integration with development processes. Since 1992, IFRC has published an annual *World Disaster Report.*[17] The two most recent editions focused on disaster risk reduction and recovery. This new focus on the links between disaster and development shows the increasing awareness in major international development and humanitarian agencies about the importance of disaster risk reduction. As with *Reducing Disaster Risk: A Challenge for Development*, the IFRC argument for a greater emphasis on disaster risk reduction building on established response mechanisms, is tied into the context of achieving the Millennium Development Goals.[18]

At the same time in recognising the growing international interest and commitment to reducing disaster risk, it is important to recognise that this has been stimulated by the emergence of national and regional institutions dedicated to research, training and application in disaster prone countries. Many of the contemporary approaches to risk management and reduction, now being discussed and advocated at the international level, have grown out of disaster reduction research and application by developing country researchers and institutions. Since the early 1990s, a growing literature has emerged in Latin America and the Caribbean, Asia and Africa.[19]

The creation of regional organisations and networks manifests the growing maturity of this process. These organisations and networks now have an important influence on international policy.

1.6 Is Sustainable Human Development Achievable Under Natural Disaster Risk?

The UNDP emphasis on human development has informed the way in which development is conceived of in this Report. Human development is about more than the rise or fall of national incomes. It is about having space in which people can develop their full potential and lead productive, creative lives in accordance with their needs and interests. People are the real wealth of nations.

Fundamental to human development is building human capabilities: the range of things that people can do or be in life. The most basic capabilities for human development are to lead long and healthy lives, to be knowledgeable, to have access to the resources needed for a decent standard of living and to be able to participate in the life of the community. Without these, many choices are simply not available and many opportunities in life remain inaccessible. The stress and shock felt by those vulnerable and exposed to natural hazards will impact in myriad ways on the capacity of people to achieve and enjoy human development gains. Levels of human development will also shape people's capacity to be resilient in the face of hazard stress and shock.

UNDP Human Development Reports (HDR) recognise the role played by disaster risk in shaping human development. Disaster risk has been a concern of regional thematic works including: *El Estado de la Region* published in 1999 and covering Central America, *Building Competitiveness in the Face of Vulnerability*, published in 2002 by the Organisation of Eastern Caribbean Sates, and *El Impacto de un Huracán*, published in 1999 in Honduras. More generally, given the close relationship between disaster risk and human development, the HDR series often discusses concerns relevant to disaster risk reduction though in a less systematic manner.[21]

BOX 1.4 MAHBUB UL HAQ ON THE MEANING OF HUMAN DEVELOPMENT

The basic purpose of development is to enlarge people's choices. In principle, these choices can be infinite and can change over time. People often value achievements that do not show up at all, or not immediately, in income or growth figures: greater access to knowledge, better nutrition and health services, more secure livelihoods, security against crime and physical violence, satisfying leisure hours, political and cultural freedoms and a sense of participation in community activities. The objective of development is to create an enabling environment for people to enjoy long, healthy and creative lives.

Source: Mahbub ul Haq [20]

1.6.1 Disaster-development linkages

The primary focus of *Reducing Disaster Risk: A Challenge for Development* is on the relationship between human development and disaster.[22] In order to clarify the ways in which disaster and development interact, it is helpful to distinguish between the economic and social elements of human development. These components are interdependent and overlapping. Nevertheless, it is useful to think of the ways that these two elements, and their constituent institutional and political components, are shaped, retarded and sometimes accelerated by disaster. Similarly, one can analyse the ways in which economic and social

BOX 1.5 DISASTER RISK, HUMAN DEVELOPMENT AND THE MDGs

The interaction of **economic development** with disaster risk has direct consequences for the meeting of MDG 1 (eradicate extreme poverty and hunger), 6 (combat HIV/AIDS, malaria and other diseases) and 7 (ensure environmental sustainability).

The interaction of **social development** and disaster risk has direct consequences for the meeting of MDG 3 (promote gender equality and empower women) and 8 (develop a global partnership for development).

TABLE 1.1 DISASTER-DEVELOPMENT

	Economic Development	Social Development
Disaster limits development	Destruction of fixed assets. Loss of production capacity, market access or material inputs. Damage to transport, communications or energy infrastructure. Erosion of livelihoods, savings and physical capital.	Destruction of health or education infrastructure and personnel. Death, disablement or migration of key social actors leading to an erosion of social capital.
Development causes disaster risk	Unsustainable development practices that create wealth for some at the expense of unsafe working or living conditions for others or degrade the environment.	Development paths generating cultural norms that promote social isolation or political exclusion.
Development reduces disaster risk	Access to adequate drinking water, food, waste management and a secure dwelling increases people's resiliency. Trade and technology can reduce poverty. Investing in financial mechanisms and social security can cushion against vulnerability.	Building community cohesion, recognising excluded individuals or social groups (such as women), and providing opportunities for greater involvement in decision-making, enhanced educational and health capacity increases resiliency.

development (and their constituent processes) work directly or indirectly to decrease or increase disaster risk.

Table 1.1 sets out these complex interactions schematically, which are discussed below and form the context for the following chapters. Social development includes social assets such as inclusive governance, but also the health and educational infrastructure that enables participation. Economic development concerns economic production and its supporting infrastructure, for example transport networks to enable market access and the integrity of natural resources for the sustainability of resource-dependent livelihoods.

Disasters limit economic development?

Disasters can wipe out the gains of economic development. In 1982, Hurricane Isaac destroyed 22 percent of the housing stock in the Tongan archipelago.[23] Reconstruction costs to correct damage to water, sanitation, energy, telecommunication, roads and railway infrastructure from flooding in Mozambique in 2000 will cost US$ 165.3 million.[24] These accounts are dramatic, but the constant drain on resources from everyday disasters similarly limits the development potential of millions of people around the world. In Viet Nam, in "normal" years, flooding destroys an average of 300,000 tonnes of food.[25]

Catastrophic disasters result in the destruction of fixed assets and physical capital, interruption of production and trade, diversion and depletion of savings and public and private investment. While absolute levels of economic loss are greater in developed countries due to the far higher density and cost of infrastructure and production levels, less-developed countries suffer higher levels of relative loss when seen as a proportion of Gross Domestic Product (GDP).

The 2001 earthquakes in El Salvador and Seattle in the United States resulted in losses of around US$ 2 billion each. While this scale of loss was easily absorbed by the U.S. economy, it represented 15 percent of El Salvador's GDP for that year.

Larger countries, with a greater geographical spread of economic assets relative to the spatial impact of disasters, are more able to avoid direct loss and minimise downstream, indirect or secondary losses. In 1995, Hurricane Luis caused US$ 330 million in direct damages to Antigua, equivalent to 66 percent of GDP. This can be contrasted with the larger economy of Turkey that lost between US$ 9 billion and US$ 13 billion in direct impacts from the Marmara earthquake in 1999, but whose national economy remained largely on track.[26]

Not only the size of a nation's economy, but also the proportion of its land area exposed to hazard will determine disaster risk. This partly accounts for the high vulnerability of small island developing states. Almost three-quarters of the island of Montserrat was made uninhabitable by a volcanic eruption in 2001. Today only 36 percent of the pre-disaster population remain, supported by the United Kingdom.

A lack of diversity in the economy can also undermine security, whether it be of a household or nation. The importance of diversification for rural livelihood sustainability has long been recognised as a mechanism to cope with changing market conditions and climatic fluctuations. There is a tension here between the dictates of global trade, which pushes countries towards specialisation, and the insecurity that a lack of diversity brings. This is particularly so for countries "specialising" in primary commodity exports that may also be at risk from drought, flooding or tropical cyclones. This is exemplified by reduced agricultural production in Africa in the 1997 El Niño year. The most significant declines were in Botswana, Lesotho, Malawi, South Africa, Swaziland and Zambia.[27]

But the relationship between economic size, diversity and risk is not simple. The lowest income countries are not necessarily the most vulnerable from an economic perspective. This group, including Burkina Faso, Ethiopia, Malawi and Swaziland, typically have agrarian economies. Although vulnerable to drought, once rains return recovery can be fast and attracts high levels of donor support. A study of drought impacts showed that intermediate economies with some diversification (such as Senegal and Zimbabwe) have been more vulnerable as economic impacts cross into manufacturing sectors. Impacts also linger, as recovery of the manufacturing sector is slower than in agriculture and may not attract so much donor attention.[28]

At the local level, disasters can seriously impact household livelihoods and push already vulnerable groups further into poverty. The loss of income earners, through death or injury, the interruption of production or access to markets and the destruction of productive assets, such as home-based workshops, are all examples of ways in which disasters affect local and household economies. Often such impacts are accumulative as the impact of everyday and frequently occurring small-scale hazards erodes livelihoods over a period of time. The capacity of a household or local community to absorb the impact and recover from a major natural hazard will be seriously limited if already weakened over time by a series of smaller-scale losses.

Disasters limit social development?

A population that has been weakened and depleted by natural disaster, particularly when this coincides with losses from HIV/AIDS, malnutrition or armed conflict, will be less likely to have the organisational capacity to maintain irrigation works, bunds in fields for water harvesting, hillslope terraces, community wood lots or shelter belts. Without these social assets, communities become more vulnerable.

In addition to the loss of social assets themselves, there are many examples of disaster events destroying the gains of the health, sanitation, drinking water, housing and education sectors that underpin social development. Examples include the El Salvador earthquake in 2001, which badly damaged 23 hospitals, 121 health care units and 1,566 schools; or the cyclone that hit Orissa, India in 1999, which led to the contamination of drinking water wells and damaged many schools in the direct impacts of a single event.[29]

Potentially negative consequences for social development do not stop with direct impacts. In the aftermath of a disaster or during the escalation of a slow-onset disaster, such as a drought or complex political emergency, problems with governance mean that aid budgets can be skewed towards the recovery of one group or sector as opposed to another. The result is a reduction in social equality.

A review of livelihoods and governance conditions that led to high losses in the Orissa cyclone in 1999 has pointed to corruption at all levels, unnecessary bureaucracy, political rivalry and an apathetic civil society as pressures that contributed to vulnerability.[30]

Disaster response may also be a time when democratic institutions come under pressure. After the 1985 earthquake in Chile, a traditional civilian response threatened to undermine a dictatorial government.[31] The response was demobilised through repression and the state took over.

Women suffer additional stresses in disaster situations and also bear a disproportionate burden of the additional domestic and income-generating work necessary for survival following a disaster event. When women are exposed to these additional stresses, the level of social development is reduced. However, over the long run, it is also possible that the net result is an increase in their economic and political participation — generating an increase in social development.

The exclusion of women from local decision-making circles in Bangladesh led to women and girls being unwilling to use hurricane shelters. Current, inclusive decision-making bodies have improved the social position of women and the management of hurricane shelters has been reformed — encouraging greater use among women.

Economic development increases disaster risk?

There are many examples of the drive for economic growth generating disaster risk. This is as true for individuals as it is for international business. The massive forest fires in Indonesia in 1997 that caused air pollution in neighbouring Malaysia were partly caused by the uncontrolled use of fire by farmers wishing to expand production of a major export crop, palm oil. Tourist developments that fringe Barbados may inadvertently be adding to their own risk as waste water and recreational sports contribute to the denudation of coral reefs, which act as a first line of sea defence against storm surges.

Hurricane Mitch in 1998 generated a wide-ranging reflection on the relationships between poverty and environmental degradation. The notion of "Reconstruction with Transformation" was coined by governments in negotiations with external aid donors. In aiming to build a changed development path into the reconstruction effort, this carried with it an explicit recognition that pre-disaster development priorities had led to high levels of risk and human vulnerability, eventually culminating in a humanitarian disaster triggered by a tropical cyclone.

It is the rules of governance that promote particular development paths that also shape patterns of risk and disaster loss. In Izmit, Turkey, systemic corruption played an important role in contributing to the failure of building regulation, sub-standard construction and high rates of building failure during the 1999 earthquake.

Contemporary disaster risk can be linked to historical development decisions and to development decisions taken by actors in distant places. Disaster risks associated with global climate change, or the pollution of rivers by industrial and household effluent that increases the vulnerability of downstream rural communities, exemplify these relationships operating at different scales.[32]

The gaps of time and place between development gain and disaster risk accumulation and the ability of some people to shift their risk onto others while enjoying the benefits of development, are not fully understood and need further examination to assist policy formation. Globalisation will undoubtedly lead to new risk factors and modify or build on previously existing risk.

Economic development does not need to contribute to the conditions that undermine human and environmental sustainability and increase disaster risk. To move forward, there must be a clear understanding of the interaction of development plans with disaster risk.

Social development increases disaster risk?

It is hard to imagine that increases in social development (improved health, sanitation, education, the participation of women in society, etc.) can increase the risk of disasters. The only possible situation that would actually place social development as a causal factor in disaster risk is one where people are forced to expose themselves or others to risk in order to fulfil their (or others) needs or desires.

Rapid urbanisation is a case in point. The growth of informal settlements and inner city slums when fuelled by international migration (for example, from East Africa to Johannesburg or from Central America to cities in the United States) or internal migration from smaller urban settlements or the countryside to large cities, has led to the burgeoning of unstable living environments. These settlements are often located in ravines, on steep slopes, along flood plains or adjacent to noxious or dangerous industrial or transport infrastructure sites. Some 600 million urban dwellers in Africa, Asia, Latin America and the Caribbean live in life- and health-threatening homes and neighbourhoods as a result of poor quality housing and inadequate provision of basic needs.[33]

In many cases, individuals will be seeking opportunities not only to improve their own quality of life, but also to enhance the health and educational attainment of their children and be prepared (or forced) to accept enhanced disaster risk today, for greater prospects for their children tomorrow. However, even this example needs consideration, as it is not increases in social development *per se* that accounts for growing risk, but the unassisted efforts of the economically marginal and politically excluded to gain access to basic human needs that has forced them to accept environmental risk.

Economic development reduces disaster risk?

For economic development to proceed without increasing disaster risk, development planning needs to reconcile three potentially conflicting drivers for development. First, the generation of wealth, which can raise the basic level of human development. Second, the distribution of wealth, which can enable even the poorest to overcome human vulnerability. Third, the externalities of wealth creation (waste, pollution, destruction of environments or human culture), which need to be controlled to prevent the loss of the fundamental assets on which human life depends and gains meaning.

The mainstreaming of disaster risk assessment into existing development instruments is critical in achieving economic development without generating new risks. This includes opportunities for building on existing risk impact assessment tools and examining opportunities for integration into activities such as housing and infrastructure development, industrial and agricultural development and the introduction of new technologies. This requires a two-pronged strategy. On the one hand, risk information can be used through instruments such as land-use planning and building regulations to increase the resistance, safety and sustainability of development interventions. On the other hand, it is necessary to evaluate the possible impacts of economic development in terms of risks in other locations and for other social groups.

The Klang River Basin Flood Mitigation and Environmental Management Project in Malaysia is a good example of development oriented towards risk reduction. The Klang River Basin is rapidly urbanising and its population is more than 3.6 million, with major portions of agricultural land being converted for urban use. Frequent flooding and degradation of the riparian environment have been escalating as urbanisation continues. An Environmental Master Plan is planned to direct environmental management. The plan aims to improve river water quality and provide flood warning and protection.[34]

Operating during the reconstruction phase of a disaster event, the Market Incentives for Mitigation aims to mobilise the resources of the World Bank and the insurance and reinsurance community and to apply the tools of commercial loss management to the design and maintenance of critical development investments. The goal is to let governments shift funding from emergency relief and reconstruction activities to more effective and sustainable disaster mitigation investment.[35]

An additional component to this agenda is to identify mechanisms for promoting the use of such tools in low- and middle-income countries experiencing rapid growth in populations-at-risk and the import of new and potentially hazardous technologies or waste.

At the local level, one possibility for building resilience comes from microfinance programmes. Microfinance has been shown to enhance development opportunities by providing individuals with access to credit. The Grameen Bank in Bangladesh has a long-standing commitment to supporting small-scale enterprise in this way. During the periodic floods that caused widespread destruction in Bangladesh in 1988 and 1998, losses were reduced amongst high-risk groups like agricultural communities by providing a mechanism for families to diversify income-earning activities across seasons.[36]

Social development reduces disaster risk?

Social development goals are key in shaping governance regimes for disaster risk management set within a developmental agenda. To reduce disaster risk, governance must be sensitive to the needs of those at risk from disaster with a natural trigger, and able to facilitate timely, equitable and strategically coherent decisions in resource mobilisation and disbursement.

The physical infrastructure underpinning social development includes health and education. Improved health and educational status help reduce vulnerability and can limit human losses in a disaster. Following the direct impact of a disaster event, a better-nourished, healthier population in which children have all been vaccinated will do much better in homes, shelters and camps set up for those displaced by disasters.

A literate and better-educated population — including girls and women — is better able to partner with experts in designing ways of protecting urban neighbourhoods and rural communities. Such an educated population also responds better to warnings and other public service announcements. The importance of extending educational opportunities to girls and women is noted in the MDGs and has been shown to improve the delivery of disaster risk reduction.

Gram Vikas, a rural development organisation, has been working in Orissa, India since 1979. In 1994, officials met resistance from women while implementing a project designed to provide drinking water to the village of Samantrapur. The women's attitude was understandable. They had been excluded from the local decision-making process. Integrating women into local decision-making was a precursor to project success. To enable this, women were offered training in basic literacy, health care and income generation. Women are now included in maintaining water supply and toilet blocks in the village and have a greater stake in the politics of the village more generally.[37]

Social development points to the importance of social cohesion, inclusiveness and open participation in decision-making. Achieving such objectives is a major challenge in many communities at risk from disaster. Social capital is often used to refer to the type and thickness of bonds in a community. Projects that can enable people to build social capital for collective good can reduce vulnerability. Though some forms of social capital can be more ambiguous — as in clientelistic relationships — or negative — as in drug gangs.

A community's quality and quantity of social capital may change over time. The impact of disaster with a natural trigger on social capital is uncertain. Comparative work on armed conflict has identified a vicious circle where the loss of interaction between social groups inhibits the flow of information, further undermining trust and restricting future collective action. This has been identified as a weakness in reaching resolution in post-conflict societies,[38] and in building democracy and economic development more generally.[39]

BOX 1.6 GOVERNANCE AND DISASTER RISK

Governance is a critical area for innovation and reform in achieving disaster risk reduction within human development. It is important to identify those governance tools that will be likely to simultaneously benefit disaster risk reduction and human development. This would include a presumption for equality in participation in decision-making across genders, religious and ethnic groups, casts and economic classes. An awareness of the need to engage with the local knowledge of at-risk individuals and groups as well as respect for scientifically informed knowledge will improve risk management and development planning efforts.

It is also important to identify governance reform that might inadvertently contribute to the generating of human vulnerability. Social networks are often in competition with one another and though this is not a bad thing in itself, when disaster or development aid is fed through and strengthens clientelistic networks this can foster corruption and inequality, further entrenching disaster risk.

The theme of governance is not followed up in Chapter 2 and the analysis of the DRI through a lack of internationally available data. However, it is returned to in discussion in Chapter 3.

The Dominican Disaster Mitigation Institute has facilitated the building of social capital in vulnerable communities in the Dominican Republic. A long-term strategy has been adopted where training sessions on leadership are interwoven with meetings on disaster preparedness. A number of communities have established women's and neighbouthood associations as a result. Community leaders have learned how to organise the community, establish a goal, and accomplish it.[40]

Can disaster risk enhance social or economic development?

The possibility of disasters having a positive outcome is not considered in Figure 1.2.

Notwithstanding this view, the recovery process can be an opportunity for building disaster risk reduction mechanisms into post-disaster development planning. Disaster-development relationships can be reconsidered and development priorities can be rethought. Importantly, it is not just local actors, but national and international actors who should be involved in these reflections.

Disruptions caused by disasters can open political space for alternative forms of social organisation. Often this is a negative experience, as with looting, but there is the possibility for more egalitarian forms of organisation to manifest. Support for such organisations is one way in which new development priorities might be carried forward beyond the immediate response period.

An example of a positive response to disaster is the Citizens' Disaster Response Network in Manila, which campaigns for greater transparency in government and grassroots participation in development decision-making. Its origin is in an ad hoc coalition of organisations that came together under the umbrella of the Support Disaster Victims Campaign after the eruption of Mount Mayon in 1984.[41]

During the disaster recovery and reconstruction periods, flows of foreign currency into a disaster-affected country from aid, debt relief, insurance, private transfers and remittances can produce an apparent improvement in national balance-of-payments, and provide the financial means for enacting new development priorities.

However, positive macroeconomic and livelihood effects tend to be limited to a short period of reconstruction. Following Hurricane Gilbert in 1988, Jamaica experienced a boom that reduced a potential external current account deficit of US$ 253 million to only US$ 38.3 million. The two main contributors to this were reinsurance flows of US$ 413 million and foreign grant aid of US$ 104 million. But the boom was short-lived and as reinsurance and grant aid sources of finance dried up, the impact of the disaster on Jamaica's productive capacity was felt. The following year, Jamaica recorded a current account deficit of US$ 297 million.[42]

These examples show the importance of using the disaster response and recovery periods as opportunities for reflecting on the root causes of disaster, and recasting development priorities to reduce human vulnerability and natural hazard. Simply reinventing pre-disaster conditions is a wasted opportunity. This is as true for the institutions of governance as it is for physical infrastructure.

1.7 How Can Development Planning Incorporate Disaster Risk?

The frequency with which some countries experience natural disaster should certainly place disaster risk at the forefront of development planners' minds. For example, Mozambique faces a regular cycle of droughts and floods: 1976-1978 (floods), 1981-1984 (drought), 1991-1993 (drought), 1996-1998 (floods), 1999-2000 (floods).[43]

In acknowledging the importance of disaster as a development constraint, there is a danger of seeing some countries as being by their very nature more disaster prone than others. Sub-Saharan Africa is popularly associated with drought, Central America with earthquakes and the Pacific and Caribbean islands with tropical cyclones. In each case, it is not geography alone that generates disaster risk. Rather, development processes have shaped human vulnerability and hazards paving the way for disaster.

In this section, several conceptual tools are presented that help to outline the ways in which inappropriate development can lead to disaster risk.

The history of international development underlies the disaster risk of today

The roots of much disaster risk can be traced to historical development decisions.[44] Many of the world's largest cities have sprawled from sites chosen in the pre-colonial or colonial eras to cover areas exposed to earthquake, flooding and tropical cyclones. Such cities with coastal locations include Dhaka, Bangladesh; Mombassa, Kenya; and Manila, the Philippines. In Latin America, a desire to control indigenous populations or locate close to mineral resources led to a colonial preference for interior sites. Post-colonial population growth has led to a rapid expansion in populations-at-risk from earthquakes. Mexico City, Mexico and San Salvador, El Salvador are examples and the latter city remains despite being destroyed by earthquake nine times between 1575 and 1986.

Decisions taken today will configure disaster risk in the future

The influence of past development on present disaster risk underlines the significance of contemporary decision-making for the disaster risk that might be experienced by future generations. This reinforces the importance of international cooperation to manage development. For example, in the need for the international community to negotiate to mitigate global climate change, and to support the adaptation strategies of those communities and countries most adversely affected by the impacts of global climate change. The rise of sea levels is placing great strain on coastal communities and climate change enhances the difficulty of planning development. In Fiji during the 1997-1998 drought, US$ 18 million in food and water rations had to be distributed.[45]

Population movements are changing the context of disaster risk

Mass migration from rural to urban settlements has resulted in the growth of city slums, many located on unsafe land and built with environmentally inadequate construction techniques. The marginalisation of poor rural families has led to their relocation on increasingly insecure agricultural lands. Poverty levels, or the absolute number of poor and destitute persons, have increased continually with dramatic effects in terms of increases in social risk and disaster vulnerability.

Development processes modify natural hazard

Hazards are being reshaped and new hazards introduced by contemporary development trends. For example, the conversion of mangrove coasts into intensive shrimp farming pools in many low-lying tropical coastlines in Southeast Asia and South America has increased the level of local hazard through coastal erosion and the loss of the coastal defence provided by the mangrove stands. The introduction of new technology such as chemicals into local agriculture, rising energy demands of urban centres and the international trade in hazardous waste, are all processes that have increased the complexity of hazard. Disaster risk reduction needs to be seen in the context of a wider interacting array of natural and technological hazards.

Everyday life is made up of everyday hazards

Everyday hazard can build cultures of resistance to danger. This is seen in the many coping strategies adopted by agriculturalists. But more common, particularly in rapidly growing urban settlements, is an association of everyday hazard with poverty and vulnerability. Typical everyday hazards include inadequate sanitation and drainage, health insecurity, malnutrition, unemployment and lack of stable and sufficient incomes, drug abuse and social and domestic violence. Exposure to everyday hazard in such cases can erode development potential and increase vulnerability to future hazard.

Risk accumulates before being released in a disaster

Everyday hazards and vulnerability form patterns of accumulating risk that can culminate in disaster triggered by an extreme natural hazard event. Achieving MDG 1 (to eradicate extreme poverty and hunger) and MDG 7 (to ensure environmental sustainability) will have a direct impact on reducing human vulnerability to everyday hazards and the accumulation of risk that prepares the way for disaster.

Large disasters are made up of many smaller disasters

The nested relationship between small and large disasters is called the concatenation of risk. Typically, an apparently simple, large-scale disaster will be composed of an array of smaller, contrasting hazard types. Hurricanes, for example, can trigger local floods and landslides. Building disaster risk reduction into development planning means taking into account large and small hazards.

This analysis leads one to ask some fundamental questions…

Do risk and disaster necessarily have to increase in incidence and effect in the future?

Is it possible to maintain economic growth while introducing policies to reduce disaster risk?

Is it necessary to change the overall parameters of future development models in order to reduce the possibility of future risk variables, or might significant improvements be made with more marginal changes?

This Report starts to address these issues by arguing for a reorientation in disaster reduction — to shift from an approach that focuses exclusively on reducing the impact of disasters on development towards an integrated risk management approach that *in addition* promotes forms of development that help reduce, rather than increase, disaster risk.

This does not mean that the elements of established disaster management (preparedness, emergency response, rehabilitation and reconstruction) are less important. But they should be complimented by an awareness of the role that poorly planned development can play in making momentary development gains at the expense of increased disaster risk.

Escalating human and economic costs of disaster point towards the need for policy responses that begin to identify and then tackle the root causes of risk that are embedded within contemporary development practices — as an integrated part of development policy. If lowering the base level of risk in society is possible while maintaining sustainable development goals, then investments in disaster risk reduction would reduce required expenditure on emergency and reconstruction and lessen the immeasurable human losses experienced by those that suffer disaster.

This agenda differentiates between two types of disaster risk management. **Prospective disaster risk management** should be integrated into sustainable development planning. Development programmes and projects need to be seen in the context of the disaster-development relationship and reviewed for potential future impacts on the reduction or aggravation of vulnerability and hazard. **Compensatory disaster risk management** (also termed corrective disaster risk management) stands alongside development planning and is focussed on the amelioration of existing vulnerability and reduction of natural hazard. Compensatory policy is necessary to reduce contemporary risk, but prospective policy is required for medium- to long-term disaster risk reduction.

Work is underway on developing methods for identifying the impact of individual development projects on disaster risk. The Caribbean Disaster Mitigation Project, Investing in Mitigation: Costs and Benefits,[46] has identified three opportunities to incorporate disaster mitigation in infrastructure investment decision-making. The first is to integrate the assessment of disaster risk into existing environmental impact assessment procedures. The second is to fully integrate natural hazard risk into the economic and financial analysis of investment projects. The third is to promote hazard mitigation when the insurance industry is called upon to underwrite catastrophic protection for the investment project.[47]

It is unlikely that prospective risk management will completely eliminate all vulnerability, so compensatory risk management is set to play a long-term role in managing disaster risk. However, even here there are opportunities for planning to build resilience into vulnerable groups or investments.

1.8 Final Discussion

Achieving a more sustainable development, and one that moves towards the meeting of the MDGs, will not be possible while disaster risk management is left outside of development. The challenge for integration lies in devising the tools required for policy makers to transparently justify the closer operation of disaster and development policy.

Bringing disaster risk reduction and development concerns closer together requires three steps:

- The collection of basic data on disaster risk and the development of planning tools to track the changing relationship between development policy and disaster risk levels.
- The collation and dissemination of best practice in development planning and policy that reduce disaster risk.
- The galvanising of political will to reorient both the development and disaster management sectors.

The first two steps are perhaps the most challenging. Once the human welfare gains to be made from mainstreaming disaster risk reduction within development policy are carried out, and transparent inventories of best practice are made available, advocating for policy change becomes more achievable.

For this to be done, information gaps must be filled. As we have already emphasised, there is a dearth of basic data on disaster impacts and risks at all levels from the local to the global. Problems of mapping data are made more difficult by the dynamic nature of risk. Flux in global processes, tied in particular to economic globalisation and global climate change, and changing local conditions, including rapid urbanisation, the spread of HIV/AIDS or civil conflict, mean that disaster risk is not a static condition.

In Reducing Disaster Risk: A Challenge for Development, UNDP seeks to move this agenda forward by presenting a review of state-of-the-art information on the distribution of disaster risk at the international level and an account of key development pressures and best practice in disaster risk reduction tied to development policy.

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3. http://www.eclac.cl/analisis/TIN53.htm#6.
4. Benson 2002 expert contribution.
5. Source: Munich RE 2002. Topics: annual review, natural catastrophes 2002, Munich, p. 15.
6. UNDP/UNEP calculations for this Report.
7. The EM-DAT database is the only existing publicly accessible global database on disasters triggered by a natural hazard event. The strengths and weaknesses of using this database are discussed in the Technical Annex.
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11. Sen, Amartya. 2000. *Development as Freedom,* New York, Random House.
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13. Here we can mention the High Indebted Countries Initiative (HIPC) promoted by the World Bank and the International Monetary Fund, and the New Partnerships for Africa's Development (NEPAD) in Africa and the integrated United Nations Development Assistance Frameworks (UNDAF) among others.
14. See the World Bank series of publications entitled *Voices of the Poor* and the *World Development Report,* 2000, p. 19.

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16. *Living with Risk: A Global Review of Disaster Reduction Initiatives* is a major output of ISDR Secretariat published in 2003. The document represents a global review of and resource on disaster reduction initiatives. Disaster risk reduction is seen in the broader context of sustainable development. The escalation of severe disasters is seen to be imposing an increasing threat to both sustainable development and poverty reduction initiatives. It is argued that the post-disaster reconstruction period provides the most opportune time to introduce disaster reduction into sustainable development planning. Therefore, political commitment and social acceptance of the value of risk reduction are necessary for forward-looking developers who want to increase the sustainability of communities.
17. *World Disasters Report 2001: Focus on Recovery* examines how governments and aid agencies are working to promote recovery from mega-disasters within a sustainable development paradigm. *World Disasters Report 2002: Focus on Reducing Risk* argues that risk reduction is an essential condition for sustainable development. It examines disaster preparedness and mitigation initiatives from disaster-prone countries across the globe. Included are chapters featuring the challenges and opportunities facing risk reduction and disaster preparedness, with success stories from Mozambique and Latin America, and details of mitigating effects of global warming in Pacific island states, among many other examples of good practice. See http://www.ifrc.org/publicat/wdr/
18. http://www.ifrc.org/publicat/wdr/
19. See references in the bibliography from institutions in Latin America and the Caribbean, Asia and Africa.
20. http://hdr.undp.org/hd/default.cfm
21. http:/hdr.undp.org/aboutus/default.cfm
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Chapter 2
INTERNATIONAL PATTERNS OF RISK

In order to improve understanding of the relationship between development and disaster risk at the global level, UNDP has begun development of a Disaster Risk Index (DRI).

The pilot DRI, presented in this Report, enables the measurement and comparison of relative levels of physical exposure to hazard, vulnerability and risk between countries. It also enables the identification of vulnerability indicators that point to development processes contributing to the configuration of disaster risk.

One objective of the DRI is to demonstrate the ways in which development contributes to the configuration of risk and vulnerability. Another objective is to provide quantitative evidence to advocate for the reorientation of development policy and planning in a way that contributes to the management and reduction of disaster risk.

In its present form, the DRI has been developed with a global level of observation and a national level of resolution, allowing comparison between countries with respect to three hazard types (earthquakes, tropical cyclones and floods).

These three hazards are together associated with approximately 39 percent of deaths in large- and medium-scale natural disasters at the global level. A DRI covering droughts and famines, which account for 55 percent of global deaths in large- and medium-scale natural disasters, was also developed. However, the development of the drought DRI revealed a series of unresolved methodological and conceptual challenges, which imply that its results do not yet have the required degree of confidence. Nevertheless, the exploration of these challenges in itself provides important insights into drought risk and vulnerability.

Work was also undertaken to develop a multi-hazard DRI that combined the results of the individual indices on earthquakes, tropical cyclones, floods and droughts. Given the challenges in modelling drought risk mentioned above, and taking into account the fact that drought and famine contribute more than half of global disaster deaths, we have considered it prudent not to present the multi-hazard DRI at this stage.

The DRI is a mortality-calibrated index. In other words, it measures the risk of death in disaster. Disaster mortality is only one facet of overall disaster loss and often is not the most significant. The choice of mortality was guided principally by global data availability and it is recognised that as such, the DRI provides only a partial picture of risk. Mortality is the most accurate type of data available for making international comparisons of disaster loss. It serves to open an agenda of analysis on the links between disaster and development. There is much potential for future work to investigate other indicators of impact, such as livelihood sustainability.

The development of the DRI has been guided both by the use of a conceptual model that seeks to explain physical exposure, vulnerability and risk as well as by the availability of global datasets of a suitable quality. This first version of the DRI represents only a first approximation towards applying the conceptual model on the basis of available global data. It is expected that through continually reviewing the process based on greater data availability and further refinements to the conceptual model, it will be possible to improve the DRI in the future.

This chapter is split into three main sections.

Section One presents the Disaster Risk Index (DRI). This section first presents a methodological overview and then DRI findings for the three hazard types included in this first index: earthquakes, tropical cyclones and floods.

Section Two drills down into the geography of risk and illustrates — with examples from Central America, South Asia and Africa — the complexity of hazard, vulnerability and risk patterns at the sub-national level.

Section Three discusses four recommendations for the future development of the DRI. Firstly, the need to improve data collection on disaster impact at all levels, but particularly at the sub-national level. Secondly, the need to progressively incorporate new variables into the index, through a learning process that will gradually improve its accuracy and usefulness. Thirdly, the need to measure the progress of policies targeted at disaster risk reduction, allowing the consideration of efforts made to reduce disaster risks as an indicator in the index. Fourthly, the need for the development of national level DRI — key to main-streaming the overall recommendations of this Report into national development policy, planning and practice.

2.1 Global Risk Factors: The Disaster Risk Index

2.1.1 What is the DRI ?

The DRI enables the calculation of the average risk of death per country in large- and medium-scale disasters associated with earthquakes, tropical cyclones and floods, based on data from 1980 to 2000. It also enables the identification of a number of socio-economic and environmental variables that are correlated with risk to death and which may point to causal processes of disaster risk.

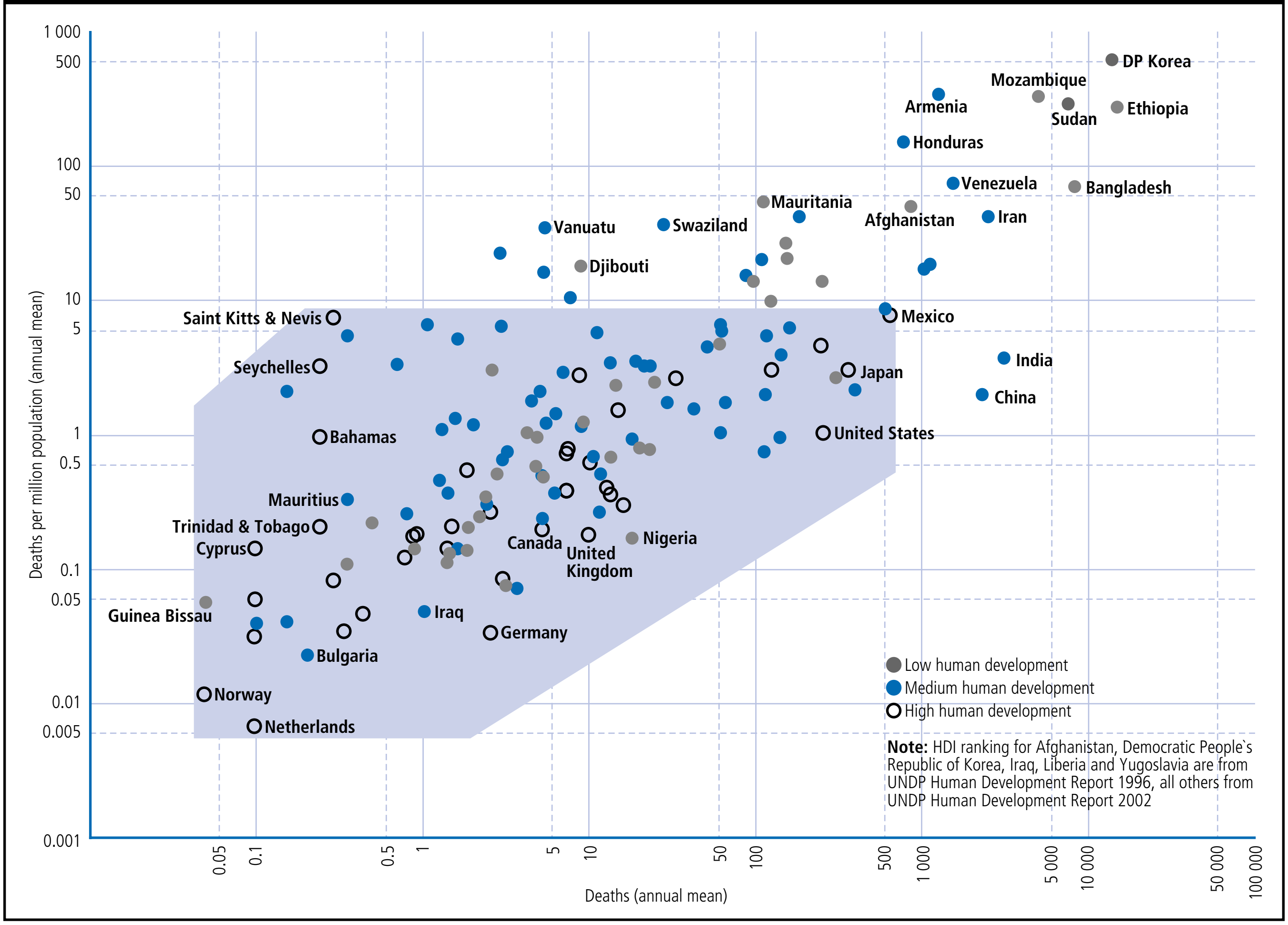
In the DRI, countries are indexed for each hazard type according to their degree of physical exposure, their degree of relative vulnerability and their degree of risk.

2.1.2 The conceptual model

Underlying the DRI is the concept that disaster risk is not caused by hazardous events per se, but rather is historically constructed through human activities and processes. As such the risk of death in a disaster is only partially dependent on the presence of physical phenomenon such as earthquakes, tropical cyclones and floods. In the DRI, risk refers exclusively to the risk of loss of life and excludes other facets of risk, such as risk to livelihood and to the economy. This is because of a lack of datasets available at the global scale with national resolution.

For an extreme physical event to be hazardous, by definition there has to be a subject to experience the hazard or the threat. For example, people, infrastructure and economic activities have to be located in an area where earthquakes occur. In the DRI, this relationship

FIGURE 2.1 DEVELOPMENT STATUS AND DISASTER DEATHS



Source: EM-DAT OFDA/CRED International Disaster Database

is expressed through the concept of *physical exposure*, referring to the number of people located in areas where hazardous events occur combined with the frequency of hazard events. Physical exposure is not an indicator of vulnerability, but is a condition *sine qua non* for disaster risk to exist. Without people exposed to hazardous events, there is no risk to human life.

Clearly however, greater physical exposure leads to greater loss of life. Assuming no change in other developmental conditions, a fivefold increase in the population living in a given flood plain would lead to a fivefold increase in mortality due to floods. Very high physical exposure in many countries reflects the concentration of population in hazard prone areas, itself a characteristic of the development process.

Physical exposure, however, is insufficient to explain risk. Countries with similar levels of physical exposure to a given hazard experience have widely differing levels of risk.

BOX 2.1 DEVELOPMENT STATUS AND DISASTER IMPACT

Figure 2.1 reveals that losses from natural disaster are tied to national development status.

While low and medium human development countries have similar loss patterns, some high human development countries occupy the bottom left-hand part of the graph. This indicates low numbers of deaths associated with natural disaster. No high human development country has recorded more than 10 deaths per million population as an annual average using data collected from 1980-2000, nor more than 600 deaths as an average in any one year. Both figures are exceeded by numerous medium and low human development countries.

This observation reinforces intuitive views about the disaster-development relationship, as discussed in Chapter 1. The aim of the DRI as presented in this chapter is to move beyond the surface view and begin a systematic examination of available data on disaster risk.

Vulnerability is the concept that explains why, with a given level of physical exposure, people are more or less at risk. In theory, vulnerability is modified by coping capacity and adaptive capacity. In the DRI, coping and adaptation are assumed to have been active in shaping recorded risk. Vulnerability brings together all these elements of human process in a single concept.

In the DRI, vulnerability refers to the different variables that make people less able to absorb the impact and recover from a hazard event. These may be economic (such as lack of reserves or low asset levels); social (such as the absence of social support mechanisms or weak social organisation); technical (such as poorly constructed, unsafe housing); and environmental (such as the fragility of ecosystems).[1]

The way vulnerability is used in the DRI means that it *also* includes variables that may increase the severity, frequency, extension and unpredictability of a hazard. For example, deforestation may increase flood and landslide hazard in some contexts and destruction of coastal mangroves may increase cyclone hazard. Thus, those development activities that influence hazard as well as those that influence human vulnerability are represented in the DRI as vulnerability.[2]

Included in the *vulnerability* index of the DRI are also those factors that may decrease vulnerability, such as appropriate development and urban planning, and specific actions to mitigate disaster losses, such as disaster preparedness and early warning systems.

In the DRI, it is assumed that the factors that make people vulnerable to earthquakes are not necessarily the same as those that make people vulnerable to floods or cyclones. Each corresponds to particular configurations of development activities. Due to the hazard specificity of people's vulnerability, it is not conceptually possible to arrive at a global multi-hazard indicator of vulnerability. Rather the vulnerability indicators suggested by the DRI are always hazard specific.

2.1.3 The development of the DRI

The key steps involved in producing the DRI were:

Calculation of physical exposure

The DRI identified the areas exposed to each of the four hazard types (earthquakes, tropical cyclones, floods and droughts) and the population living in these areas to arrive at a calculation of *physical exposure* for each country. This is the average number of people exposed to a hazard event in a given year. Physical exposure for each hazard was mapped in a Geographical Information System. Physical exposure varies both according to the number of people as well as to the frequency of hazard events. In the DRI, physical exposure is expressed both in absolute terms (the number of people exposed in a country) and in relative terms (the number exposed per million people).

Calculation of relative vulnerability

The risk of death in a natural disaster is a function of physical exposure to a hazardous event and vulnerability to the hazard. People are more or less vulnerable to a given hazard depending on a range of social, economic, cultural, political and physical variables. The DRI has used the number of people actually killed by each hazard type in each country as a proxy for *manifest risk*. In other words, the occurrence of past disasters manifests, by definition, the existence of conditions of physical exposure and vulnerability.

The DRI, therefore, was able to calculate the relative vulnerability of a country to a given hazard by dividing the number of people killed by the number exposed. When more people are killed with respect to the number exposed, the relative vulnerability to the hazard in question is higher.

Calculation of vulnerability indicators

The DRI then examined the manifest risk for each hazard type against a bundle of social, economic and environmental indicators through a statistical analysis using a multiple logarithmic regression model. A total of 26 variables selected through expert opinion were available as global datasets and analysed for each hazard type. This enabled the selection of those vulnerability indicators that were most associated with risk for each hazard type.

A detailed description of the data sets used and the operations performed on the data is provided in the Technical Annex.

2.1.4 Limitations to the DRI

In order to understand the results of the DRI, identify the possible uses of these results and above all to avoid the very real risk of misrepresentation and misuse of the results, it is important to critically and explicitly discuss a number of key limits with respect to the data used and the analysis presented.

The DRI represents the risk of death

Disasters affect people's lives and livelihoods in many ways. Depending on the type of hazard, houses may be damaged or destroyed, crops may be lost and land may be eroded or washed away. Social infrastructure such as schools, hospitals and community centres may be destroyed, economic activities may be directly or indirectly affected, family members may suffer from illness or injury and be unable to work or study, and lives may be lost. Therefore, the risk of mortality is only one aspect of disaster risk. Many disasters cause enormous social and economic impact without serious mortality. This is particularly so for slow-onset disasters associated with drought.

The use of deaths as a proxy for manifest risk, therefore, strictly limits the analysis of disaster risk to human development. Deaths do not capture human development losses and can only point to comparative orders of magnitude in vulnerability and loss. An economic outcome of disaster risk should complement the current approach based on human losses. Not only are disaster risk trends in industrialised countries not addressed when using mortality calibrated models, but the different economic impacts among different types of hazards skew disaster risk trends within least developed countries.

In the DRI, mortality was chosen as a proxy indicator for disaster risk because reliable data on other aspects of disaster risk (people affected, economic impact) is not available in global level disaster databases. The DRI used the EM-DAT database (see Technical Annex), the only global disaster database in the public domain. While mortality is an indicator of broader risk to human development, the DRI only represents risk to loss of life and cannot be inferred to represent other physical, social and economic aspects of risk.

The DRI examines risks associated with large- and medium-scale disasters

Disaster risk can be represented as a continuum from, at one extreme, the risk from everyday hazards (such as contaminated water supplies, poor sanitation, house fires and dangerous working and living environments) to, at the other extreme, the risk associated with infrequent catastrophic hazard events, such as major earthquakes or cyclones that devastate entire countries and regions. In between these two extremes lie the risks associated with frequently occurring small-scale hazard events (such as highly localised landslides, flash floods and debris flows) and periodic medium-scale hazard events.

Publicly available global data on disaster impact is currently only available for large- and medium-scale disaster events, defined as those involving more than 10 deaths, 100 affected and/or a call for international assistance. As the DRI is based on this data, it does not represent risk associated with small-scale and everyday disasters. At the same time, a recent study undertaken for the ISDR Working Group 3 on Risk, Vulnerability and Impact Assessment, indicates that international reporting may not be capturing all the medium- scale disaster events that occur. Nevertheless, and taking into account these data limitations, we consider that for the purposes of an Index constructed with a global level of observation and a national level of resolution, the large- and medium-scale disasters captured in international databases represent a very good sample of overall disaster risk.

The DRI represents risks associated with earthquakes, tropical cyclones and floods

At the global level, and with respect to large- and medium-scale disasters, the three hazard types analysed in the DRI (plus drought, presented here as a work in progress) account for approximately 94 percent of total mortality. Nevertheless, in individual countries, other hazards may have an important local impact and are not considered in the DRI. For example: landslides, debris flows and fires.

At the same time, primary hazards may trigger a range of secondary hazard events. Earthquakes, for example, often provoke landslides and fires and tropical cyclones cause sea surges and flooding. The DRI only represents the *primary* hazard events as recorded in global disaster databases, even when in some cases the majority of loss may be associated with a range of different hazard types triggered by the primary event.

The DRI represents disaster risk in the period 1980-2000

The DRI has been calibrated using data from the period 1980-2000 because it was considered that access to information before that period was less reliable. This, however, weights the work in favour of countries that suffered catastrophic disaster events with large loss of life in the two decades under analysis and against countries that suffered such events in the 1970s, for example, but not since then.

At an early stage, volcanic eruptions were excluded from the DRI analysis because of the need to differentiate locally between different types of volcanic hazard. Data for such a task exists and could be compiled into an international database.

The DRI tests vulnerability indicators from available global datasets

The DRI has run statistical regression analysis comparing some 26 socio-economic and environmental variables with risk levels in order to identify possible indicators of vulnerability.

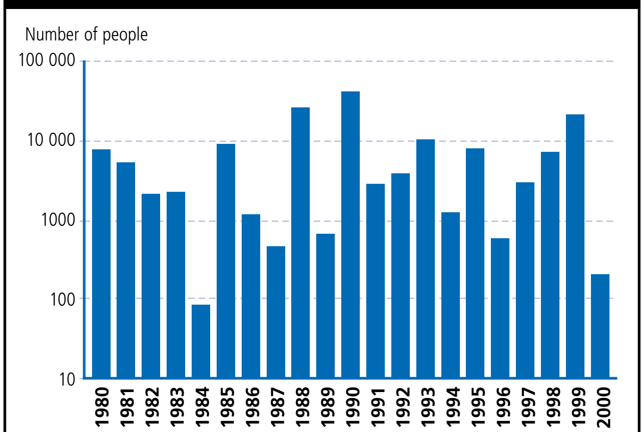
Clearly the variables that could be tested are those that were available in global datasets. This implies that there may be other variables that potentially might help build a better correlation with risk, but for which no global datasets were available at the time of production of the DRI. The choice of vulnerability indicators presented in the DRI, therefore, is limited by available data. It is hoped that in the future more direct indicators of national vulnerability might be available, for example, soil types or the proportion of earthquake resistant buildings per country for earthquake hazard.

The logarithmic base of the model can highlight long-term trends, but does not allow predictive casualties to be made. Small differences in the vulnerability indicator figures can mask major changes in disaster risk.

The DRI does not include indicators on disaster risk management and reduction

In terms of assisting the advocacy purposes of the DRI, an ongoing aim is to generate a disaster risk reduction component. National change over time or comparison between countries operating alternative

FIGURE 2.2 PEOPLE KILLED BY EARTHQUAKES, 1980-2000



Source: The EM-DAT OFDA/CRED International Disaster Database

risk management strategies can be used as an initial level of analysis of the comparative effectiveness of competing risk reduction strategies (including a do-nothing option). But a dedicated comparative index built up of components found to indicate risk reduction would be a clearer tool. Unfortunately, conceptual work remains to be done in identifying key indicators for multiple hazard types operating in a range of socio-political contexts.

2.2 Hazard Specific Risk Profiles

2.2.1 Earthquake hazard

A total of 158,551 deaths were associated with earthquakes around the world between 1980-2000 (see Figure 2.2).

Iran has the highest toll of death for this period, with 47,267 people killed in earthquakes.

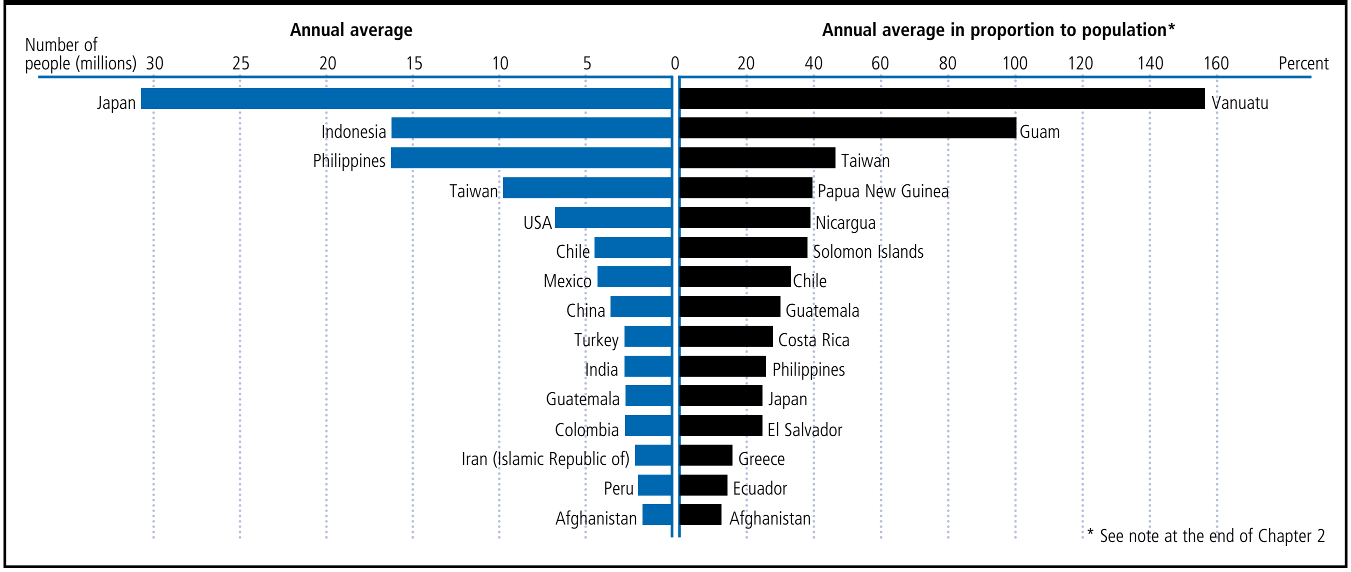
About 130 million people were found to be exposed on average every year to earthquake risk as the defined in this Report.

The left hand axis of Figure 2.3 shows the fifteen countries with the largest absolute populations exposed to earthquake hazard. Populous Asian states (Japan, Indonesia and the Philippines) top the list with the Americas (USA, Chile, Mexico), Turkey and India also included. The right hand axis displays the fifteen countries with the highest proportion of their populations exposed to earthquake hazard. Smaller island states (Vanuatu, Guam, Papua New Guinea) and Central American states (Nicaragua, Guatemala) top the list.

Comparing the size of exposed populations with the number of recorded deaths to earthquake hazard is used as a measure of relative vulnerability in Figure 2.4. Those states closest to the top left-hand corner of the graph show highest relative vulnerability.

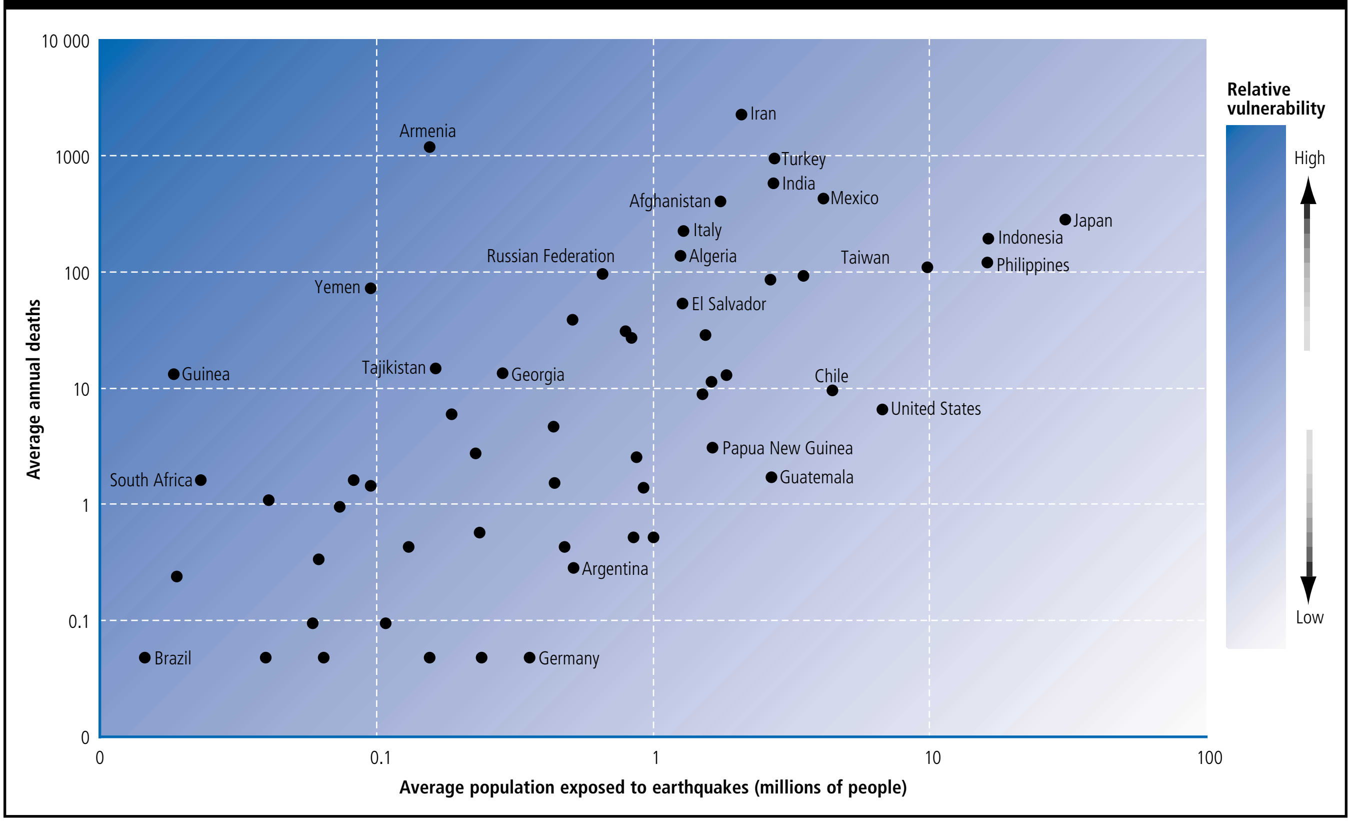
The graph represents relative earthquake vulnerability between 1980 and 2000 only. Armenia stands out as being particularly vulnerable to earthquakes due to a single major catastrophic event that occurred during the reporting period. Similarly, earthquakes are rare in Guinea, however a significant event occurred in the reporting period. In contrast, Guatemala appears far less vulnerable because the catastrophic earthquake of

FIGURE 2.3 PHYSICAL EXPOSURE TO EARTHQUAKES, 1980–2000



Source: UNDP/BCPR; UNEP/GRID-Geneva

FIGURE 2.4 RELATIVE VULNERABILITY FOR EARTHQUAKES, 1980–2000

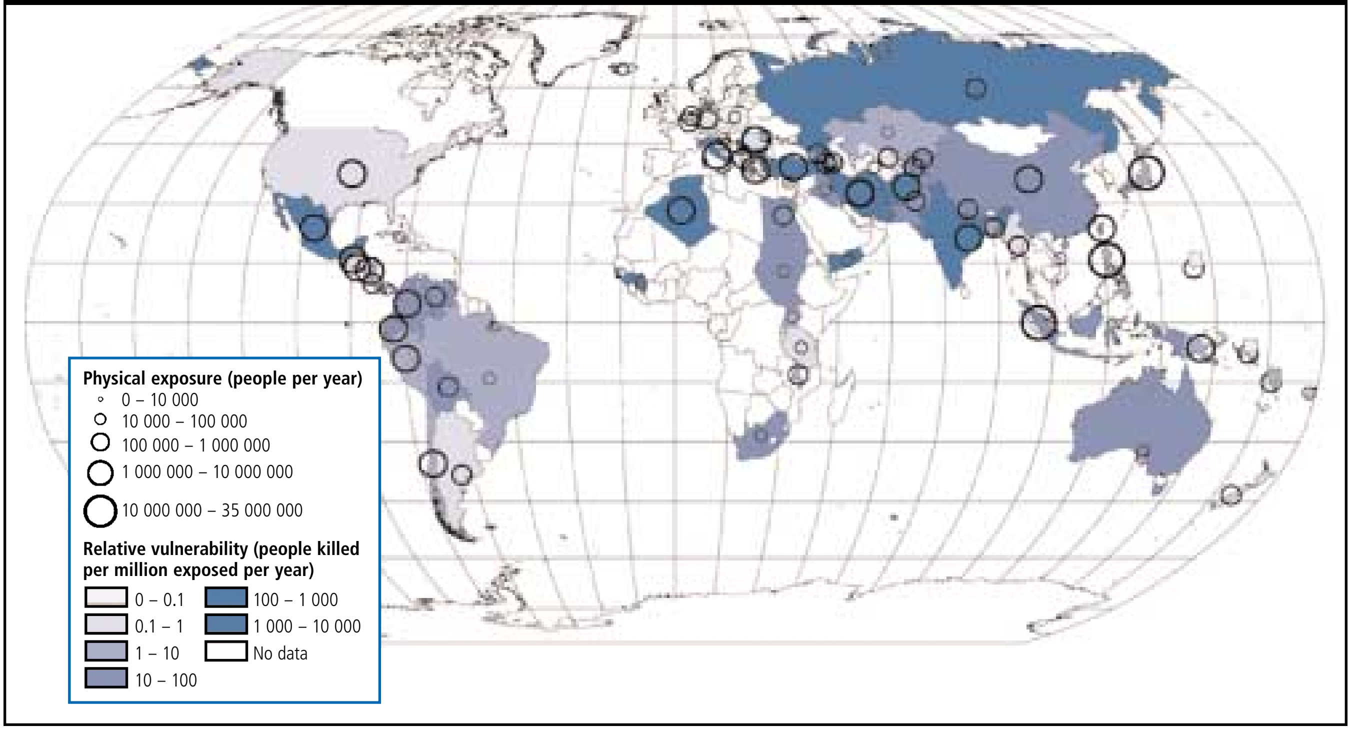


Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

1976 occurred outside of the reporting period. China and Peru are other countries that experienced very high mortality in catastrophic earthquakes during the 1970s and therefore outside of the reporting period. The analysis, however, does show countries, such as the Islamic Republic of Iran, Afghanistan and India, which do experience frequent earthquakes suffering proportionally far higher loss of life than others, such as Chile or the United States of America.

The tight fit of countries in Figure 2.4 along an axis from the bottom left to the top right-hand corner indicates intuitively a strong correlation between the number of deaths and physical exposure. In other words,

FIGURE 2.5 PHYSICAL EXPOSURE AND RELATIVE VULNERABILITY TO EARTHQUAKES, 1980–2000



Source: Université Catholique de Louvain: The EM-DAT The OFDA/CRED International Disaster Database (victims); Council of the National Seismic System (CNSS): Earthquake Catalog (earthquakes extent); CIESIN, IFPRI, WRI: Gridded Population of the World (GPW), Version 2 (population); Compilation and computation by UNEP/GRID-Geneva

the more people living in areas exposed to earthquake events, the higher the risk of death.

Regression analysis of vulnerability indicators showed that statistically, physical exposure and the rate of urban growth acted together in being associated with the risk of death to earthquake. In other words, the risk of dying in an earthquake was greater in countries with rapid urban growth.

Urban growth does not *explain* human vulnerability to earthquakes *per se*. Rather it is particular processes and factors of urban change that characterise rapidly urbanising countries that increase human vulnerability to earthquakes. These processes and factors will vary considerably from context to context. The earthquake disasters of Turkey in 1999 and Algeria in 2003 highlighted the lack of enforcement of building regulations as a key factor in generating physical vulnerability (see Box 3.1). A study of earthquake vulnerability in Lima, Peru showed that a process of deterioration and overcrowding of inner city rental housing was the key process associated with urban growth that was generating earthquake vulnerability.[3] In the 2001 Gujarat earthquake in India, it was non-earthquake resistant structures in both rural and urban housing that proved to be a key vulnerability factor. In urban areas, the high density of dwellings increased fatalities.[4]

The fact that some countries with high urban growth rates have low relative vulnerability means that it is impossible to generalise. However, common to all the examples above is the fact that in many rapidly growing cities, earthquake risk considerations have not been factored into the building and planning process. In general, city governments have not been capable of regulating either building or settlement in a way that reduces risks. This is a key issue that will be explored in greater depth in Chapter 3.

A final representation of earthquake risk is shown in the World Map in Figure 2.5. Again, urban countries appear most at risk. (See the Appendix for data on individual countries.)

2.2.2 Tropical cyclone hazard

The term tropical cyclone used in this report includes tropical storms, hurricanes (alternatively termed typhoons, tropical cyclones or severe cyclonic storms), and super typhoons. Up to 119 million people were found to be exposed on average every year to tropical cyclone hazard and some people experienced an average of more than four events every year. As a result, a total of 251,384 deaths have been associated with tropical cyclones worldwide, 1980-2000 (Figure 2.6). Bangladesh accounts for more than 60 percent of the registered deaths in this period while the Philippines show the highest frequency of tropical cyclones with reported deaths.

Hazard zones for tropical cyclones were based on data from the Carbon Dioxide Information Analysis (CDIAC) of the US government.

A total of 84 countries distributed over the tropics presented different levels of physical exposure to tropical cyclones (Figure 2.7). Those countries with the largest exposed populations have highly populated coastal areas and especially densely populated deltas (China, India, the Philippines, Japan, Bangladesh). Expressing exposure as a proportion of national population flagged island states and territories (Guam, the British Virgin Islands, Vanuatu, Mauritius) and the Philippines (a collection of islands).

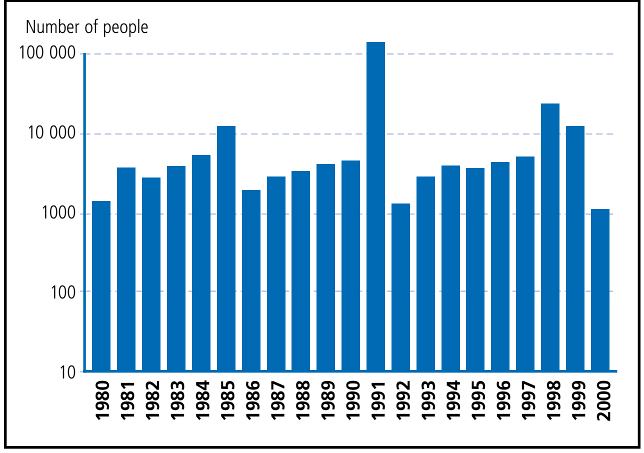
Comparing the size of exposed populations with the number of recorded deaths to tropical cyclones is used as a measure of relative vulnerability to tropical cyclone death in Figure 2.8. Those states closest to the top left-hand corner of the graph show highest relative vulnerability.

A very large proportion of the population of Bangladesh is exposed to tropical cyclones, particularly the heavily populated rural communities along the fertile delta at the confined head of the Bay of Bengal. The large number of recorded deaths shows that in this case high vulnerability accompanies high physical exposure.

Honduras and Nicaragua, while not among the countries with the highest physical exposure, appear as the most vulnerable countries in the period 1980-2000. This reflects the extraordinary magnitude and duration and the devastating human impact of Hurricane Mitch, which occurred in 1998.

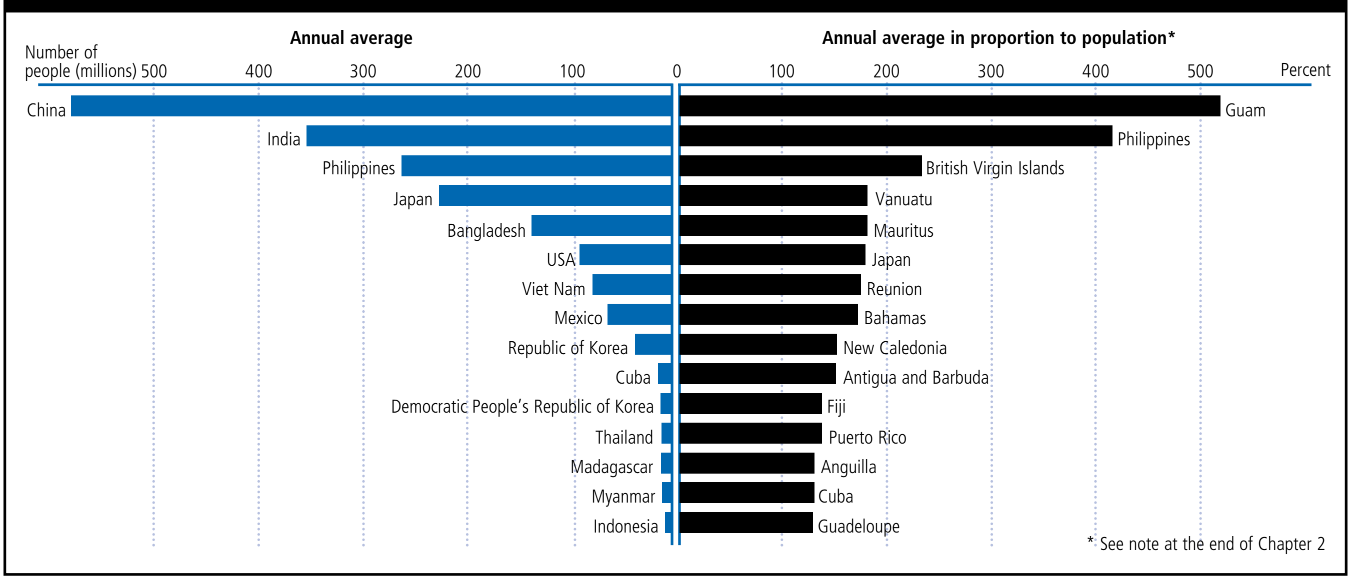
The complexity of the hazard events associated with tropical cyclones illustrates another of the limitations of the DRI model mentioned in section 2.1.2. Much

FIGURE 2.6 PEOPLE KILLED BY TROPICAL CYCLONES, 1980-2000



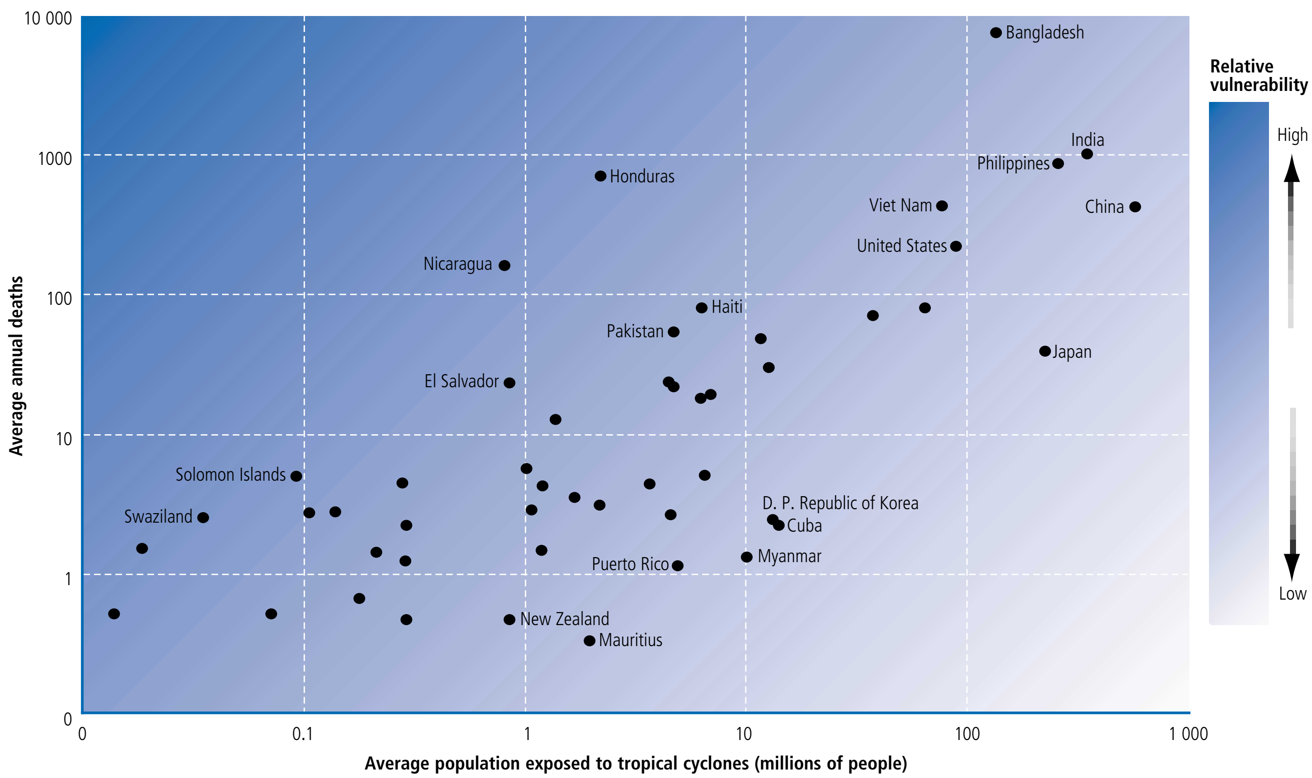
Source: The EM-DAT OFDA/CRED International Disaster Database

FIGURE 2.7 PHYSICAL EXPOSURE TO TROPICAL CYCLONES, 1980–2000



Source: UNDP/BCPR; UNEP/GRID-Geneva

FIGURE 2.8 RELATIVE VULNERABILITY FOR TROPICAL CYCLONES, 1980–2000

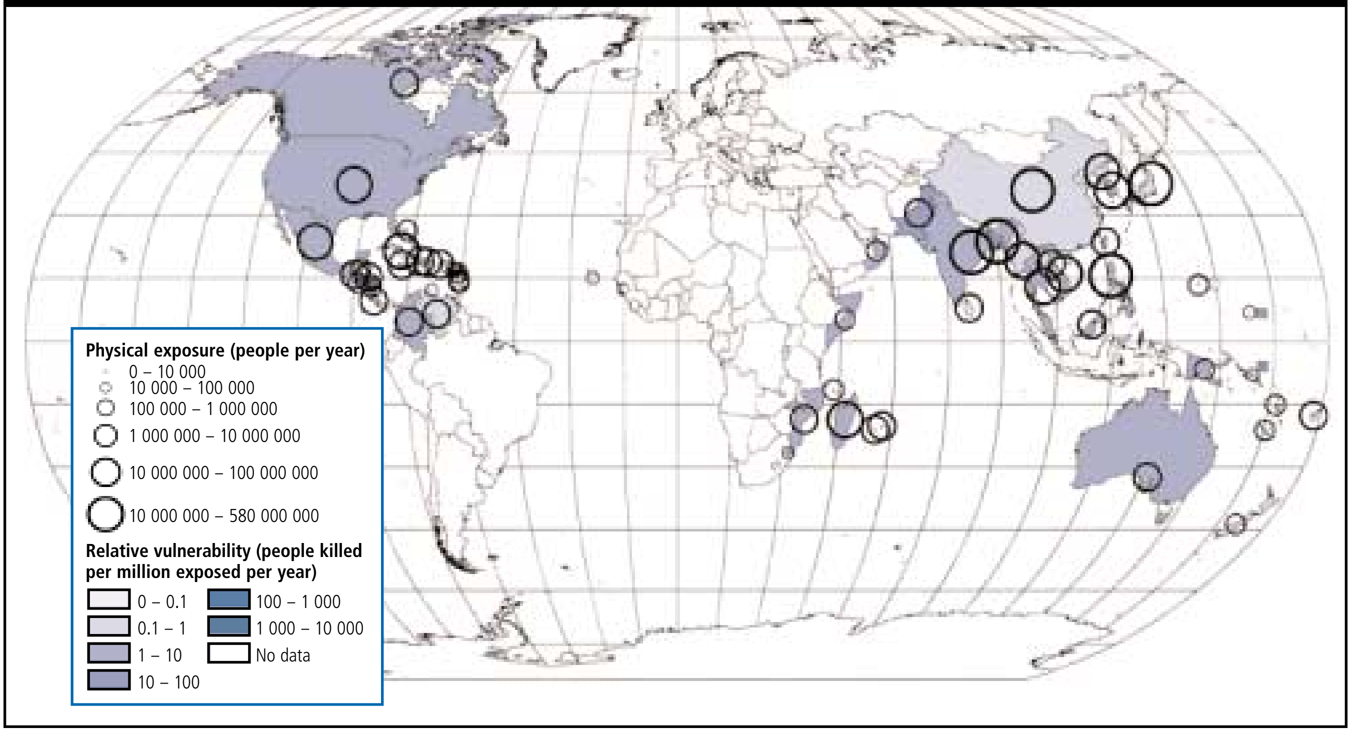


Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

FIGURE 2.9 RELATIVE VULNERABILITY FOR TROPICAL CYCLONES IN SMALL ISLANDS, 1980–2000

Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

FIGURE 2.10 PHYSICAL EXPOSURE AND RELATIVE VULNERABILITY TO TROPICAL CYCLONES, 1980–2000



Source: Université Catholique de Louvain: The EM-DAT The OFDA/CRED International Disaster Database (victims); Carbon Dioxyde Information Analysis Centre: A Global Geographic Information System Data Base of Storm Occurence and Other Climatic Phenomena Affecting Coastal Zones (tropical cyclone frequency); CIESIN, IFPRI, WRI: Gridded Population of the World (GPW), Version 2 (population); Compilation and computation by UNEP/GRID-Geneva

of the impact of Hurricane Mitch in Honduras and Nicaragua was not due to hurricane force winds *per se*, but to the large number of floods, flash floods, landslides and debris flows triggered by the hurricane. The severity of these secondary hazard events was magnified by the effects of processes of environmental degradation that occurred over several decades. These were possibly aggravated in turn by the drought and fires associated with an ENSO (El Niño Southern Oscillation) event the previous year. All these hazard events coincided with a highly vulnerable population in both social and economic terms and weaknesses in early warning and disaster preparedness that led to large losses of life.

Figure 2.9 shows differences in relative vulnerability between Small Island Development States. Haiti is shown to have the highest relative vulnerability, perhaps linked to its small economy, degraded environment and weak institutions of governance. Cuba and Mauritius are the least vulnerable, despite both islands having relatively large proportions of their populations exposed to tropical cyclones. In both cases, though from contrasting political and policy orientations, resources have been made available for early warning, disaster preparedness and evacuation. The positive results are evident.

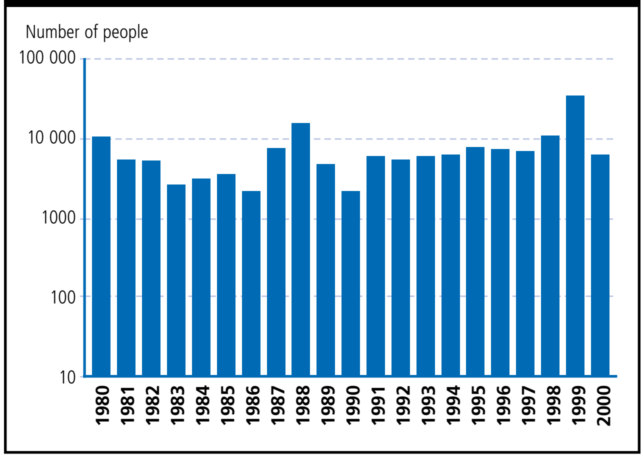
Figure 2.9 also clearly illustrates the influence of human development status on risk. Haiti — the island state most at risk — has low human development, again contrasting with the higher human development countries of Cuba and Mauritius. This does not point to policy implications in itself, but does highlight the close link between development and disaster risk.

The regression analysis carried out for tropical cyclone risk showed a strong correlation between *physical exposure, percentage of arable land* and *Human Development Index* with observed risk. Countries with large, predominantly rural populations and with a low HDI rank will be most closely associated with tropical cyclone risk.

There are a number of reasons why this may be so. Rural housing in many countries will tend to be more vulnerable to high winds, flooding and landslides than urban housing and will generally be associated with higher mortality. Conversely, the weakness or non-existence of emergency and rescue services in rural areas of poor countries and lack of access to disaster preparedness and early warning are all other factors that would help to explain mortality rates. The cyclone preparedness programme in Bangladesh is one of the few success stories in this area. By coupling cyclone shelters and community-based preparedness measures, the programme has managed to dramatically reduce vulnerability from the 1970s to the (still high) levels observed in the 1980-2000 reporting period. The relationship between rural livelihoods, vulnerability and disaster risk is a key issue for further discussion in Chapter 3.

Figure 2.10 (see previous page) shows a World Map of physical exposure and relative vulnerability for tropical cyclones.

FIGURE 2.11 PEOPLE KILLED BY FLOODS, 1980-2000



Source: The EM-DAT OFDA/CRED International Disaster Database

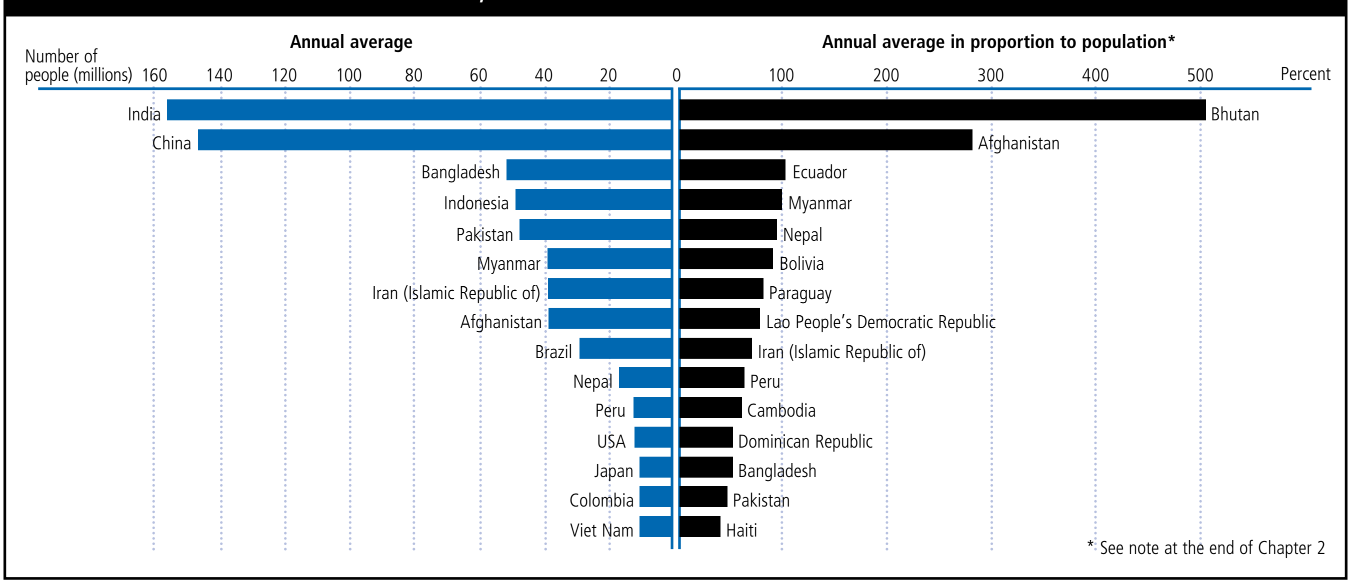
2.2.3 Flood hazard

About 196 million people in more than 90 countries were found to be exposed on average every year to catastrophic flooding. Some 170,010 deaths were associated with floods worldwide between 1980-2000 (see Figure 2.11).

The analysis of physical exposure to floods was weakened by the fact that no single global database was available. In addition, lack of information on duration and intensity of floods impeded the identification of different classes of flood hazard. In the absence of a worldwide floods database, floods registered on the EM-DAT database were used and mapped onto those watersheds where the flood occurred. The entire watershed was mapped as a flood prone area, despite the fact that only a small area of the watershed was usually flooded. This means the number of people identified as being exposed to flooding in the DRI (Figure 2.12) is likely to be greater than numbers observed on the ground. As a consequence, losses calculated as a proportion of exposed populations (Figure 2.13) may appear smaller and the relative vulnerability lower than observed.

The geospatial analysis carried out for the calculation of human exposure identified 147 countries with populations exposed to floods. Figure 2.12 shows those states with the largest exposed populations. Populous South Asian countries (India, Bangladesh, Pakistan) and China figure strongly at the top of the list, as absolute population and population exposed as

FIGURE 2.12 PHYSICAL EXPOSURE TO FLOODS, 1980–2000



Source: UNDP/BCPR; UNEP/GRID-Geneva

a proportion of national populations. This is tied to the large populations living in extensive river floodplains and low lying coasts in this world region. Less populous states with mountainous topography (Bhutan, Ecuador, Nepal), and Central American and Andean states are also flagged among those states as having large absolute and proportional populations exposed to flooding. While these countries are more mountainous than those in South Asia, they nevertheless contain many population centres located in river floodplains.

Comparing the size of exposed populations with the number of recorded deaths to flood events is used as a measure of relative vulnerability in Figure 2.13. Those states closest to the top left-hand corner of the graph show highest relative vulnerability.

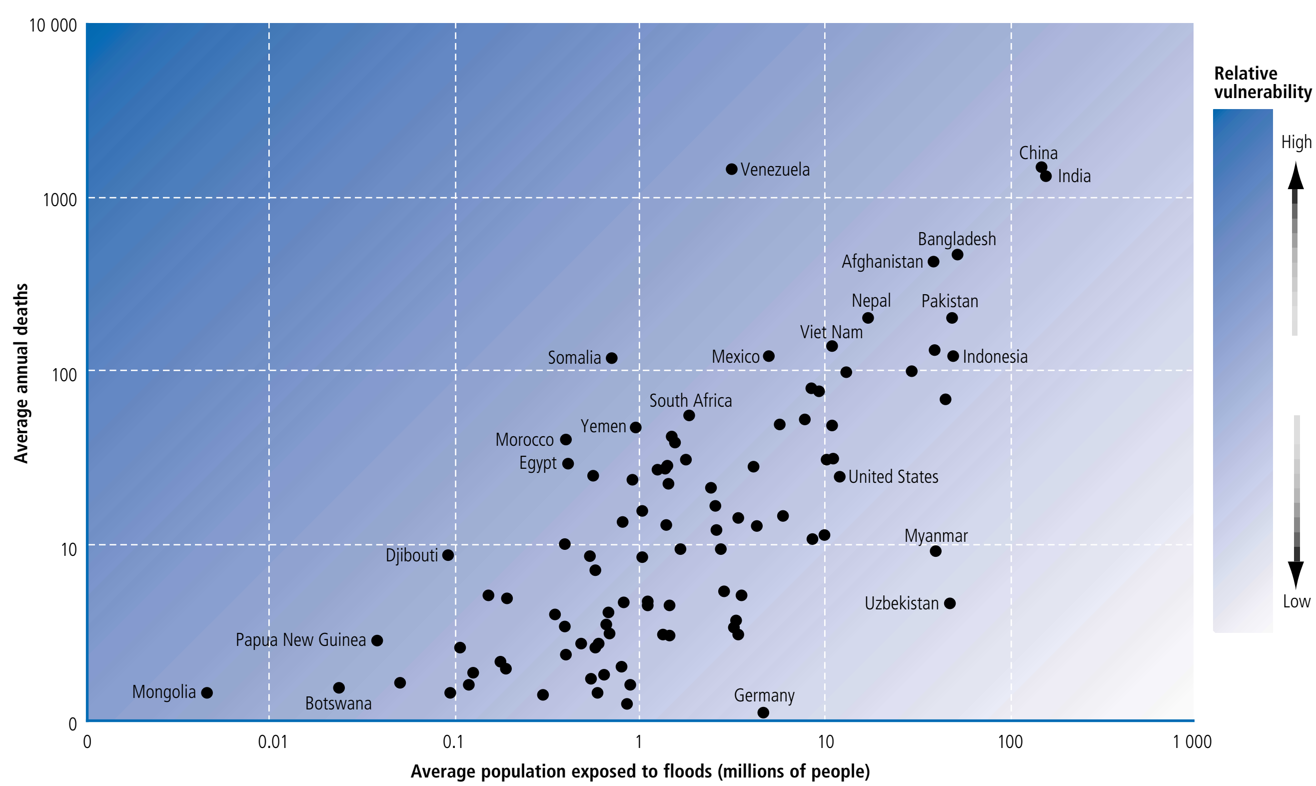
As in the case of earthquake and tropical cyclone hazard, the calculation of human vulnerability to floods clearly illustrates some of the limitations to the DRI model that were outlined in 2.1.2.

Venezuela appears to be the country with highest relative human vulnerability to flooding, based on recorded lives lost to flood events. Again this is due to a single exceptional event occurring in 1999. At the same time, while the event was described generically as a flood in the EM-DAT database, a large proportion of the deaths were associated with debris flows in dense urban communities not located in floodplains.

At the same time, given the fact that whole watersheds were considered when calculating the population exposed, the ratio of killed-to-exposed people (relative vulnerability) does not have the same analytical power that it has for the other hazards, although this does not affect the DRI itself. Floods are made to appear less deadly than in reality. This may explain the positioning of Myanmar and Uzbekistan as countries with apparently low relative vulnerability. Care should be taken in drawing conclusions from this analysis, as it may be that exposed populations are exaggerated or deaths have not been picked up in the recording process.

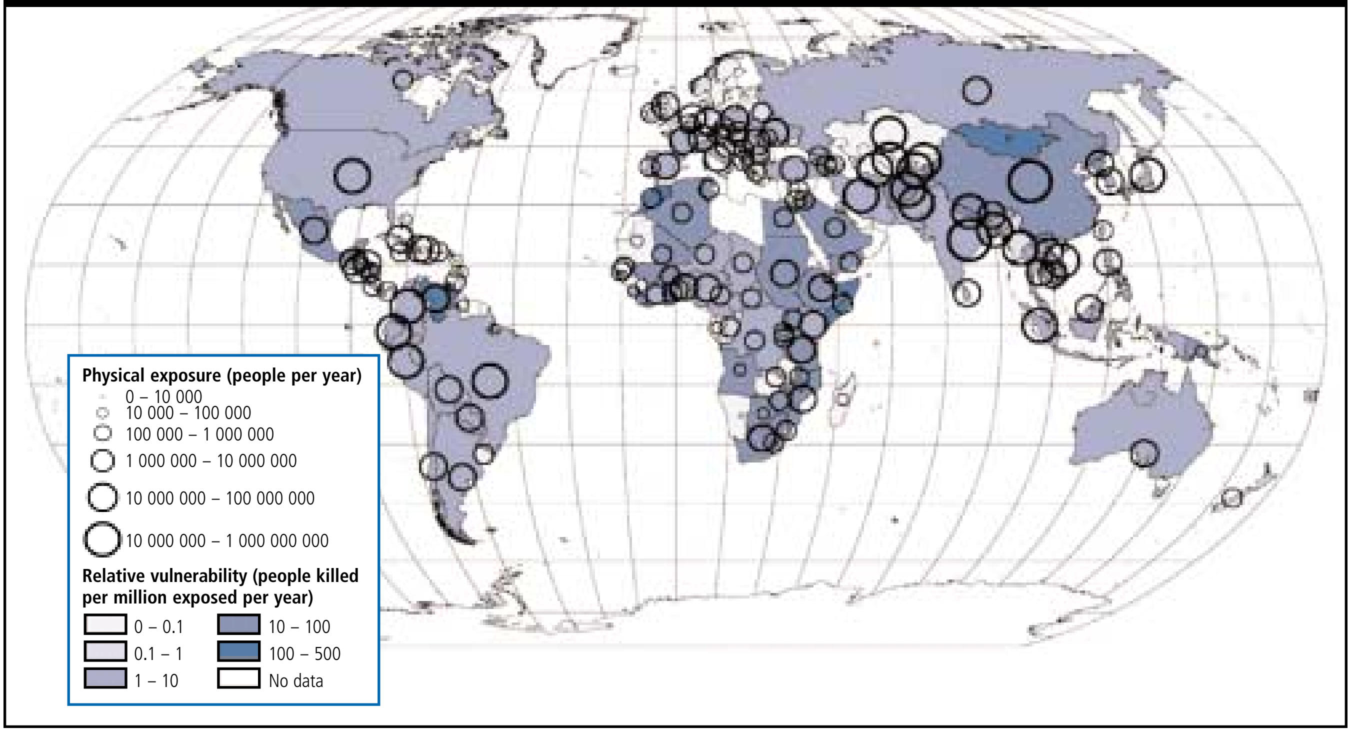
Many flood events are highly localised in character and result in losses that are either below the threshold required to be registered in EM-DAT database or are simply not recorded internationally.

FIGURE 2.13 RELATIVE VULNERABILITY FOR FLOODS, 1980–2000



Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

FIGURE 2.14 PHYSICAL EXPOSURE AND RELATIVE VULNERABILITY TO FLOODS, 1980–2000



Source: Université Catholique de Louvain: The EM-DAT The OFDA/CRED International Disaster Database (victims); U. S. Geological Survey: HYDRO1k Elevation Derivative Database (flood affected watersheds); CIESIN, IFPRI, WRI: Gridded Population of the World (GPW), Version 2 (population); Compilation and computation by UNEP/GRID-Geneva

The use of mortality as an indicator of vulnerability to floods could be supported by case specific information on losses to agricultural production, to housing and to social and economic infrastructure, which might be incurred without necessarily causing a large loss of life.

Taking into account and clarifying these different limitations, Figure 2.13 does show a range of countries, particularly in Africa and Asia, with higher human vulnerability to floods than countries such as Germany and the United States of America.

As in the cases of earthquakes and cyclones, there was a strong association with *physical exposure.* With floods this variable was tied to GDP *per capita,* which was inversely correlated with recorded deaths. There was a negative correlation between deaths from flooding and *local density of population*

Countries with low GDP per capita, low densities of population and high numbers of exposed people were most at risk from flood.

These indicators identify pathways into vulnerability to floods. The next stage of assessment would be to explore the detailed relationships that allow this to take place. This is partly the aim of Chapter 3.

Intuitively, one could expect mortality from floods to be high in countries with sparsely populated, poor rural areas, where disaster preparedness and early warning is non-existent and where health coverage is weak and not easily accessible. In such areas people would have less possibility to evacuate from flood prone areas and would be more vulnerable to death through flood related diseases.

Figure 2.14 presents a map of physical exposure and relative vulnerability to floods.

2.3 Unpacking Global Risks

In the first section of this chapter, the DRI was used to demonstrate the ways in which development constructs differential and heterogeneous risk patterns between countries at the global level. At a national level of observation and a local level of resolution, risk and vulnerability exhibit similar patterns of variance and heterogeneity, meaning that different regions and localities within a country are more risk-prone than others.

As was emphasised in Chapter 1 and will be explored in more detail in Chapter 3, risk is configured historically

BOX 2.2 NATIONAL DISASTER DATABASES

This box presents three initiatives for national level data collection.

The Latin America DesInventar

This methodology was initiated by the Network for Social Studies on Disaster Prevention in Latin America (LA RED) in 1994. It seeks to record all discrete events that have resulted in adverse effects on life, property and infrastructure triggered by natural and man-made phenomena and geo-referenced to the smallest available political-administrative unit in a given country — usually the District or Municipality. By collecting disaggregated data, DesInventar enables the recording of individual localised small-scale disasters as well as the impacts of large-scale hazard events at the local level.

National level DesInventar disaster databases, with up to 30 years of data, have been developed to date in 17 countries in the Americas. These are Argentina, Chile, Peru, Ecuador, Venezuela, Colombia, Panama, Costa Rica, Nicaragua, Honduras, El Salvador, Guatemala, Mexico, Dominican Republic, Trinidad and Tobago, Jamaica and Guyana. Sub-national databases have been developed for the Departments of Antioquia and Valle del Cauca and for the city of Pereira in Colombia and for the State of Florida in the USA.

Local disasters with very limited direct impacts are included (e.g. the destruction of one house or a household affected by the loss of their harvest as a result of a frost), as well as those with more widespread impacts (e.g. earthquakes affecting metropolitan districts). These databases have been developed by national governments, international organisations, universities, scientific organisations and Non Governmental Organisations (NGOs). Data is obtained from the media and government agencies and existing databases. Once collected, data is verified nationally for consistency. Shared definitions are used for some key hazards, while for others local specificity is more important. The challenge of uniformity between the databases remains, limiting the capacity for international comparisons.

The Orissa Experience

In 2002, UNDP set about producing a database including an inventory of disaster events with a natural trigger for Orissa. The aim of the project was to develop a tool to help decision-makers prioritise expenditure in an objective manner. Orissa is to act as a pilot with the next stage, including replication in an additional four Indian states and integration into a national Government of India Integrated Disaster Resource Network. The methodology was modified from the experience of the Latin America DesInventar.

News media and government sources of information are used to build up the disaster events database. A historical database going back to 1970 has been collated and is updated weekly. Before data is entered, it has to be cleaned to enable a comparable analysis. For example, when a source measures disaster impacts in the number of families, this is recorded in the database as 'people impacted' by including six people for every family. Events are standardised so that similar events like cyclones and hurricanes are classified as cyclones, with whirlwind and tornado being recorded as gales. A new event 'boat capsize' was created.

Different data sources were given different data categories to enable reviews on structural differences in the reporting format used by the press (where there is much variation between individual reporting styles and events) and government sources (which are very comprehensive but formally structured). A particular constraint has been the unequal coverage of Orissa by data sources. The media, for example, does not cover Western Orissa as thoroughly as Coastal Orisa.

MANDISA: South Africa

The programme for Monitoring, Mapping and Analysis of Disaster Incidents in South Africa (MANDISA) is a core activity for the Disaster Mitigation for Sustainable Livelihoods Programme of the University of Cape Town (DiMP). MANDISA was initiated as a pilot study in the CMA (Cape Town Metropolitan Area) in the Western Province of South Africa from 1990-1999. The methodology was inspired by DesInventar, but has been adapted for the South African context.

MANDISA focuses on South African-relevant losses including large urban 'non-drainage' floods, wildfires and extreme wind events, as well as highly frequent 'small' and 'medium' fires. Socio-economic and environmental risk factors that affect disaster impact are included where possible, allowing the potential for tracking the developmental conditions that prefigure disaster. While newspapers formed one source of information for tracking disaster events, the South African experience indicated that these provided limited insight into the highly recurrent 'small' events that occur in informal settlements reflecting only 649 of the 12,300 total incidents tracked through a thorough review of twelve different data sources, including incident reports from Fire Services, Social Services, the South African Red Cross Society and Disaster Management agencies.

MANDISA is viewed as an approach rather than a disaster tracking IT tool. This requires multi-agency cooperation, consultation and feedback, active sourcing of emergency and disaster information, strategic consolidation of information across agencies and robust geo-referencing. MANDISA is an internet-accessible database. This is intended to encourage local ownership as well as provide on-line information for schools, researchers, planners and disaster management personnel.

Source: Latin America DesInventar: http://www.desinventar.org/desinventar.html; Orissa: http://www.undp.org.in/orissa/; Mandisa: http://www.egs.uct.ac.za/dimp/

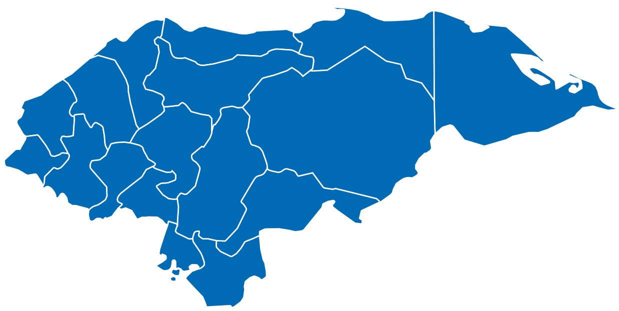
through the linked processes of economic development and environmental change, such as urbanisation and global climate change. Each risk scenario at the local level represents a unique configuration of hazards and vulnerabilities in the context of broader processes of development at the national and global levels. But ultimately, vulnerability and risk are manifested at the local level.

It is hoped and expected that the DRI is useful to illustrate global level risk and vulnerability patterns and to advocate for development policies and practices that contribute to disaster risk reduction.

However, for this sea change in development culture to take root, national governments have to adopt appropriate development policies in the context of the more detailed and complex patterns of risk and vulnerability that exist within each country.

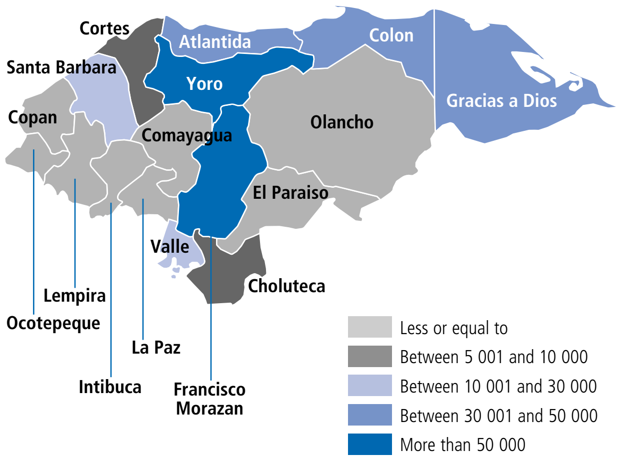
In this section of the Report, we will illustrate some of the complexities of risk at the sub-national level through a number of examples.

FIGURE 2.15 NUMBER OF HOUSES DESTROYED BY HURRICANE MITCH IN HONDURAS (GLOBAL OBSERVATION AND NATIONAL RESOLUTION)



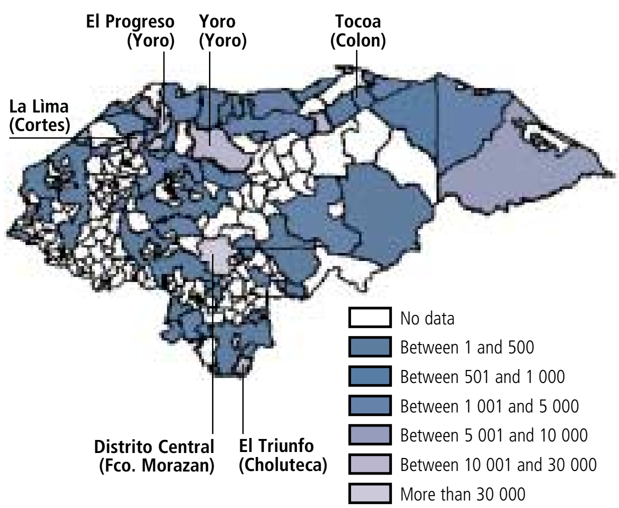
Source:COPECO-La Red, DesInventar-Mitch[5]

FIGURE 2.16 NUMBER OF HOUSES DESTROYED BY HURRICANE MITCH IN HONDURAS (NATIONAL OBSERVATION AND DEPARTMENTAL RESOLUTION)



Source:COPECO-La Red, DesInventar-Mitch[5]

FIGURE 2.17 NUMBER OF HOUSES DESTROYED BY HURRICANE MITCH IN HONDURAS (NATIONAL OBSERVATION AND MUNICIPAL RESOLUTION)



Source:COPECO-La Red, DesInventar-Mitch[5]

2.3.1 Risk patterns at the national and local levels

The DRI has been developed with a global level of observation and a national level of resolution. It allows the analysis of comparative risk levels between countries. This perspective can be complimented by viewing risk from a national level of observation and a local scale of resolution. When this is done, complex local risk patterns become apparent that are hidden at the global level.

National disasters are composed of multiple local disasters

Examined at the national level, large-scale disasters have a complex and heterogeneous impact on both territory and social groups. In this case, large-scale, national disasters may appear represented as a large number of small-scale disasters associated with a particular hazardous event. Box 2.3 explores this issue further with data from Hurricane Mitch in Honduras. The data was collected using the Latin America DesInventar methodology (See Box 2.2 on the previous page) by the National Commission for Contingencies (COPECO) of the Government of Honduras. In this case, what appears from the global level as a single, national scale disaster, takes on completely different characteristics seen with a national level of observation and a local level of resolution. This *bottom up* vision of the impact of Hurricane Mitch in Honduras clearly illustrates that risk and vulnerability patterns are locally configured.

BOX 2.3 MITCH: ONE DISASTER OR MANY?

The nested quality of disaster, where large-scale events identified at the global scale can also be interpreted as a collection of localised and small- or medium-scale events, is illustrated by the experience of Hurricane Mitch in Honduras, 1998.

Figure 2.15 represents a vision of Mitch from a global level of observation and a national level of resolution. Simply, a large number of houses were destroyed by the hurricane at the national level. Figure 2.16 moves to a national level of observation and a departmental level of resolution. At this level of resolution, widely differing impacts can already be observed between different departments. While a large number of departments had less than 5,000 houses destroyed, two departments had more than 50,000 houses destroyed. In Figure 2.17, the resolution is increased to the municipal level revealing yet another pattern of impact. While two municipalities suffered more than 30,000 destroyed houses (El Progreso in the Sula Valley and the central district of Tegucigalpa), a large number of municipalities in the country did not report destroyed houses at all.

Source:COPECO-La Red, DesInventar-Mitch[5]

BOX 2.4 TRACKING RISK THROUGH TIME HIGHLIGHTS THE IMPORTANCE OF CONTEXT AND CULTURE

The Orissa database points to epidemics as the greatest cause of deaths and fire as the greatest cause of property destruction in the state (see Figures 2.18 and 2.19). It is possible that epidemics will follow floods and cyclones so that the picture is a little more complicated than it might first appear. However, the recording of high death counts as losses to epidemics, does show the importance of indirect losses, compared to direct losses recorded from drowning or injury from a flood or cyclone. Epidemics following floods or cyclones and house fires are preventable. Their occurrence indicates high human vulnerability and a lack of adequate planning.

From the Orissa database it became evident that despite an underlying increasing trend in the number of reported fire events for the state, damage to property due to fire was declining (Figure 2.20). It is thought that this is because of increasing urbanisation, which marks a change from traditional and flammable construction materials towards a preference for houses constructed from concrete.

Some preliminary data also suggest a higher level of risk in some highly populated coastal areas. The concentration of people and risk into a small number of coastal districts shows the importance of sub-national studies for building up accurate pictures of risk that are hidden at the national or regional level.

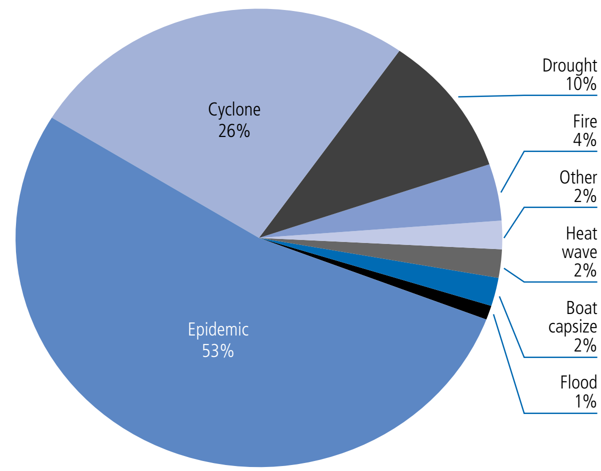
Source: UNDP India, preliminary results of Orissa DesInventar database

Each municipality in Honduras represented a particular configuration of hazards and vulnerabilities with respect to the housing sector, irrespective of the fact that the natural phenomenon itself (Hurricane Mitch) affected more or less the entire territory of Honduras. In other words, the disasters were associated with Mitch, but were related to a particular range of localised hazards and vulnerabilities, configured in the context of broader development processes at the global and national level.

Apart from the large-scale and medium-scale disasters that are represented in the DRI, the underlying local conditions of risk, hazard and vulnerability are manifested as frequently recurring small- and medium-scale disasters that are either individually too small to be included in global datasets, or else are not reported internationally.

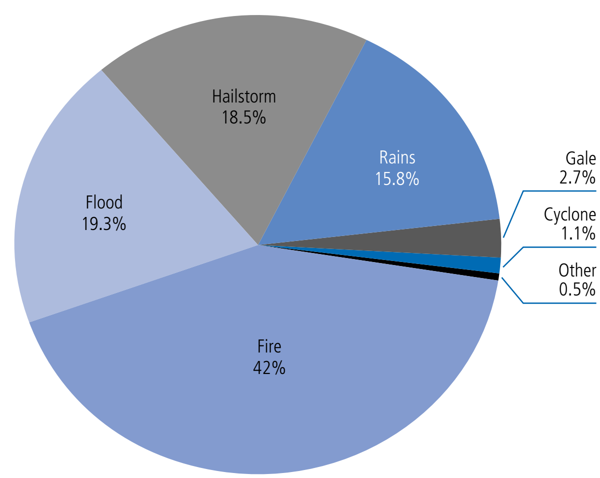
Such events represent a significant proportion of disaster loss in countries such as Panama, which is only rarely affected by major hurricanes and earthquakes. In Panama, the official national disaster database maintained by the National System for Civil Protection recorded 904 disaster events between 1996 and 2001.[6] These 904 events are associated with only 46 deaths, but involved considerable damage to livelihoods.

FIGURE 2.18 NUMBER OF DEATHS REPORTED DUE TO DIFFERENT DISASTER EVENTS IN ORISSA, 1970–2002



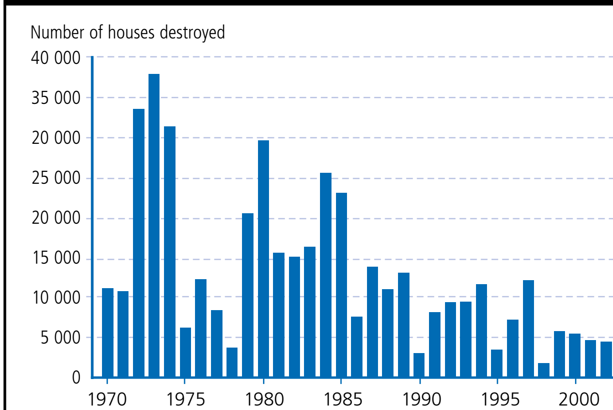
Source: UNDP India, preliminary results of Orissa DesInventar database

FIGURE 2.19 NUMBER OF HOUSES DESTROYED DUE TO DIFFERENT DISASTER EVENTS IN ORISSA, 1970–2002



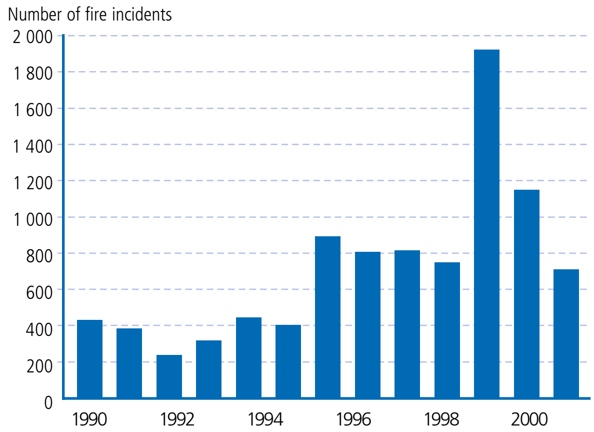
Source: UNDP India, preliminary results of Orissa DesInventar database

FIGURE 2.20 NUMBER OF HOUSES DESTROYED BY FIRE IN ORISSA, 1970–2002



Source: UNDP India, preliminary results of Orissa DesInventar database

FIGURE 2.21 NUMBER OF FIRE INCIDENTS FOR CAPE TOWN MUNICIPALITY, 1990 – 2002



Source: MANDISA Project

For example, 40,531 hectares of crops were lost in these disasters. In the case of small landowners and subsistence farmers without insurance, the loss of a few hectares of crops can represent a catastrophic blow to livelihood sustainability.

Opening the DRI analysis to data feeding in from sub-national databases would introduce a broader spectrum of hazard types. As was mentioned in the section on the DRI, the losses associated with *primary* hazards, such as earthquakes, cyclones and floods, seen at the local level are linked to other secondary hazards events, including fires, landslides and liquefaction.

An examination of disaster losses in the Orissa DesInventar shows that more houses have been destroyed by fire and more deaths are lost in epidemics than through cyclones.

Locally specific data can show the interaction of risk from an array of natural and anthropogenic hazards

Locally specific data can help refine disaster risk reduction policy. The links between disease epidemics and disaster events, particularly floods and tropical cyclones, has long been a focus for research. The dynamics between disaster and disease continue to require a strengthening of our understanding. The importance of fires at the local level and in urban areas points to the need for further work on the relative importance of multiple hazards interacting with development at different levels. Deaths and injuries to road traffic accidents are likely to have a similarly significant local impact.[7]

House fires were not considered in the global DRI, which is oriented towards natural hazards. But this form of anthropogenic hazard is clearly important at the local level. This points to the opportunity for understanding risk processes that could come from exploring the links between development processes and risk to local anthropogenic hazards and larger scale natural hazards. How does exposure to small local events affect individual and collective vulnerability to large-scale hazards and vice versa? What are the implications for local development planning and risk reduction?

Providing a local lens allows for the large number of small events to be catalogued, re-shaping perceptions on risk as a priority concern for development policy. In the MANDISA project, it was originally anticipated, based on expert opinion, that the database would identify about 600 events for the period 1990-1999 in Cape Town, South Africa. In the end, 12,300 events were logged. Preliminary analyses from 1990-1999 have indicated that of the 12,300 incidents, 97 percent were fire-related. The most vulnerable houses were those in the informal housing sector. In an analysis of fire in the poor suburb of Gugulethu from 1990-1999, fires in the informal housing sector constituted 88.5 percent, with only 11.5 percent in the formal housing sector.

2.4 Future Directions in Natural Disaster Risk Modelling

In this section of the Report, two exercises are presented that were undertaken within the DRI. Each pushes against the barriers imposed by data availability. The exploratory nature of these exercises limits the conclusions that can be drawn. But the processes involved are themselves illuminating, they point towards future directions in natural disaster risk modelling.

2.4.1 Can drought risk be modelled?

Compared to the development of the DRI for earthquake, tropical cyclone and flood, modelling drought risk presented a series of additional challenges, which were only partly overcome. These include:

The difficulties in modelling drought hazard *per se.* A model of meteorological drought was used, but meteorological drought does not necessarily lead to agricultural or hydrological drought.

Compared to the other hazard types, deaths are a limited representation of manifest drought risk. Severe livelihood attrition may occur with only few recorded deaths, as was the case in Southern Africa in 2002. It is possible that many of the deaths labelled as drought disasters in the EM DAT database are due to other factors such as armed conflict.

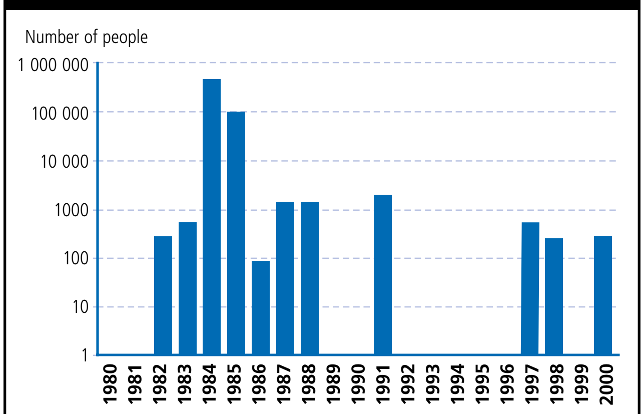
Given these uncertainties regarding both the hazard model as well as the use of deaths as a risk indicator, the results should be considered only as illustrative.

To explore the possibilities of modelling drought, hazard data was examined using the same methods employed for earthquake, tropical cyclone and flood hazards. Methodological detail can be found in the Technical Annex, where particular challenges and some interpretation of results are offered.

A total of 832,544 deaths were associated with the occurrence of droughts worldwide, 1980-2000.[8] The drought conditions affecting sub-Saharan African countries from 1984 to 1985 were associated with the highest drought-related casualties for the period considered in the analysis. Ethiopia, Somalia and Mozambique recorded the most deaths.

Frequency and intensity were the main characteristics helping to delimit rapid onset events and only events crossing certain minimum thresholds were considered as disaster. For drought this is not the case and it is the duration of each drought that plays the most important role in characterising its hazard level. Droughts develop slowly and may last over a period of many years.

FIGURE 2.22 PEOPLE KILLED BY DROUGHT AND FAMINE, 1980–2000



Source: The EM-DAT OFDA/CRED International Disaster Database

Given the length of time over which drought can be actively interacting with development processes, isolating deaths as a result of drought events is difficult. Deaths to drought are not direct, but rather the result of a complex interaction of drought and vulnerability as embedded in the economy. The link between drought and famine, for example, is full of intervening pressures.[9]

For the period 1980-2000, twenty countries are recorded in EM-DAT as having deaths associated with drought.

BOX 2.5 DEFINING AND MAPPING GLOBAL DROUGHT HAZARD

The methodology used to map exposure to meteorological droughts was developed and provided by the International Research Institute for Climate Prediction (IRI), Columbia University. Data was obtained from the US National Centres for Environmental Prediction (NCEP) and its Climate Prediction Centre accessed through the IRI Data Library (http://iridl.ldeo.columbia.edu/).

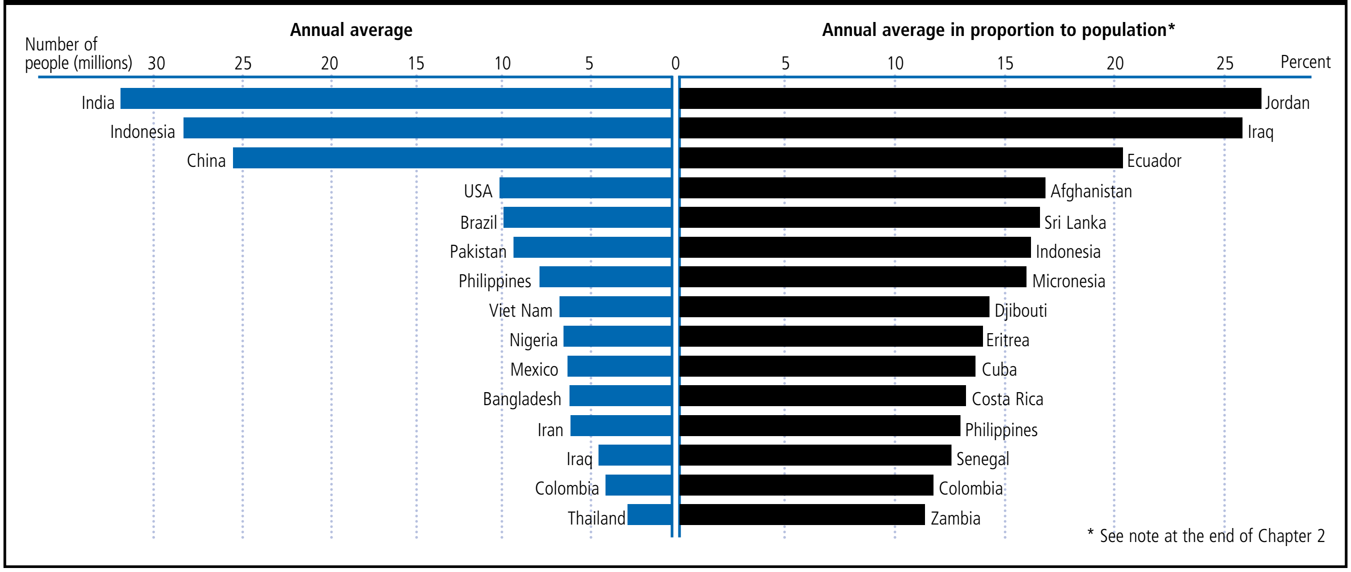
Meteorological drought was defined as a sustained period (three months or more) in which monthly precipitation at a given location is significantly below the long-term average (in this model, more than 23 years). By definition, desert regions are perpetually dry and therefore do not reflect the type of deficient precipitation we are considering. Three months of deficient precipitation in succession is generally considered the minimum duration required to define a drought. Many drought events persist for periods ranging from several months to several years.

The data used in the analysis consisted of monthly precipitation figures for the globe for the period 1979-2001. The dataset was based on a blend of surface station observations and precipitation estimates from satellite observations. Data was spatially organised in a 2.5 x 2.5 degree latitude/longitude grid.

The first step in assessing exposure to meteorological drought was to compute, for each calendar month, the median precipitation for all grid points between the latitudes of 60S and 70N over the base period 1979-2001. Next, for each grid point, the percent of the long-term median precipitation was computed for every month during the period January 1980 to December 2000. For a given month, grid points with a long-term median precipitation of less than 0.25 mm/day were excluded from the analysis. Such low median precipitation amounts can occur either during the dry season at a given location or in desert regions. In both cases our definition of drought does not apply. Finally, a drought event was defined as having occurred when the percent of median precipitation was at or below a given threshold for at least three consecutive months. The different thresholds considered were 50 percent, 75 percent and 90 percent of the long-term median precipitation with the lowest percentage indicative of the most severe drought according to this method. The total number of events during the period 1980-2000 were thus determined for each grid point and the results aggregated to country level.

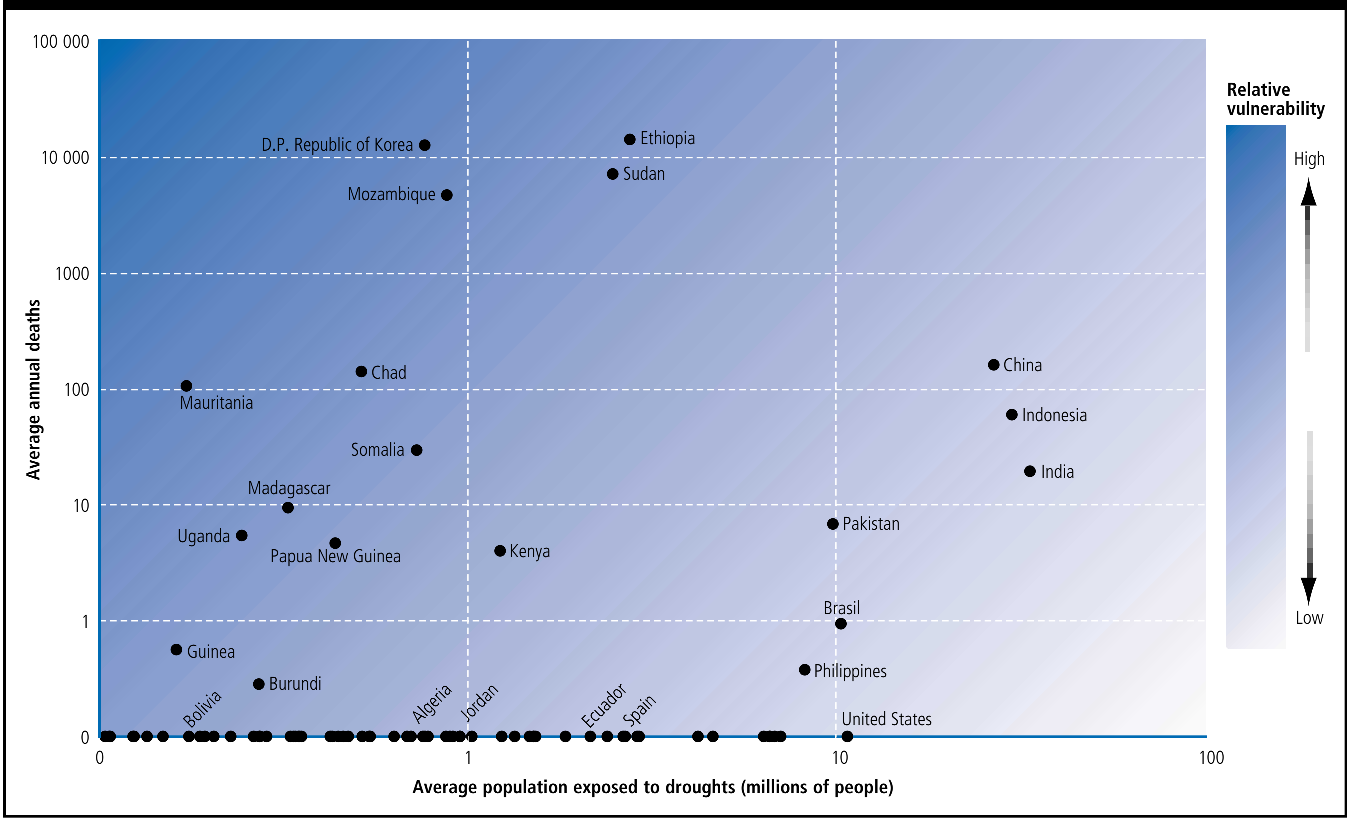
Data was from the US National Centres for Environmental Prediction (NCEP), Climate Prediction Centre (CPC), available through the IRI Data Library (http://iridl.ldeo.columbia.edu/).

FIGURE 2.23 PHYSICAL EXPOSURE TO DROUGHTS, 1980–2000



Source: UNDP/BCPR; UNEP/GRID-Geneva

FIGURE 2.24 RELATIVE VULNERABILITY FOR DROUGHTS, 1980–2000



Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

The periodic and country specific nature of drought is indicated in Figure 2.24 (see previous page), which presents annual deaths attributed to drought by EM-DAT.

A basic approach to the mapping of meteorological droughts was achieved by using a simple index that applied a threshold-criteria to identify droughts. This took account of both shortfalls in precipitation and the duration of precipitation deficits. Box 2.5 (see previous page) describes the approach. The human exposure analysis, using a threshold of a 50 percent shortfall in precipitation over a three-month period, was applied to 107 countries where data was available.

Using this approach, highly populated countries with large territories from Asia and the Americas are among those states with the largest exposed populations to meteorological droughts. When annual physical exposure is expressed per million inhabitants, less populated countries gain visibility.

Around 220 million people were found to be annually exposed to drought. An exploratory analysis of relative vulnerability was undertaken to investigate the relationship between drought (as defined as a 50 percent shortfall in rainfall over three months) and deaths attributed to drought at the international level. Figures 2.24 and 2.25 suggest that while few sub-Saharan African countries have large absolute or relative populations exposed to meteorological drought, seven of the 10 most vulnerable countries are located in sub-Saharan Africa.

Mozambique, despite being hit by flooding in 2000, presents a higher level of relative vulnerability to droughts. Ethiopia shows similar levels of vulnerability to drought and has recorded a higher number of drought-related casualties for the period of 1980-2000.

Most of the countries situated on the top left of the graphic (relatively more vulnerable) have suffered major armed conflicts[10] during the period under analysis. Ethiopia, Sudan, Mozambique, Chad, Uganda and Somalia suffered long armed conflicts for more than a decade during the period 1980-2000, often combined with other minor conflicts.[11] In addition, Mauritania and Papua New Guinea suffered more occasional conflicts (less than 1,000 deaths). North Korea, though not embroiled in a conflict, has been affected by its international isolation and this is reflected in very high relative vulnerability to drought. The role of political processes, and in particular armed conflict, in translating drought exposure into vulnerability and human loss of life is made all too clear by this analysis.

The national DRI model results contrast greatly with the other hazards studied in this Report. The socio-economic variables that had the greatest association with recorded drought deaths were the *percentage of population with access to improved water supply* and *physical exposure.*

Physical exposure is less important when associated with deaths to drought than when compared to earthquake, tropical cyclone and flood. This suggests that socio-economic factors play a greater role in generating drought risk than is the case with rapid-onset hazards. In fact, one of the conclusions of this DRI exercise is that it may be incorrect to label the deaths recorded as drought deaths at all. The deaths probably have much more to do with poor governance, conflict and internal displacement than with meteorological drought *per se.* While this implies that this DRI may not be a *drought* DRI, it does create great opportunities for risk reduction through development policy.

At the same time, however, the weak association between physical exposure and risk may also be due to the characteristics of the hazard model or to the use of deaths as an indicator of risk. If it were possible to model agricultural rather than meteorological drought and to use livelihood attrition rather than death as a proxy for risk, then the association between physical exposure and risk might be quite different.

It is important to note that the indirect connection between drought and mortality signifies that the selection of mortality as the outcome for which risks are evaluated affects the way drought losses should be interpreted. Drought impacts are widespread throughout economies with high dependence on primary sector activities. Their cumulative effect can be significant for people's livelihoods, even in situations where mortality attributable to the hazard event is not widespread. This may affect the placement of African countries in the rankings.

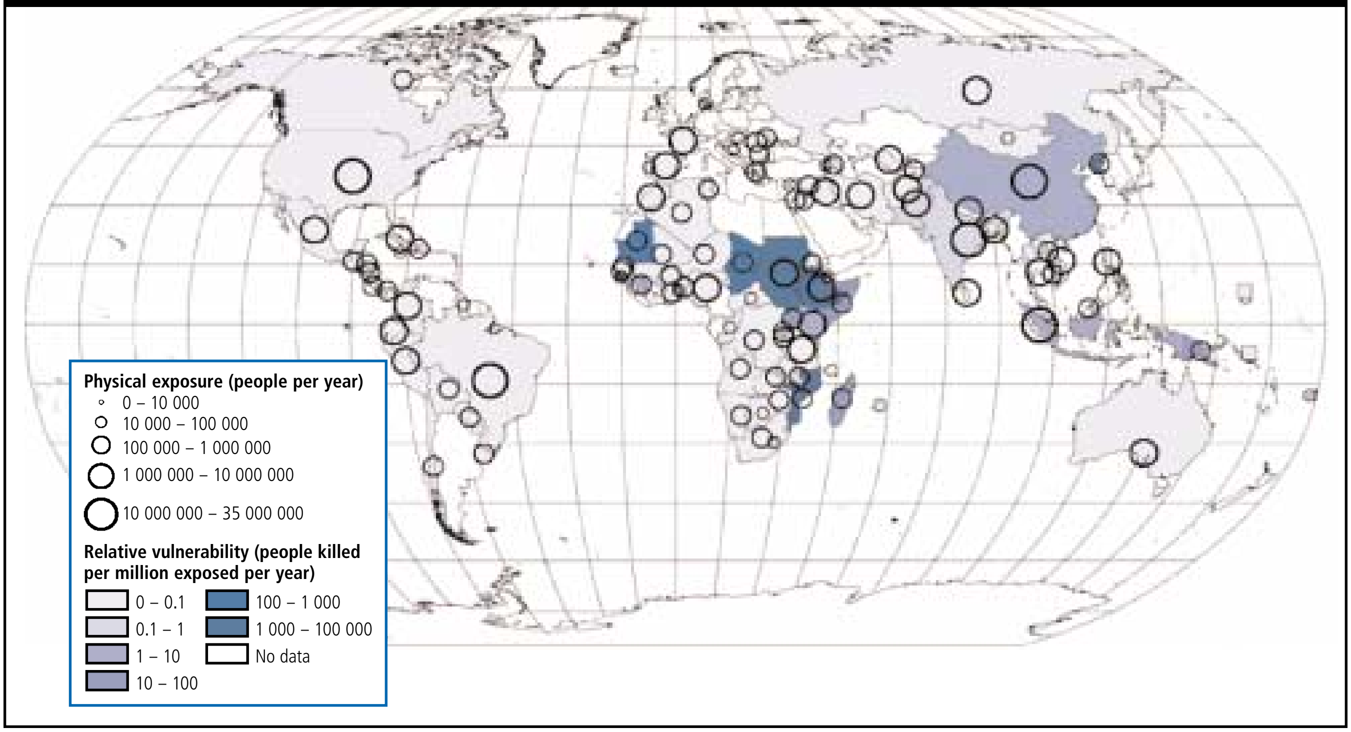
Relative vulnerability to drought and physical exposure are also presented as a world map in Figure 2.25 on the following page. Data for individual countries is in the Statistical Appendix.

2.4.2 Towards a multi-hazard disaster risk model

Is it possible to build on the individual hazard indices for earthquake, tropical cyclone, flood and drought to form a multi-hazard DRI? In this section, initial steps towards the development of such a tool are presented. The Technical Annex records the methodology and results.

Developing a multi-hazard DRI model serves two purposes. First, it is an opportunity to break with the

FIGURE 2.25 PHYSICAL EXPOSURE AND RELATIVE VULNERABILITY TO DROUGHTS, 1980–2000



Source: Université Catholique de Louvain: The EM-DAT OFDA/CRED International Disaster Database (victims); International Research Institute for Climate Prediction (droughts extent); CIESIN, IFPRI, WRI: Gridded Population of the World (GPW), Version 2 (population); Compilation and computation by UNEP/GRID-Geneva

use of disaster impacts (deaths) to indicate disaster risk. The multi-hazard DRI models risk based on socio-economic variables associated with past disaster losses. This opens the way for a concrete analysis of the interaction of development processes with disaster risk. Individual social processes can be examined in relation to disaster risk. Through time it will be possible to track changes in development policy, changing socio-economic status and disaster risk. Second, in combining risk associated with four hazard types, the multi-hazard DRI is working towards providing a sharp tool for policy advocacy.

From hazard to disaster risk

The multi-hazard model is built from the socio-economic variables associated with individual hazards and identified in Sections 2.2 and 2.4.

The socio-economic variables used were: for earthquake, physical exposure and urban growth; for tropical cyclone, physical exposure, percentage of arable land and HDI score; for flood, physical exposure, GDP per capita and local density of population; for drought, physical exposure and percentage of population with access to improved water supply.

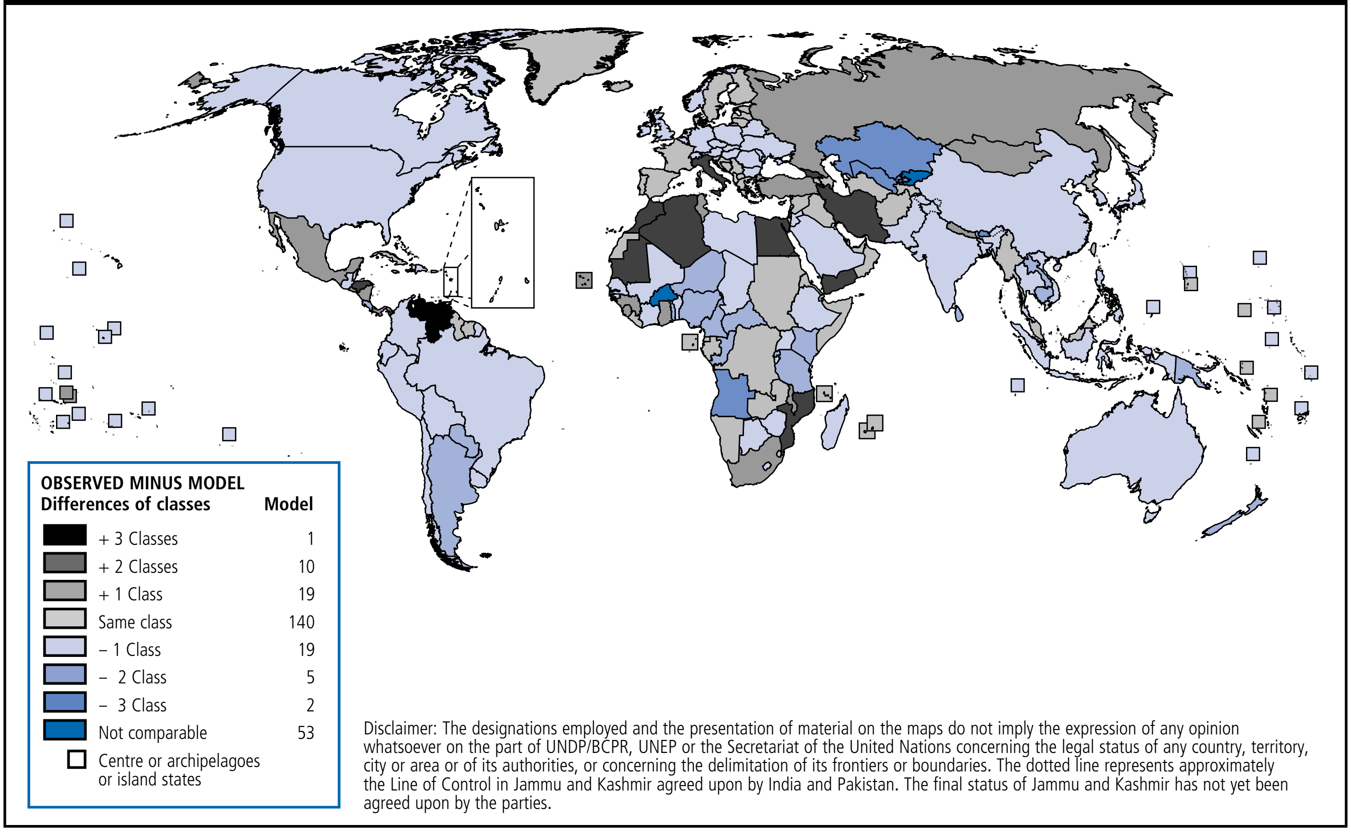
The potential for a multi-hazard DRI model is explored here by examining Figure 2.26, which shows differences between recorded deaths from EM-DAT and deaths calculated using the DRI multi-hazard model.

Even at this early stage, a number of conclusions can be drawn from the process of developing the multi-hazard DRI model.

Cases where the model overestimates people killed suggest the need to refine differences between poverty, as represented by HDI or GDP per capita, and vulnerability. Countries falling into this group are low income, for example Burkina Faso and Bhutan, but have recorded less people killed than the model suggests. This finding brings new weight to discussions about the utility of indicators of poverty in vulnerability assessments and the importance of governance. Lower recorded deaths may also indicate that episodic hazards with long time intervals between events, particularly earthquakes in Bhutan, did not coincide with the 1980-2000 period used in analysis.

Cases where the model underestimates people killed point to the influence of catastrophic disasters. For example, in 1999 about 30,000 people were killed in Venezuela associated with flooding and secondary landslide events.[12] Building a framework for analysis that can cope with small-scale local disasters and

FIGURE 2.26 DIFFERENCES BETWEEN OBSERVED AND MODEL CLASSES



Disclaimer: The designations employed and the presentation of material on the maps do not imply the expression of any opinion whatsoever on the part of UNDP/BCPR, UNEP or the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Source: Geoprocessing, analysis and infography UNEP/GRID-Geneva 2003

catastrophic events is a challenge that the DRI model is working to address.

In 196 out of 249 countries, it was possible to compare the recorded and model deaths. Fifty-three countries were left out because of the absence of data. The drought hazard data was available, but with a low confidence on the ability of the vulnerability variables to capture driving pressures such as governance, armed conflict and HIV/AIDS, it was decided not to pursue analysis.

2.5 Improving Disaster Indicators

2.5.1 Improving Disaster Data

The DRI and other risk information systems use a deductive methodology[13] in which data on disaster impact is used as an indicator of *manifest risk*.

As was mentioned in Section 2.2, a key constraint is that reliable global data is limited to mortality. And this is only for large-scale and a part of the medium-scale disasters that occur. One opportunity for improving risk information, therefore, lies in improving the quality, coverage and accuracy of disaster data. Perhaps most required is more accurate data on losses and associated socio-economic variables with global coverage and sub-national resolution.

The Working Group 3 on Risk, Vulnerability and Impact Assessment of the Inter-Agency Task Force of the ISDR has recommended the development of a multi-tiered system of disaster reporting. In this system, disaggregated disaster data collected at the local level is progressively aggregated into national and global disaster datasets, using a unique global disaster identifier to link sub-national, national and global datasets.

The development of such a multi-tiered system of disaster reporting is a complex and challenging undertaking.

The collection of disaster data at the national level for all scales of development planning is a basic need if disaster risk is to be integrated into development planning. Only with this information can policies have the precision needed to tackle the variations in vulnerability and hazard that exist at the local level.

BOX 2.6 TOWARDS A MULTI-TIERED SYSTEM OF DISASTER REPORTING

The achievement of complete global coverage of national disaster datasets, using an appropriate comparable methodology, would be a major asset to risk analysis. Given the relatively significant coverage of national level disaster datasets in Latin America and the Caribbean, this requires promoting the compilation of national datasets in other regions such as Asia, the Pacific and Africa. Global coverage of national datasets is essential to underpin a range of upcoming initiatives, such as assessing the probable impact of climate change. A first step would be to survey additional national databases, especially to find out what more may be available at the national level and to bring those resources into the larger global effort

The consolidation of a system for creating a unique global disaster identifier for each disaster event is another important step in improving global disaster data. Right now, for example, a number of different institutions are involved in developing the Global Identifier (GLIDE) concept, originally proposed by the Asian Disaster Reduction Center (ADRC). GLIDE has been further developed by the Centre for Research on the Epidemiology of Disasters (CRED), the UN Office for the Coordination of Humanitarian Affairs (OCHA) and other partners in order to ease the linking of national and international datasets. GLIDE also permits disaster data to be annotated with reports, articles, photos and other material — a concept that is already being put into practice through the Relief Web project.

The adoption of a unique disaster identifier, based on GLIDE, in national datasets would allow the aggregation of disaster effects in different local administrative areas by disaster event. At the same time, it would allow the communication of medium-scale disaster events from national to international datasets, enriching global datasets like EM-DAT and enabling the integration of national and international reporting and data capture systems. In turn, this requires assistance with database integration and on-line access to participating countries and institutions. Other important steps include:

- The development of common reporting standards and protocols for capturing and exchanging data in both national and global databases with a view to increasing correlation and convergence.
- The development and promotion of methods and standards for capturing economic losses that are currently not adequately reported in either national or international disaster databases.
- The development of national capacities to compile and maintain disaster databases according to the common standards and protocols mentioned above. This requires the identification of national institutions able to undertake these tasks on a regular, predictable and sustainable basis. Previous experience with the development of national databases indicates that academic institutions may be the most appropriate to compile historical disaster inventories, while disaster management organisations may be appropriate to maintain and update disaster datasets on a day-to-day basis.

Source: Report of Working Group 3 of the Inter-Agency Task Force of the ISDR, October 2002[14]

National disaster databases have relatively good coverage in Latin America and the Caribbean, but far less so in other regions. While detailed assessments of the economic impact of particular large-scale disasters are

BOX 2.7 GLIDE – THE UNIQUE GLOBAL DISASTER IDENTIFIER

The GLIDE concept was developed by the Asian Disaster Reduction Center (ADRC) in association with the UN Office for the Coordination of Humanitarian Affairs (OCHA) Relief Web project, the Food and Agriculture Organization (FAO), the USAID Office of US Foreign Disaster Assistance (USAID-OFDA), the Centre for Research on the Epidemiology of Disasters (CRED) and other partners.

GLIDE was introduced in 2002 and makes the system of building an international database of national and sub-national disaster events much easier and more transparent.

Before the introduction of GLIDE in 2002, numerous organisations operated their own disaster databases. This meant searching the database of each organisation individually for every disaster. Sometimes different organisations would use different names for the same disaster, making searching more difficult. With no direct links between organisations, verifying data was also difficult.

Source: http://www.glidenumber.net/

carried out by The Economic Commission for Latin America and the Caribbean (ECLAC) and others, regular reporting of economic loss in disaster events is uneven and unreliable. Problems of data compatibility and definitions abound.

Nevertheless, the potential for improving risk information, and in turn for informing development policy and planning, is so great that it is clear that this is an area in which major investments are both justified and required.

The current project of the Government of India and UNDP to develop a fully on-line system of disaster reporting at the state and national level is another example of innovative ongoing initiatives that start to address this challenge.

2.5.2 Enhancing the DRI

A constraint on the DRI was the availability of reliable global datasets based on hazard patterns and the socio-economic and environmental variables tested as vulnerability indicators. However, new datasets are constantly becoming available. Since the pilot DRI was completed, a number of new and potentially important datasets have become available which could be used to enhance and improve the accuracy and usefulness of the DRI model and expand it to additional hazard types.

It will be possible, therefore to generate further iterations of the DRI in the future with improved and enhanced datasets and on the basis of expert critique of the results and models used. Gradually, the DRI should be able to produce a far more fine-tuned simulation of reality than was possible when this first pilot version was produced.

There are a number of other ongoing initiatives to develop indicators and indices on disaster risk and related themes. Of particular relevance to the mapping of disaster risk presented in this Report are two projects:

- In 2001, the World Bank, in association with Columbia University and the ProVention Consortium, commenced a Global Disaster Risk Hotspots research programme.[15]
- In 2002, the Inter-American Development Bank and Universidad Nacional de Colombia embarked on an Indicators for Disaster Risk Management in the Americas project.[16]

Both projects aim to develop decision-making tools to identify areas of high risk and causal factors underpinning risk with a view to help the targeting of national and international development investments. An overview produced for the Working Group 3 of the Inter-Agency Task Force of the ISDR is included as an Appendix.

Clearly, enormous potential exists for sharing data and feedback among the different methodologies and models used, as has already occurred in the development of the pilot DRI. Synergies between the different initiatives should be actively promoted and encouraged

2.5.3 Developing a disaster risk reduction indicator

The indicator of relative vulnerability for each hazard type developed in the DRI, presents a value which encompasses not only the different factors that increase the risk of mortality in a country, but also the factors that may decrease mortality. These latter factors include efforts being made in many countries to enhance disaster preparedness and mitigation and in some cases to manage and reduce disaster risks.

The importance of exposing capacities hidden in non-disaster situations is an overall challenge in promoting effective disaster risk reduction across the globe. The case studies included in Chapter 3 of this Report point to the range of actions being undertaken at the local and national levels to reduce disaster risk within the development process.

The pilot DRI did not include considerations of the relative capacity of countries in disaster risk management in the process of identifying and testing vulnerability indicators. In other words, the low relative vulnerability of a country to a given hazard may be due to the application of effective risk management measures. However, this cannot be captured by the DRI.

Potentially, if global datasets were to exist that measured in different ways countries' capacity to manage and reduce disaster risk, these could also be used as indicators within the DRI. This would enhance the advocacy role of the DRI by demonstrating how appropriate policy and planning interventions can reduce vulnerability to hazard.

The development of disaster risk reduction indicators is still at an early stage of development. The ISDR

BOX 2.8 THE ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN

The Economic Commission for Latin America and the Caribbean (ECLAC) has led the way in developing methodologies for calculating the economic impact of natural disasters. The division of impacts into direct, indirect and secondary losses presented in Chapter 1 were first developed by ECLAC.

In 2003, ECLAC published a *Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters.* This is a tool for quantifying damages, identifying the most affected regions and those requiring priority attention during the reconstruction phase. It reckons that the total amount of accumulated damages to disaster in the region is probably more than US$ 65 billion. These losses primarily affect smaller, less developed countries, particularly in the Andes, Central America and the Caribbean.

Based on thirty years experience measuring the main disasters in the region, the ECLAC methodology for measuring damages and losses was first published in 1991. The revised methodology makes it possible to quantify economic, social and environmental effects.

ECLAC recently completed a study of the socio-economic impact of the January 2003 earthquake in Mexico's Colima state. The earthquake, which measured 7.8 on the Richter scale, affected the Mexican states of Colima, Jalisco and Michoacán. It caused 28 deaths and injured many more and caused considerable damage. Using the revised ECLAC methodology, an assessment of impacts in Colima state set the total amount of damages at about US$ 90 million, or 3 percent of its GDP in 2002, one of the highest losses to a natural disaster in Mexico in recent years.

After the flooding in Argentina's Santa Fe province in April 2003, the regional government requested an evaluation from ECLAC, which was carried out jointly with the UNDP. The final report estimates that losses reached US$ 1 billion.

Source: http://www.eclac.cl/analisis/TIN53.htm#6

BOX 2.9 A FRAMEWORK TO GUIDE AND MONITOR DISASTER RISK REDUCTION

Monitoring progress towards development and disaster risk reduction goals is made more transparent when measured by shared criteria.

The UN International Strategy for Disaster Reduction (ISDR) and UNDP have proposed a framework of five thematic areas each opening up to reveal a cluster of disaster risk management concerns with potential benchmarking tools. The Framework was presented by ISDR in 2002 in *Living with Risk: A Global Review of Disaster Reduction Initiatives.*

The thematic areas that drive the proposed framework are: governance, risk identification, knowledge management, risk management and preparedness, and emergency management. There are a host of suggested benchmarking tools to measure standards of practice. These include elements of policy and planning, legislation, codes and their enforcement, availability and use of disaster risk and impact assessments, education and training, the existence of social security and financial instruments for risk burden sharing, and the coverage of community-based preparedness.

This is an ambitious agenda covering a huge variety of organisational practices and technical specialisms. It will require international support. One possibility is to tie indicators in with the MDGs and other sub-national development targets. This will prevent unnecessary duplication of effort. Similarly, the Framework will need to specify which actors or partnerships of actors have responsibility for undertaking or completing individual tasks. To succeed as a vehicle for changing practices, the framework will need to be accepted by multiple stakeholders from civil society, the private sector and government agencies. To do this, these groups' participation in the planning process is paramount.

From 25 August 2003 to 26 September 2003, the Framework was presented for open scrutiny in an on-line conference. The need for tools to help enhance the transparency of the process of building disaster risk reduction into development planning was reinforced, as was the need for a flexible set of benchmarks that are robust, yet sensitive to local context.

Source: Source: http://www.glidenumber.net/

Secretariat and UNDP are currently working to develop a core set of indicators as a proposal to further develop a methodology against which to guide and monitor disaster risk reduction and are the result of an expert consultation. As a starting point to this process, the Secretariat has prepared a core set of principles and goals.[17]

2.5.4 The development of national level DRIs

As we have emphasised, the purpose of the global DRI is to illustrate relative patterns of vulnerability and risk between countries. Its goal is to provide evidence of the contribution of development to the configuration of disaster risk and to advocate for a change in development policy and planning. It is also of use to international organisations that may wish to set priorities according to a quantitative measure of relative risk between countries at the global level.

However, if disaster risks are to be managed and reduced, change in development policy and planning is required at the national level. In order to inform such change, the development of national level risk indicators and indices is required.

The development of DRI, with a national level of observation and a local level of resolution, that would enable the identification and explanation of relative risk and vulnerability, have enormous potential to support national development planning.

There are two main criteria for selecting in which countries to develop national level DRI. The global DRI analysis points towards those countries where risk to a given hazard is greater and where a national level DRI would be most useful. Indeed, all countries would not need to be covered for all hazards if they were not affected, or had a low level of risk.

A second consideration is data availability. As we have discussed above, national disaster data currently exists only for a small number of countries, mainly in Latin America and the Caribbean, and this would be a limiting factor on the development of national DRI. In contrast, in many countries at the national level there are relevant datasets that can be used to identify and test a far larger and better attuned variety of socio-economic and environmental vulnerability indicators than is possible at the global level. Building up national level databases of local conditions of vulnerability, to complement those national databases of local occurrences and impacts of disaster discussed above, would provide a strong foundation for fine-tuning the global assessments of disaster risk at the national level.

Recognising the weight of small and medium disaster events in total disaster losses has critical implications for our understanding of how risk is generated and accumulates at the local and national levels. A similar conclusion is presented in the *Human Development Report, 2003.* Here, the mapping of sub-national data for conflict with human development index scores makes clear the spatial bounding of exposure to conflict in Indonesia, Colombia, Nepal and Sri Lanka.[18] Variance in levels of exposure to conflict and differing development status at the local level are revealed by a sub-national resolution and supported by sub-national level HD indicators.

This again points to the need for a multi-layered, nested approach to collecting data on disasters and linking risk analysis with development policy.

The global scale of observation is most useful for highlighting national priorities for action to confront failures of development and disaster risk management. Hurricane Mitch in Honduras was clearly such a case. Developing targeted risk reduction programmes below the international scale requires a local focus based on local disaster data gathering. Building the picture up from the local to the global again can indicate those countries that have experienced comparative success or failure in tackling development and disaster management weaknesses.

Note on physical exposure: physical exposure represents the number of people exposed per year to a particular hazard. This means that for some cases, this figure can be higher than the population of the country when a hazard is affecting a large part of the population and more than once per year. For example, in the Philippines, the population is hit by 5.5 cyclones per year. On average therefore, the physical exposure is much larger than the population.

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1. One of the first and most complete definitions of vulnerability was developed by Gustavo Wilches-Chaux. See Wilches-Chaux, Gustavo, "La Vulnerabilidad Global in Maskrey," Andrew (Ed), 1993, *Los Desastres no Son Naturales,* LA RED, Bogota, Colombia.
2. See Lavell, Allan in Fernandez, Maria Augusta, 1999, *Cities at Risk: Environmental Degradation, Urban Risk and Disasters,* LA RED/USAID, Quito, Ecuador.
3. Maskrey, Andrew and Romero Gilberto. 1986. *Urbanizacion y Vulnerabilidad Sismica en Lima Metropolitana,* PREDES, Lima.
4. Salazar, A. (2002) Normal Life after Disasters? 8 years of housing lessons, from Marathwada to Gujarat, Architecture + Design, New Delhi, Jan/Feb.
5. http://www.desinventar.org/sp/proyectos/lared/comparacion/index.html
6. http://www.sinaproc.gob.pa/estadisticas.htm
7. *IFRC World Disasters Report 1998.*
8. Famine deaths are also included in this figure.
9. Dreze and Sen 1998. *Hunger and Public Action,* Oxford University Press; Oxford.
10. **Major conflict:** At least 1000 battle-related deaths.
11. **Minor conflict:** At least 25 battle-related deaths per year and fewer than 1000 battle-related deaths during the course of the conflict.
12. EM-DAT: The OFDA/CRED International Disaster Database, Universite Catholique de Louvain, Brussels, Belgium.
13. A discussion of deductive and inductive models for risk modelling is presented in Maskrey, Andrew, 1998, *Navegando entre Brumas: La Aplicacion de los Sistemas de Informacion Geografica al Analisis de Riesgos,* LA RED, Bogota.
14. http://www.unisdr.org/task-force/eng/about_isdr/tf-meeting-6th-eng.htm
15. For more information and contact details, see appendix on international initiatives at modeling risk.
16. Indicators for Disaster Risk Management in the Americas. This project was initiated in August 2002 and involves the Instituto de Estudios Ambientales (IDEA), Universidad Nacional de Colombia and the Inter-American Development Bank (IDB). It is Component II of a technical cooperation entitled an Information and Indicators Programme for Disaster Risk Management in Latin America and the Caribbean. This indicators programme is developing an assessment methodology to measure key elements of countries' vulnerability and the performance of different risk management tools. The purpose of the project is to improve decision-makers' access to appropriate data and methodologies needed to meet the challenges of reducing and managing their risk to natural hazards in the region. Testing of the indicators methodology will be done in approximately 10 countries and include: (i)The definition of vulnerability and performance indicators for disaster risk management and their conceptual foundation. (ii) The design of the data/information collection method (iii) The testing of the indicators methodology in selected countries. The project will also finance a regional technical workshop with policy makers and experts from the region to evaluate the assessment methodology and disseminate results. For information regarding the indicators programme and its conceptual framework see: Cardona 2003, http://idea.unalmzl.edu.co/
17. See ISDR Secretariat 2002.
18. *UNDP Human Development Report 2003,* p. 48.

Chapter 3
DEVELOPMENT: WORKING TO REDUCE RISK?

For many people across the globe development does not appear to be working. The increasing number and intensity of disasters with a natural trigger are one way in which this crisis is manifest.

In the preceding chapters, the disaster-development relationship has been outlined and the extent of disaster risk and the key variables of human vulnerability found at the international scale have been reviewed. In this chapter, the analysis is expanded by providing more concrete evidence for the ways in which failures in development configure and prefigure patterns of disaster risk.

The central message of this chapter is that the strategic integration of disaster risk management within development planning can make a significant contribution to meeting the MDGs.

The choice of topics to be covered is guided by the evidence presented in Chapter 2. The variables of urban growth and agricultural land use were associated with vulnerability and the first task of this chapter is to use urbanisation and rural livelihoods as lenses through which to examine the disaster and development relationship. Neither urbanisation nor rural livelihoods are static phenomena and for each a key dynamic pressure is discussed — economic globalisation for urbanisation and global climate change for rural livelihoods.

The analysis of vulnerability undertaken by the DRI model is limited to those variables for which global datasets exist and can be compiled at the international level. Right now, a number of important development pressures, in which case study evidence suggests a close connection with disaster risk, do not have datasets of the necessary coverage and quality.

The second section of Chapter 3 aims to partially fill this gap by outlining the influence of violence and armed conflict, the changing epidemiology of disease (HIV/AIDS), governance and social capital on the disaster-development relationship.

Throughout the Chapter, case material and examples of good practice in overcoming development constraints are presented.

In a final discussion, the evidence provided in the Chapter is reviewed against the MDGs.

3.1 Risk Factors

In this section, an overview of two key variables that were associated with disaster risk in the DRI: *urbanisation* and *rural livelihoods,* is presented. For each, a critical dynamic pressure likely to shape the future characteristics of these variables is also examined.

For urbanisation, *economic globalisation* is discussed, and for rural livelihoods, *global climate change* is discussed.

In reality, both urbanisation and rural livelihoods will be impacted by economic globalisation and climate change while simultaneously interacting with each other through migration, financial flows and the transfer of information, goods and waste products.

In addition to urbanisation and rural livelihoods, the national HDI rank was associated with vulnerability to tropical cyclones in the DRI. In the analysis presented in this Chapter, the focus is on critical sectoral relationships rather than the broad background of human development. Consequently, HDI rank is integrated into the text, but not discussed as a separate theme. Similarly, rather than structure a discussion around environmental variables identified by the DRI (access to drinking water and man-made environmental degradation for drought hazard, and physical exposure for all other hazard types), they have been integrated into discussion throughout the Chapter. Environmental sustainability could be a theme for future editions of the Report.

3.1.1 Urbanisation

During the next decade, most of the world's population increase will occur in urban areas in the countries of Africa, Asia and Latin America and the Caribbean, with more than half of the world population becoming urban by 2007.

The average size of the world's 100 largest cities increased from 2.1 million in 1950 to 5.1 million in 1990. In developing countries, the number of cities with more than 1 million people has jumped sixfold since 1950. In the year 2000, the number of cities larger than 5 million was 41, and the United Nations believes this number will increase to 59 by 2015. This will add another 14 million people to the streets and homes of large cities. The complexity and sheer scale of humanity concentrated into large cities creates a new intensity of risk and risk-causing factors. This is a real challenge for planning and for the ability of the market to provide basic needs.[1]

It is in small- and medium-sized towns that the majority of the urban population live. In 2000, more than half of the world's urban population lived in towns of less than 500,000 people.[2] Smaller cities contribute less pollution to global climate change, but show high levels of internal environmental pollution and risk.[3] In smaller cities, very high rates of urban growth often coexist with a very limited technical and financial capacity to plan for and regulate urban expansion. That means that disaster risk considerations are very rarely factored into the urban development process.

The complexity of risk and vulnerability in cities suggests that dedicated high resolution data collection systems would be required in order to identify patterns of hazard, vulnerability and risk at a scale that can provide information for urban planning. For example, the national level disaster databases described in Chapter 2 point to house fire as a critical cause of death and loss in cities, a hazard type that is not highlighted in international databases.

The relationships between urbanisation and disaster risk are extremely complex and clearly context specific. Urbanisation does not necessarily have to lead to increasing disaster risk and can, if managed properly, contribute to reduce it. However, there are a number of key characteristics of the urbanisation process that can directly contribute to the configuration of risk.

Risk by origin

As was outlined in Chapter 1, cities may have been founded in highly hazardous locations for both political and economic reasons. Lima, Peru for example, was a major political and economic centre in South America in the colonial period, but was founded in an area of very high seismicity. The city was severely damaged by destructive earthquakes in 1687, 1746, 1940, 1966 and 1970. This constitutes a case of *risk by origin* shared by other urban centres founded in the colonial period in Asia, Latin America and the Caribbean and Africa.

Increasing physical exposure

The urbanisation process leads to the concentration of population in cities and in districts within cities: both megacities and rapidly expanding small- and medium-sized urban centres. When populations expand faster than the capacity of urban authorities or the private sector to supply housing or basic infrastructure, informal settlements can explode. Some 50 percent to 60 percent of residents live in informal settlements in Bogota, Bombay, Delhi, Buenos Aires, Lagos and Lusaka; 60 percent to 70 percent in Dar es Salaam and Kinshasa; and more than 70 percent in Addis Ababa, Cairo, Casablanca and Luanda.[4] In these conditions, everyday risks accumulate and prepare the way for disaster.

When cities are located in hazard-prone locations, this leads to a rapid increase in the number of people exposed to hazard — a phenomenon that has been described as physical exposure in the DRI.

Clearly, physical exposure itself does not explain nor automatically lead to increased risk. If urban growth in a hazard-prone location is accompanied by adequate building standards and urban planning that takes into account risk considerations, disaster risk can be managed and even reduced.

One way of planning to reduce urban risk is to compensate for losses in one neighbourhood by shifting patterns of production, consumption and servicing to nearby unaffected districts. This is difficult in the cities of Low and Middle Human Development countries, where more than half of the urban population may be living in illegal and unserviced neighbourhoods.

Despite less than half of Asia's population being urban, this world region includes six of the 10 largest cities in the world. Its importance as an urbanising region is set to increase as Asia and the Pacific has the highest urban population grow rate (2.7 percent) of any world region.[5]

BOX 3.1 EARTHQUAKE HAZARD AND DWELLING CONSTRUCTION STANDARDS: ALGERIA AND TURKEY

Algeria and Turkey are both recorded as having high vulnerability to earthquakes in the DRI. As Medium Human Development Countries with large urban populations exposed to earthquake hazard, they exhibit many of the characteristics of other countries at risk from earthquake hazards.

Lack of appropriate construction standards and failure to implement those standards that do exist are often sited as proximate causes of building failure and human loss from earthquakes in urban areas. In 2003, an earthquake causing more than 2,200 deaths hit Algiers and surrounding towns. Building collapse caused many deaths. It was found that public sector buildings (with the important exception of primary schools) were better constructed than buildings (mainly homes) in the private sector. This may be expected in a city with a sizeable informal housing sector, but the ability to construct appropriately in the public sector suggests that capacity does exist for safe building to be undertaken in the city.

Research following the Marmara earthquake in Turkey in 1999 has shown that high competition for contract design work and low levels of remuneration have reduced engineers' willingness to develop professional competence in disaster-proofing. Design engineers tend not to inspect on-site construction, allowing modifications that can compromise the buildings' resistance to earthquakes. The inability of municipalities to employ sufficient numbers of well-trained and paid personnel to inspect building work contributes to this dilemma. One possibility is to transfer construction supervision to the private sector with costs being carried by developers.

Source: Özerdem, A. (2003), and Government of Algeria (2003); www.proventionconsortium.org/articles/innovations.htm

The significance of both disasters and urbanisation for development in Asia has led to a number of innovative urban disaster risk management initiatives.

A number of projects have been implemented in the Philippines. For example, a project to reduce the vulnerability of two cities to natural hazards, beginning with the mitigation of floods in Naga City and followed by multi-hazard mitigation in San Carlos. In addition to hazard mapping and mitigation planning, the project emphasizes land-use planning, the formation of disaster management standards and the training of urban professionals. This is one of nine national demonstration projects initiated by the Asian Urban Disaster Mitigation Programme (AUDMP). Other projects are underway in Bangladesh, Cambodia, India, Indonesia, Lao PDR, Nepal, Sri Lanka and Thailand.[6]

Social exclusion

Compared to rural areas, risk accumulation in cities is shaped by greater levels of social exclusion and the market economy.[7] Social exclusion is tied to the high number of migrants at risk among rapidly expanding

BOX 3.2 COMMUNITY PARTICIPATION AND THE URBAN ENVIRONMENT IN RUFISQUE (SENEGAL)

Through community participation, nine low-income communities in the small Senegalese town of Rufisque were able to break the cycle of local risk accumulation and turn a public nuisance into a public asset.

Risk stemmed from a lack of sanitation. Much residential land lies below sea level and ground water sources of drinking water are easily polluted by sewerage from pit latrines. Together with the pollution of open spaces by excrement, dirty flood water and sewage has had a devastating effect on the health of the population, especially the children. Statistics prior to 1990 show high incidences of diarrhoea, dysentery and skin diseases.

Change began during the 1980s, when a government/INGO project was implemented to reinforce the coast and prevent loss of houses from coastal erosion. During this time, it became clear that the community was capable of joint action to improve the area. Today, through community efforts aided by Environmental Development Action in the Third World (ENDA-Third World) and The Canadian Host Country Participation Fund, and in collaboration with the Rusfique Local Authority, sanitation problems are well on their way to being solved. Horse-drawn carts collect rubbish and low-cost, narrow plumbing pipes dispose of waste water and sewage. Sewage, waste water and refuse all end up in a purification and recycling centre where young people treat and combine them to form compost for use in market gardens. The scheme is run by local management committees, which are democratically elected. Local people handle technical aspects and women and young people are active at all levels. In addition, most of the funding comes from the community itself and credit, initially provided by international funding, will soon no longer be necessary as it will be replaced by a local revolving credit system.

The local community actively participates in the scheme and women are prominent in all of this. Along with the other benefits, the project has enormously reduced the workload of women, compared to the situation before the scheme began. The safe disposal of rubbish, the elimination of excrement as a source of disease, the reduction of flies and mosquitoes and their accompanying diseases (such as malaria), have all improved both ecology and health. At the community level, the sanitation scheme reinforces the independence of the community and increases a sense of citizenship through training and interaction between various groups.

Above all, this example of urban governance and disaster risk reduction reveals a successful solution well suited to low-income areas.

Source: Gaye and Diallo (1997)[8]

urban populations. Social ties may be strong, but nevertheless tend to be less deeply held than those of rural communities. The market for goods in the city means little can be acquired without money, contrasting with rural areas, where it is often possible to obtain construction materials, water and food without the need of first earning money.

Little is known of the detailed interaction of multiple hazards with livelihoods and coping strategies in cities. Work by PeriPeri and the Disaster Mitigation for Sustainable Livelihoods Programme, based in the University of Cape Town in South Africa, is one initiative that is seeking to generate knowledge in this area for Southern Africa.[9] This is a first step in identifying the different qualities of disaster risk that affect different social groups, defined for example by age or gender, and for including those individuals most at risk in development planning programmes.

Migrants to the city are often at high risk from disaster. The functioning of land and property markets and inability of land-use planning to cope with rapid population growth means migrants frequently locate in hazard-prone locations. For example, in peripheral squatter settlements located in ravines, on unstable slopes or in flood-prone areas, or else in dense inner city slums.

Poor or non-existent sanitation, high unemployment and underemployment, deficient health and education services, insecure land tenure, crime and violence, and other factors configure a panorama of everyday risk.

For individuals caught up in the immediate concerns of daily survival, disaster risk management is often not a priority. However, at the scale of the city and over the medium- to long-term, sustainable development rests on the successful integration of disaster risk management into development planning. This is beginning to be recognised, for example, in the 1996 Habitat Agenda 'Disaster Prevention, Mitigation and Preparedness, and Post-disaster Rehabilitation Capabilities'.[10] Municipal government will have a central role to play in strategic planning for disaster risk at this scale.

Modification and generation of hazard patterns

Through processes of urban expansion, cities transform their environments and their surrounding hinterlands and may generate and create new hazard patterns. For example, seismic hazard may be significantly greater on reclaimed wetlands and on landfills than in other areas of a city. The destruction of mangroves in coastal areas may increase hazard associated with storm surge. The urbanisation of watersheds — through settlement, land use change and infrastructure development — may modify the hydraulic regime and destabilise slopes and increase flood and landslide hazard.

Additionally, in cities the hazards of natural origin interact with those of technological and man-made origin. Inadequate waste disposal in riverbeds and ravines may cause floods. Refuse tips may themselves become hazards, as occurred in the Philippines in 2000 (killing 300) and Bogota in 1997. When natural hazards affect industrial plants, the resulting contamination and pollution may constitute additional and more serious hazards. In other words, cities are not just affected by hazards, they can be generators of hazards.

In Calcutta and Baroda, a project by the Asian Urban Disaster Mitigation Programme (AUDMP), Baroda Citizens Council (BCC), assisted by Urban Studies Centre and Times Research Foundation with input from the Government of India, has identified numerous manufacturing and hazardous materials storage sites that magnify natural hazard in densely populated urban areas of the two cities. The project consists of hazard mapping and vulnerability assessment, the development of guidelines for incorporating technological hazards into urban development planning, and implementing a mitigation strategy and emergency preparedness plan.[11]

As it transforms the natural environment in and around cities, urbanisation generates and magnifies hazard problems. Quito exemplifies this relationship well as unplanned urbanisation and environmental degradation are compounding the hazards faced by a city population whose vulnerability and exposure are also increasing.

Between 1960 and 1995, the population of Quito quadrupled while its land area has also exponentially increased. The mountainous topography, where unplanned peri-urban settlement takes place, makes it difficult and expensive for the state to provide drinking water, sewerage, paved roads, electricity, waste collection and other services. The rate of deforestation through urbanisation has reached 247 hectares per year or more, increasing the instability of slopes and landslide hazard. Approximately 3,200 tons of solid waste per year is disposed of in ravines, obstructing drainage and increasing flash flood hazard. Brick manufacturing accounts for the destruction of another 116 hectares of forest per year while access roads also destabilise mountain slopes. The increased incidence of floods, flash floods, landslides, erosion and debris flow is being generated by the urbanisation process as the city configures its own risk scenario.[12]

Increasing physical vulnerability

In low- and middle-income countries, city governments have often proved ineffective in regulating the process of urban expansion through land-use planning and building codes. Unregulated low-income settlements, where land values are lowest, often occupy the most hazard-prone locations. Low building standards may reflect a lack of control and supervision in middle-income areas and the lack of resources to build hazard-resistant structures in low-income areas.

Hazard-prone locations are often preferred by the poor as a way of reducing everyday risks by gaining greater accessibility to urban services and employment, even though natural hazard risk may be increased. In central Delhi, a squatter settlement in the floodplain of the Yemuna River has been inhabited for more than 25 years. The settlement floods annually, but this is seen as the price to pay for living in the centre of the city at low cost.[13]

Rapid urban growth may also be accompanied by the physical and economic deterioration of established city areas, which were not necessarily risk-prone originally. Cities are not static and different areas fulfil different functions over time. The vulnerability of low-density residential areas in central locations can rapidly increase due to overcrowding and lack of maintenance as the former owners move to the suburbs and the area is transformed into a mixture of commerce and low-income rental housing. In Manila, the Philippines, for example, local flooding is concentrated in such densely populated areas and compounded by limited access to garbage collection, sanitation and drinking water.

The overcrowding and deterioration of inner city slum areas in Lima, Peru has been identified as a critical process of seismic risk accumulation in that city.[14]

Cultural assets at risk

Historical architecture is an important part of cultural heritage. This is valuable in itself, but also plays a role in economic development through helping to attract foreign investment or strengthen the tourism sector. The old centre of Quito provides an example of national architectural heritage at risk from disaster. The colonial architecture — that makes central Quito a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site — is

BOX 3.3 THE HURRICANE RESISTANT HOME IMPROVEMENT AND INSURANCE PROGRAMME FOR INFORMAL HOUSING IN THE CARIBBEAN

Small Island Developing States have some of the highest risk to tropical cyclones. Despite this, property insurance is generally not available to low-income households in the Caribbean. This is due to a combination of lack of legal property title, non-standard housing construction and affordability.

During the mid-1990s, the Caribbean Disaster Mitigation Project (CDMP) in collaboration with the Cooperative Housing Foundation introduced a Hurricane Resistant Home Improvement Programme in Dominica, Saint Lucia, St Kitts/Nevis and Antigua and Barbuda. Working through local NGOs, a training programme was initiated for building contractors, artisans and others working in the formal and informal building sectors. More than 145 local craftsmen were trained in safer construction techniques in Saint Lucia and Dominica. Safer construction manuals and minimum standards checklists were developed to guide retrofitting and home improvement work. NGOs also worked with local actors to establish a revolving loan fund to extend credit to low-income households to finance retrofitting work.

By 2001, the Saint Lucia safer housing programme had disbursed 43 home improvement loans and as of 2002, 371 homes have benefited from the programme. Although property insurance is generally not available to low-income households in the Caribbean, retrofitting was used to convince a local insurance broker to offer a group-based insurance programme for the beneficiaries of the scheme. Loan officers were trained in valuing the property and assessing the level of risk, which helped in keeping the underwriting costs low and making this innovative entry from the formal property insurance sector into the informal housing sector a reality.

Source: Vermeiren (2000), USAID (2001)[15]

as exposed to earthquake and volcanic hazard from the La Pichincha volcano as the low-income communities that live among the historical buildings in the overcrowded and poorly maintained city centre. The municipal government recognises this risk and has integrated architectural heritage into its disaster preparedness plan.

Urbanisation of new regions

Urbanisation can also configure new risk patterns over wide areas of territory as new economic relations unfold and communications links are developed. The construction of roads that link previously isolated areas to markets can trigger a rapid process of urban growth and territorial transformation — leading to a configuration of completely new risks that were not present previously. For example, the earthquakes that occurred in the Alto Mayo, Peru in 1990 and 1991; Limon, Costa Rica in 1991; and the Atrato Medio, Colombia in 1992; exposed new patterns of risk through urbanisation in regions that had a history of seismic activity, but which had never experienced earthquake disasters of this type before. Rapid expansion of urban corridors, for example, along China's coast are actively reshaping patterns of exposure.

Disasters, such as the one associated with the landslide of Chima in La Paz, Bolivia in March 2003, point out the ways in which urbanisation can configure disaster risk. Landslide hazard had been shaped by mining activity that over time had weakened the stability of the hillside of Cerro Puculama. At the same time, the population of Chima was made up of temporary migrants dedicated to mining activities and with high levels of social and economic vulnerability. In this context, the heavy rains that provoked the landslide only transformed a scenario of pre-configured disaster risk.[16]

Access to loss mitigation mechanisms

Small hazard events that do not grab headlines destroy poor people's livelihoods and homes. Local floods, fires and landslides are a common occurrence in many cities. For low-income communities, risk is tied to a hazardous living environment with limited access to emergency services, sanitation or drinking water. For middle-income communities, scope exists for affordable housing insurance (whether arranged through a NGO, government agency or a commercial company) to act as a mechanism for spreading risks and losses if disaster strikes. Box 3.3 discusses a programme aimed at building resilience to risk by extending access to household insurance to low-income groups in the Caribbean.

There are many more examples of participatory urban risk reduction driven from the bottom up.[17] Box 3.4 presents a case study of a participatory approach to urban risk management in Angola, which points towards the possibilities for bringing local actors, the government and private sector together in risk reduction.

According to the World Disasters Report, 'effective and accountable local authorities are the single most important institution for reducing the toll of natural and human-induced disasters in urban areas. An increasingly urbanised world actually holds the potential to greatly reduce the number of people at risk from hazards, but only if urban governments become more accountable to all their citizens'.[18] This echoes work on urban governance that also argues for the key role to be played by municipal government as a champion for governance — linking public, private and civil society actors in the city and bridging the gap between international and national level actors on the one

BOX 3.4 THE LUANDA-SUL SELF-FINANCED URBAN INFRASTRUCTURE PROGRAMME, ANGOLA

In 2000, The Luanda-Sul Self-Financed Urban Infrastructure Programme in Angola won a Dubai International Award for Best Practices in Improving the Living Environment.

The programme succeeded in integrating the aims of reducing everyday hazard with those of enhancing development opportunities. Daily life hazards for residents were reduced through extending access to urban infrastructure. This included the construction of 70km of pipes providing drinking water, 23km of drainage, 12km of power lines, and 2,210 houses and adequate shelter for 16,702 people. Development gains were made in the process of enacting the programme by providing livelihood opportunities, enabling local participation and engaging the private sector.

The programme was initiated in 1995 as a partnership between Government agencies, the private sector, community-based organisations and the population living in temporary settlements, many of whom have been displaced by war.

Finance for the project came from three sources. First, the sale of land tenure rights derived from the allocation of public land for private development. Second, taxes raised from the sale of goods and services. Third, investments made by the private sector. The willingness of private investors to become involved in the programme was made possible through the Government issuing guarantees for private investments. The programme involved an initial investment of US$ 30 million and a subsequent investment of US$ 14 million.

The community participated in the design and planning of the programme and members were given the first option to buy land. Technical and human resources came from a team of urban and infrastructure experts. In addition, some 4,000 jobs were created in the implementation phase of the programme.

The process involved the identification of suitable land for urban development, the acquisition of the land from landowners by the state, the legislation of the status of the land according to a land-use plan and the mobilisation of capital investment by the private sector. Infrastructure development includes community facilities, schools, commercial establishments, an industrial estate and a hospital.

Continuity is provided as the programme is now part of the Luanda Master Plan, supported by the World Bank.

Source: http://www.sustainabledevelopment.org/blp/awards/2000winners/summary.pdf

BOX 3.5 URBAN GOVERNANCE FOR URBAN DISASTER RISK MANAGEMENT, MANIZALES (COLOMBIA)

Earthquakes are a recurrent hazard for Manizales. In the late 19th century, authorities banned the use of inherited colonial building technology and Manizales developed its own earthquake-resistant building style using local materials. This wall-building bahareque technique, based on wooden elements and local bamboo, has become the predominant method of construction in Manizales. Colombia's national earthquake-resistance building code today recommends using this building technique in publicly subsidized homes after structural studies were made in the local university. The success of this technique was evident during the massive earthquake of 1938, which did not damage the city significantly. Similarly, the earthquakes of 1962, 1964, 1979, 1995 and 1999 caused only minor or moderate damage.

Since the 1980s, the city has had a municipal disaster prevention system in place, based on municipal development and land-use plans, that incorporates disaster risk management as a strategic and political cornerstone. Disaster preparedness has become part of the city's culture. Prevention-related information and education activities are conducted regularly in schools. Drills are held periodically to ensure that awareness and alertness remain high. The mayor has a disaster risk advisor for inter-agency coordination and the city employs a team of professionals who work at scientific research centres. All residents who take steps to reduce the vulnerability of their homes receive a tax break as an incentive. A collective and voluntary housing insurance scheme has been promoted by the city. It is added to local bimonthly tax payments, with the aim of covering the tax-free lower socio-economic strata, once a defined percentage of taxpayers paying for the insurance has been achieved. Seismic micro-zonation has enabled the local administration to estimate the expected annual losses of its public buildings and insure them selectively.

The city administration of Manizales has produced a disaster risk plan that aims to translate state-of-the-art theory into practice, transfer best practices from current experiences in other places, focus on local participation and sustainability, and build in local ownership. Broader integrated risk management activities have reinforced a number of themes and issues related to organisational structures and inter-organisational coordination for risk identification and reduction, preparedness, response and recovery.

Source: Cardona et al (2002); http://www.alcaldiamanizales.gov.co/Manizales_Alcaldia/Informacion/Gestión+del+Riesgo/

hand, and urban or community level organisations on the other. Box 3.5 presents a successful urban governance regime case study that has reduced risk in Manizales, Colombia.

A dynamic pressure: economic globalisation

'We believe that the central challenge we face today is to ensure that globalisation becomes a positive force for all the world's people'.

This extract from the statement of the Heads of State and Government of the United Nations in the Millennium Declaration was accompanied by a recognition that global economic and political ties — for the first time in history — offer an opportunity to fully confront global poverty.

Economic globalisation is not a new phenomenon, but the characteristics of the present form are distinctive from those of previous centuries. Shrinking space, shrinking time and disappearing borders are linking people's lives more deeply, more intensely, more immediately than ever before.[19]

Today's version of economic globalisation consists of the creation of new markets, the development of new tools of communication, a global forum for negotiating economic interests (the World Trade Organization or WTO), and the elaboration of new rules relating to trade, services and intellectual property supported by powerful enforcement mechanisms.

From the point of view of disaster risk, the growing interconnectedness of global society means that catastrophic events in one place have the potential to affect lives and public policies in distant locations. At the same time, globalisation also has the power to shape new local economic relations and subsequent geographies of risk.

Niche territories that may offer competitive advantages in a given economic sector may experience very rapid economic and urban growth, while other territorial niches enter into an equally rapid decline.

Given that the decisions that generate such conditions (such as free trade agreements) are taken at the international level and without detailed knowledge of the territories potentially affected, it is not surprising that risk patterns are generally not considered.

Strengthening mechanisms for collecting accurate, detailed information on risk patterns at the global level would help attempts to factor risk considerations into investment decisions. But at the same time, the fast-changing and turbulent nature of markets means that globalisation adds a new, unpredictable and troubling dimension to risk at the local level. This, and the lack of channels for local consultation and participation in global economic decision-making, makes disaster risk reduction planning increasingly complex and challenging.

In the best of cases, investors undertake risk assessments when considering location in order to minimise risk to their investment. However, the impact of that investment on the shaping of new risks in the surrounding region is rarely considered.

There is need for disaster risk assessment to be integrated into development planning. There are particular opportunities for integrating risk assessment into the planning of large-scale infrastructure projects and private sector investments where environmental and social impact assessments are commonplace. Such projects are often supported by the World Bank or regional development banks. In both cases, there exists an opportunity to build risk assessment into development planning.

There have been many examples where past investment in large-scale power, irrigation and transport infrastructure has led to reconfigured and increased disaster risk. A contemporary example is a US$ 4 billion investment in an oil pipeline between Chad and Cameroon, with funding from the World Bank agreed in 2003. The project brings a major boost to the Chadian national exchequer. However, the distribution of social costs and benefits in terms of disaster risk has not been examined. In these early stages, the potential for human development and the lowering of Chad's high relative vulnerability to drought that this financial boost could support, has not been fulfilled. The massive size of the development has caused inflation, doubling the price of basic foods and increasing risk of food insecurity among the poor. While it is hoped that such effects are temporary, they will clearly impact on people's well-being, health and livelihood security.

Economic globalisation can provide opportunities for the enhancement of livelihoods and life quality in those places receiving new inward investment. However, without appropriate government oversight, investment can encourage economic and residential development in hazardous places.

In Central America, disaster risk reduction is being considered in some ongoing regional investment programmes. CEPREDENAC has played a pioneering role in recording and analysing links between development policy and disaster risk.[20] New investment contexts, such as those being opened up by Plan Puebla Panama (a vast infrastructure construction project that covers nine states in south-southeast Mexico and the seven Central American republics) are being studied. One of the eight initiatives of the Plan Puebla Panama is the Mesoamerican Initiative for Disaster Prevention and Mitigation. This initiative aims to include risk reduction concerns at the different stages of development planning.[21]

Such initiatives are not the norm. Encouraging governments and investors to formally take account of disaster risk in their decision-making might be a first step in raising the profile of disaster in corporate social responsibility, as well as promoting the responsibility of employers for human rights and environmental stewardship in and beyond the workplace in order to prevent the accumulation of disaster risk.

Disasters can greatly disrupt trade. This can be felt through flooding, droughts or tropical cyclones affecting the export of primary commodities, which form the primary source of foreign exchange earning for a number of countries. Flooding in Bangladesh has affected garment-manufacturing units in export-processing zones of Dhaka and Chittagong and damaged the country's biggest export sector. In Bangalore, India flooding and public demonstrations in its aftermath undermined the efforts of the authorities to present an image of the city to global investors of an international centre for the high-tech industry.[22]

Globalisation has greatly concentrated financial and data processing functions and subsequent disaster risk in urban centres. Disaster events that strike at key centres of the global exchange system for information, money and material resources, are particularly feared because they have the potential to create havoc throughout a vast web of interconnected states and societies.

The interconnectedness of contemporary global society has become apparent most recently through the impact of international tourism on disaster response in the Caribbean. Tourism and agriculture are the mainstay of Caribbean island economies — sectors with high vulnerability to natural hazards.[23] There is a perception in tourism-dependent island economies that national disaster declarations — a pre-requisite for accessing international humanitarian assistance funds — will create a negative economic impact on the tourism industry, creating greater economic losses than the storm itself and prolonging the recovery period for the tourism sector. This has led to reluctance from governments to declare national disasters following disaster events. In turn, disaster relief agencies that require they only intervene in declared disaster situations have had to reconsider their policy.

The challenge of globalisation is to ensure that measures are in place to promote equity and opportunities for those households that find their former livelihoods constrained and their risks increased by the rapid flows of capital made possible by global information networks and investment mechanisms. The current globalisation of economies and ongoing regional integration processes[24] are creating new threats to and opportunities for human security.[25]

BOX 3.6 WORLD BANK AND GOVERNANCE, POVERTY REDUCTION STRATEGY PAPERS

In responding to critiques of the structural adjustment process, which often led to high levels of social dislocation and exacerbated inequality and poverty, the World Bank has repackaged its development aid lending strategy through national Poverty Reduction Strategy Papers (PRSP).

Today, 21 countries have finalized three-year PRSPs and more than 30 other countries have begun progress in this direction. The PRSP approach helps to strengthen a focus on pro-poor strategies, encourages more consultation amongst stakeholders, provides a focus for strategic programming, highlights the importance of accurate poverty measurement, and encourages alignment of donor assistance in individual countries. However, in spite of progress being made, questions remain concerning the quality of stakeholder participation, country ownership of the process and necessary capacity building, the coordination of international assistance behind PRSPs, and the unrealistic timeframe of three years that was imposed by PRSP framework for sustainable poverty reduction to be realized. As a recent United Nations Conference on Trade and Development (UNCTAD) publication noted, effective poverty reduction will require policy which moves 'beyond adjustment policies and anchors PRSPs, which are three-year plans of action, within long-term development strategies'.

The implications of PRSP for disaster-development relationships have yet to be concretely explored, but the early stages of an evolving development approach is an appropriate time to consider more seriously the role of disaster in development and particularly poverty reduction. Can the PRSP move disaster risk reduction forward?

One interesting case is Madagascar, a poor island-economy in the Indian Ocean sharing many development concerns with countries in sub-Saharan Africa. It had a per capita GDP of US$ 260 and an extreme poverty headcount of 62 percent in 2000. It is frequently exposed to natural hazards, such as tropical cyclones, floods and droughts. The evidence presented in chapter 2 shows that this country has the thirteenth highest national population exposed to tropical cyclones, and has a higher than average relative vulnerability to droughts. Recently, within the context of the preparation for the Madagascar PRSP (2003), policy-makers have started paying increased attention to the role of shocks as a factor causing and perpetuating poverty. This was especially so after a six-month long political crisis (see note 1 below), which contributed to a 6 percent increase in the national extreme poverty rate. As a result, the PRSP incorporates risk and vulnerability considerations into poverty analyses. And in strategic planning, such as land planning, agriculture and transports, effectively integrates disaster risk and development policy.

Note 1: The crisis was the result of the disputed presidential election in December 2001. For six months, the country had two parallel governments, each with its own central bank and administration. Clashes between the two parties led to the destruction of key infrastructure and claimed about a hundred lives. The domestic instability also led to the isolation of the economy, freezing of Madagascar's assets abroad, a suspension of foreign exchange trading and a closure of the T-bills market for several months. The lower estimate of the cost of the political crisis alone increase to 11 percent of GDP. This led to the discontinuing of many social services and caused widespread suffering (CAS, 2002). The shock also had a powerful negative impact on jobs, income and prices.

Source: IDB/ECLAC (2000), IMF/WB (1999), UNCTAD, (2002), UNDP (2001), UNDP (2003); http://www.prspsynthesis.org/connections9.pdf

The transforming power of international financial investment for disaster risk can be seen in the mushrooming of business parks, free trade zones and transportation infrastructure to facilitate international trade and investment. Concentrated investment provides an opportunity for disaster risk reduction to be part of the development process. But time and again this has not been the case. The deepwater port in Dominica was designed to handle international trade. One year after construction, Hurricane David hit the port and required repairs equivalent to 40 percent of the original construction costs. Building disaster-proof design elements into the original plan would only have added 12 percent to construction costs.[26]

New global and regional markets will very possibly intensify current trends, such as urbanisation and marginalisation of rural areas that shape disaster risk. Through structural adjustment policies, the World Bank/International Monetary Fund (WB/IMF) have played a significant role in shaping macro-economic policy and restructuring urban and rural livelihood opportunities and basic needs provision by the state.[27] More recently these institutions have taken on board the need for a pro-poor stance. This policy shift and its implications for disaster risk are explored in Box 3.6 (see previous page).[28]

To prevent these inequalities from further polarising the world into those at risk and those who are not, the opportunities and benefits of globalisation need to be shared much more widely. This can only happen with stronger governance.

3.1.2 Rural livelihoods

The World Bank estimates that 70 percent of the world's poor live in rural areas. There is a great variety in the structure of rural economies and societies and their interaction with the environment. These dynamics shape local experiences of development and disaster risk and warrant against any easy generalisations. However, there are recurrent themes that characterise the ways in which flawed development can increase vulnerability and risk in the countryside.

Rural poverty

The absolute lack of assets and the precarious economies of many rural livelihoods is one of the key factors that configures risk to hazards such as floods and drought.

In severe droughts in the *sertao* of northeast Brazil, poor landless labourers are the first to reach a critical stage of asset depletion and be forced into either publicly funded emergency programmes or else into migration. Small landholders are often forced into selling their land to pay off debts created by the deficit in production and the need to buy food and basic necessities. Large-scale landowners, on the contrary, have better access to groundwater as well as credit.

The rural poor, who are most at risk, are often no longer subsistence peasants. In Haiti, for example, less than 30 percent of income in rural areas is derived from agriculture.[29] Instead, rural dwellers depend on complex livelihood strategies, including seasonal migration or inputs from remittances sent from relatives living in cities or overseas (see Box 3.18).

Many rural communities have sophisticated coping strategies that enable them to live and prosper in potentially hazardous environments. Shifting cultivation, nomadic cattle herding and intensive rice cultivation are three examples of specific agricultural systems that are well attuned to particular socio-environmental contexts.

Vulnerability can arise when the pressures that have shaped such coping systems over many generations rapidly change. Climate change is a key force that underlies such change and is discussed at length in the following section. Other driving forces for instability are increasing or decreasing populations, changing markets or local environmental degradation. Geographical information systems provide an opportunity for mapping the changing relationships between socio-economic, environmental and disaster risk variables, and can guide proactive disaster risk reduction planning.

The loss of adaptive capacity often comes from socio-economic structures that restrict flexibility in livelihood systems. In response, rural development initiatives have focused on programmes to foster livelihood diversity. Initiatives have included rural microfinance, cooperative production and marketing, and increasing the value added onto rural production through local skills training. Box 3.7 provides an account of the contribution of rural microfinance in building resilience to disaster stress in Bangladesh, a state with high exposure and vulnerability to tropical cyclones and flooding.

BOX 3.7 MICROFINANCE FOR DISASTER RISK MANAGEMENT IN BANGLADESH

Microfinance programmes include mechanisms for extending savings and insurance services to low-income groups.

Microfinance instruments can reduce risk by helping poor households diversify their income by source and season, and also by earner by providing earning opportunities for women. Diversifying income-earning opportunities and building assets through microfinance help poor households to offset disaster risk. If risk does materialise as disaster, microfinance can help again through loan forgiveness or rescheduling, enhancing the targeting of relief programmes through microfinance networks, improving the flow of information among the clientele of microfinance organisations, and the empowerment of women. An important feature of microfinance is its capacity to build social capital as expressed in specific mitigation measures.

The Bangladesh Floods, 1998

The role of microfinance services in responding to disaster risks was first demonstrated in Bangladesh during the 1998 floods. Approximately 100,000 square kilometres was inundated for two- and one-half months, affecting 30 million people. Damages to standing crops, livestock and houses virtually suspended the rural economy. During the floods, in addition to relief work coordinated by the government and military, microfinance workers were able to help recovery by maintaining contacts with local scheme members. Workers carried money with them and provided immediate interest-free consumption loans so that the members would not go hungry. Different programmes, as discussed below, provided a number of specific financial services.

The Grameen Bank set up a Disaster Mitigation Task Force at the central level. It prepared and implemented a rehabilitation programme, which included new loan products and loan assistance for housing rehabilitation and agricultural production. The Bank gave fresh loans to members who had five to 10 installments remaining in the repayment schedule. The borrowers who had already paid half or more of their loans were eligible to take new loans for the amount that they repaid.

Two large NGOs with microfinance programmes were also involved:

The Bangladeshi Rural Advancement Committee extended loans to 240,000 families to support the repairing and rebuilding of homes. It also purchased 364 tons of rice in the open market and sold it at subsidized rates to group members.

The Proshika took up an emergency rehabilitation programme worth Tk50 million, through which 100,000 affected families were provided an interest-free loan of Tk500 each. It also supported a credit programme worth Tk30 million for aman, vegetables and winter crop cultivation.

In addition to these credit operations, all the programmes took up a number of relief and recovery activities, independent of their credit operations. For example, they set up medical centres and distributed food, drinking water, milk and medicine. They also agreed to support a number of activities in the non-farm sector, which would help the people affected by floods to resume their economic activities.

A number of factors contributed to the effective intervention of microfinance programmes in the 1998 floods. Programmes with good leadership responded quickly to the situation, availed of existing disaster mitigation funds or developed alternative fundraising strategies to meet the demand for resources. The involvement of committed field staff was also very important. Close monitoring allowed for the collection of information on the damage to assets and income of clients and loss of programme income as a result of potential drops in savings and repayment. On the basis of this information, programmes projected capital requirements for loans during the rehabilitation period.

Source: Vatsa (2002)

Environmental degradation

Often the poorest in rural areas occupy the most marginal lands and this forces people to lead precarious and highly vulnerable livelihoods in areas prone to drought, floods and other hazards. The densely populated agricultural communities of coastal Viet Nam and on the 'bunds,' or islands, in the delta of the Ganges in Bangladesh, are examples.

In some Central American and Andean countries, settlement of previously sparsely populated areas has been used as a strategy to overcome rural poverty in other areas of a country. However, the subsequent destruction of tropical forests to make way for agricultural production that is often poorly adapted to the new ecosystem, can lead to the generation of new patterns of flood, drought, fire and landslide hazard. This in turn increases the impoverishment of the migrants. At the same time, migration breaks the cultural relationship between the rural population and their environment, meaning that people are unaware of and unable to manage the hazards in their new environment.

Market pressures and government policies may also increase risks in rural areas. Subsidised cultivation of crops with a high demand for water in arid areas can increase drought hazard over time. The cultivation of coca for the lucrative drug market has lead to the massive destruction of tropical forests in Colombia (more than 100,000 hectares are under coca cultivation), increasing flood, drought, fire and landslide hazard.

In the Islamic Republic of Iran, the negative effects of the severe drought that affected the country from 1999 through 2002 were magnified by non-climatic factors. In 2000, it was estimated that there were losses of US$ 1.7 billion in livestock and crop production. In 2001, it was estimated that these losses increased to US$ 2.6 billion. Additional effects of the drought included displacement from rural to urban areas, deterioration of public health and outbreak of water borne diseases, increased unemployment, the disappearance of wetlands of international significance, and increases in related hazards such as fires, wind and soil erosion, flood and landslide hazard. While severe deficits of precipitation occurred over a three-year period, meteorological drought was magnified by the inappropriate use of water resources for irrigation and drinking. Irrigation water efficiency is only 35 percent, which suggests that two thirds of the water is lost. Per capita water usage in Tehran is 239 litres per day, compared to 120 litres per day in Western European countries. More than 25 percent of drinking water is lost in eroded pipes. Rangelands were being used for grazing three times more than their peak capacities in a non-drought year, resulting in severe degradation as well as accelerated soil erosion. The cultivation of high water-consuming plants, such as sugar beet, in arid areas is a further factor that depletes water resources.

Free trade and fair trade

For the majority of rural communities connected to the global economy, livelihoods are vulnerable to fluctuations in world commodity prices. When low commodity prices coincide with natural hazards, rural livelihoods come under high stress. In Nicaragua and Guatemala, the most impacted communities following a drought in 2001 were seasonal farm workers in depressed coffee-growing regions.

Ethiopia's rural economy depends on coffee revenues for a large part of its income. Fifty-four percent of the country's exports come from coffee, so the current coffee price crisis is having a significant impact on the national economy. Ethiopia's export revenues from coffee declined from US$ 257 million in 2000 to US$ 149 million in 2001 — a 42 percent reduction in just one year. This drop in income is nearly twice the US$ 58 million granted the country in debt reduction under a World Bank programme for Highly Indebted Poor Countries.

Fluctuations can be felt directly by those who extract a livelihood from the sale of primary resources (farmers, fishermen and foresters), but also by the rural landless who are reliant on selling their labour and may be the first to suffer in an economic downturn.

Isolation and remoteness

Those rural economies that are isolated from the global economy do not suffer from world market price fluctuations, but are not necessarily any less at risk. While in good years, dependence on local resources will insulate communities, in times of stress isolation tends to limit choices for coping strategies and may increase vulnerability. Reciprocal relationships, where wealthier individuals or households provide work or gifts for more food insecure groups, has been noted as an important risk reduction strategy in rural Asia and Africa.[30]

BOX 3.8 CAN FAIR TRADE REDUCE RISK?

Economic development strategies oriented towards primary commodity exports can offer substantial benefits for local development. These strategies can also be held hostage to fluctuating world commodity prices or terms of trade negotiated with partners in bilateral or regional trade agreements. Fair trade offers the potential for guaranteed prices, often above minimum market rates. Fair trade also seeks to provide for the empowerment of all partners. This can mean the promotion of collaborative decision-making and the setting aside of resources for enhancing social development or ecological protection. For those communities facing disaster risk, access to higher and more predictable levels of income can help build resilience. Where social empowerment and ecologically sustainable development is practiced, the gains are magnified even more by enhancing the capacity to cope with natural hazard and avoid disaster.

Kuapa Kokoo is a Ghanian cocoa growers cooperative which in 1998 joined forces with Twin Trading, The Body Shop, Christian Aid and Comic Relief to found The Day Chocolate Company. Kuapa Kokoo own one third of the shares in the company and two elected farmer representatives sit on its board.

Kuapa Kokoo sells about 1000 tonnes of yearly output to the European fair trade market. This means that, providing their production methods meet internationally audited conditions, the producers receive a guaranteed price for their goods and the security of long-term trading contracts. In the case of cocoa, recent prices on the world market have fallen as low as US$ 1,000 per tonne. In comparison, on the fair trade market they receive US$ 1,600 per tonne, plus an extra US$ 150. Even if the world market price reached US$ 1,600, the fair trade price would still include the extra US$ 150 on top of the world market price. Therefore, as well as the benefits that the farmers receive through being part of Kuapa Kokoo, they also benefit from the premium price paid for their cocoa on the fair trade market.

Kuapa Kokoo also has supported income-generating activities for women to supplement their incomes and to make them less dependent on men, as well as provide money for the family during the off-season while the cocoa is growing. For example, a project has been set up to make soap from the potash produced from burnt cocoa husks. This soap is then sold internationally, generating additional income from the waste cocoa materials.

Despite transaction costs, there is a growing waiting list of villages wanting to join Kuapa Kokoo. Training is all done in-house and the cooperative employs more than a dozen society support and development officers as part of its operations team. The buying and logistics as well as management systems have been gradually regionalised and by the 1999-2000 season, Kuapa Kokoo was operational in five cocoa-growing regions, with about 460 village societies and 35,000 farmer members. The proportion of women farmers has increased from 13 percent to nearly 30 percent.

Source: www.ico.org; www.oxfamamerica.org; http://www.divinechocolate.com/kuapa.htm

Deficient rural infrastructure, together with its vulnerability to hazard impacts, can increase livelihood risks and food insecurity in rural areas. During the 2002 food crisis in Mozambique, northern Mozambique was actually producing a surplus of food while the southern part of the country was experiencing a dramatic shortfall in cereal production. The weakness in the country's north-south communication, aggravated by the effects of floods on roads and bridges, meant that it was too costly to transfer the cereal surplus of the north to address the food crisis in the south. The destruction of crops during disaster or the loss of agricultural labour power that prevents cultivation (as in the case of households and families who have lost members to disease such as HIV/AIDS or to armed conflict), can ultimately lead to a crisis in food security for the household or community. As discussions regarding data used to present losses from drought in the DRI have indicated however, such crises are rarely a straightforward result of temperature or rainfall extremes.

In an open and equitable society, food can be accessed from elsewhere, bought from the international market or sourced from donors before food crises develop.

It is in those places where physical access is restricted that the greatest risk prevails. Physical access may be hindered because of physical barriers, such as floodwaters and high winds that can prevent emergency response or longer-term food aid arriving at the right time. But physical access can also be interrupted by human intervention, such as armed conflict, intentional or accidental diversion of aid, and in the worst cases, can be used as a political or military strategy.[31]

The use of land mines results in the loss of productivity of farmlands, removal of vast tracts of arable land from safe use for decades and disruption of transportation and agricultural markets (for example, in Angola).

BOX 3.9 FROM REGIONAL VULNERABILITY TO VULNERABLE PEOPLE: CHANGING CONCEPTUALISATIONS OF RURAL VULNERABILITY IN ETHIOPIA

Policies apparently aimed at combating rural vulnerability can sometimes be biased against those most at risk. Until recently, this was the case in Ethiopia. Government food aid was distributed at the regional level, based on accumulated knowledge of areas known to have suffered from chronic drought and food insecurity in past years. This was regardless of the spatial and temporal changes in vulnerability among affected regions over time or in relation to particular drought characteristics. In the 1995-1996 harvest period for example, 63 percent of the regions receiving aid had populations that already had access to at least the requirement of 1,680 kilo calories per person per day.

Ineffective targeting stems from an inability in the system of regional scale, food insecurity assessment to differentiate local needs. The responsibility for fair distribution is held at the national level, where the motives for aid giving can be shaped by many factors peripheral to farmers' needs.

The Government's rationale for basing food aid disbursement on regional measures of vulnerability is founded on a history of regionally specific famine affecting the north, particularly in 1974 and 1982-1984. There are also socio-economic similarities among people in specific areas in terms of income and economic constraints. Yet, it has been demonstrated that the actual relationship between food availability and food aid receipts in Ethiopia is not conditioned on localised need. The attention given to similarities obscures the specific vulnerabilities of the north's sub-regions.

Learning from these experiences in 2001, a draft handbook for use by practitioners in the field was agreed to by international and national agencies on the Food Aid Targeting Steering Committee. There is now an emphasis on differences in vulnerability at the community level — an outcome of both a policy change and collaboration among early warning organisations.

This has amounted to a shift in policy from the recent past. Previously, drought, vulnerability and food insecurity in Ethiopia were appraised through the lens of international agreements, the changing priorities under national political transitions, and concepts of sovereignty, nationhood and ethnicity. These perspectives had the effect of producing policies and strategies that, in effect, de-emphasized the situation of vulnerable people while targeting analysis and response to the region and nation. Now the pattern is changing. The vulnerability of people as well as regions are receiving the attention they deserve.

Source: Stephen, Linda (2002)

A dynamic pressure: global climate change

'Populations are highly vulnerable in their endowments and the developing countries, particularly the least developed countries…have lesser capacity to adapt and are more vulnerable to climate change damages, just as they are more vulnerable to other stresses. This condition is most extreme among the poorest people'.[32]

Climate change brings with it long-term shifts in mean weather conditions and the possibility of the increasing frequency and severity of extreme weather events. The latter is perhaps more threatening to agricultural livelihoods. A multi-agency report on poverty and climate change[33] identified specific challenges for Africa, Asia, and Latin America and the Caribbean and cross-cutting themes shaping vulnerability in small island states. Some of these are shown below:

- Key challenges for Africa include droughts contributing to a decrease in grain yields and sea level surges affecting most of Africa's largest cities.

- In Asia, some northern areas might experience increased agricultural productivity. However, for more populated central and southern Asia, sea level surges and increased intensity of tropical cyclones could result in the displacement of tens of millions of people from low-lying coastal areas.
- For Latin America, a mixture of increases in flooding, droughts and tropical cyclone activity will change risk profiles.
- Small island states will be especially prone to stresses attributed to sea level surges, including loss of land, dislocation of people, salinisation of freshwater aquifers and damage to highly productive coastal mangrove and coral ecosystems.

Taken together, the effects of climate change increase uncertainty and the complexity of risk for everyone, ranging from poor, small-scale farmers to wealthy agriculturists. While the developed nations of the world produce the majority of greenhouse gases, the burden of impact will be more severe on developing countries as they have larger vulnerable populations and are less equipped to deal with extreme weather events.

Changing natural hazard risks related to climate change will alter disaster risk patterns. Of hydro-meteorological hazards potentially affected by climate change, floods, storms and droughts present the most widespread direct risk to human assets.

Flooding and landslides, pushed by heavier rainfall, and by surging sea levels in coastal areas, may become increasingly common. With sea levels predicted to rise by up to nearly one metre in the coming century, heavily populated areas of low-lying land — such as southern

BOX 3.10 CLIMATE CHANGE AND DISASTERS: TOWARDS AN INTEGRATED CLIMATE RISK MANAGEMENT

The scientific evidence that the climate is changing due to greenhouse gas emissions is now incontestable. It is equally well accepted that climate change will alter the severity, frequency and spatial distribution of climate-related hazards. However, even while the modelling of the linkages between global climate change and particular extreme climate events becomes increasingly sophisticated, it is still not possible to predict with any degree of confidence how particular climate events will behave in the future in specific locations. Even with regular and much better understood climate phenomenon like ENSO, considerable regional and temporal variations in impacts are observed from event to event.

The lack of capacity to manage and adapt to climate-related risks is already a central development issue for countries with low-lying coastlines or exposed to hydrometeorological hazards. The lack of capacity to manage the risks associated with current climate variability (on a season-to-season and year-to-year basis) will be magnified in countries exposed to global climate change. Here, disaster risk reduction will have to contend with additional pressures stemming from the complexity and uncertainty of global climate change. The challenges of climate change might best be met by building on current disaster risk reduction capacity. Such a synthesis of concerns reduces the likelihood of overlapping responsibilities and increases the cost efficiency of disaster and climate change risk reduction. Medium- and long-term adaptation must begin today with efforts to improve current risk management and adaptation. Responses to the local and national consequences of global climate change can benefit from current best practice in disaster risk reduction.

Current approaches towards managing disaster risk and adaptation to climate change fail to address the issue for different reasons. First, disaster risk is still predominantly focused on response to disaster events and fails to address the configuration of hazards, vulnerabilities and risks. Next, disaster risk reduction continues to be structured around specific hazard types rather than generic patterns of human vulnerability. This does not match with experiences of hazard which prevail in contexts more and more typified by concatenation, synergy and complexity. Third, focus on the impact of future climate change on risk fails to make the connection with currently existing climate-related risk events and patterns. At the same time, both approaches are divorced both in concept and in terms of the institutional arrangements and programming mechanisms at the national and international levels.

If development is to be advanced in countries affected by climate risks and if development is not to aggravate climate change risk, an integrated approach to local climate risk reduction needs to be promoted. Successful risk reduction approaches already practiced by the disaster risk community should be mainstreamed into national strategies and programmes. Addressing and managing climate risk, as it is manifested in extreme events and impacts today, will help to strengthen capacity to deal with future climate changes.

Integrated climate risk management would address both the hazards and vulnerabilities that configure particular risk scenarios. This could range in scale from actions to manage the local manifestations of global climate risk to global measures to mitigate hazard (for example by reducing greenhouse gas emissions) to reducing vulnerability by increasing the social and economic resilience of vulnerable countries (for example, SIDS). Integrated climate risk management would need to include elements of anticipatory risk management (ensuring that future development reduces rather than increases risk), compensatory risk management (actions to mitigate the losses associated with existing risk) and reactive risk management (ensuring that risk is not reconstructed after disaster events).

Integrated climate risk management could provide a framework to allow the disaster community to move beyond the still dominant focus on preparedness and response. In the adaptation to climate change, this could stimulate a move beyond the design of hypothetical future adaptation strategies. In some regions, such as the Caribbean and the South Pacific, synergy such as this is already being achieved. However, urgent actions must be taken at the international, national and local levels if integrated climate risk management is to move from a concept to a practice and serve to reduce risks and protect development.

Bangladesh, the Nile delta, parts of eastern China and many atoll islands of the South Pacific and Indian Oceans — face a bleak future. So, too, do the long stretches of low-lying coasts in western Africa from Senegal to Angola, in South America from Venezuela to Recife in Brazil, and much of the coastlines of Indonesia and Pakistan.

The damages associated with the regional climate impacts of El Niño provide some early indication of those that could accompany the regional consequences of global climate change.

The last strong cycle of El Niño appeared in mid-1997 and continued through 1998. A large number of countries in Central and South America and the Asia-Pacific region were severely affected by El Niño-related floods and droughts. Estimates of global economic loss range from US$ 32 billion to US$ 96 billion.[34]

The difference is that El Niño is a periodic event while climate change will generate lasting and cumulative stresses and shocks.

Climatic disturbances that change hazard profiles demand changes in coping strategy. Drought is a case in point. This hazard type, potentially under the influence of global climate change, has probably affected more households in southern and western Afghanistan than the recent conflict.[35]

In adjoining Pakistan, the drought in the Baluchistan and Sindh provinces were reported to be the worst in the country's history. In Iran, a 50 percent to 96 percent decrease in rainfall during the 1998-1999 winter season caused the loss of 37 percent of annual wheat production and 63 percent of annual barley production. Low water flows in the Tigris and Euphrates rivers basins in Iraq meant irrigated as well as rain-fed agriculture suffered.[36]

People have been living with drought in these and other regions for millennia. Whether and how their distribution and frequency will be affected by global climate change is not known. Nor is the extent to which traditional coping strategies, such as seasonal migration, will be useful under these changing conditions of hazard.

Where the dynamics of global climate change and economic globalisation are seen to interact, the shifting nature of hazard and disaster risk becomes even more apparent. The contribution of local disaster datasets to understanding the local distribution of impacts will assist in tracking the evolution of risk as climate change unfolds.

It remains to be seen what links the interaction of economic globalisation to global climate change. Some contemporary interactions are being felt in Ethiopia, where drought in 2002-2003 combined with extremely low world prices for coffee have produced a double crisis for the national economy and for small farmers, farm workers and their families.

Climate change increases the uncertainty faced by vulnerable communities through a widening range of future climate variations and hazards. This is not a hypothetical risk to be addressed several decades into the future, but a real increase in risk that is presently threatening lives and livelihoods.

As local climates become more unstable, farmers have greater difficulty knowing what and when to

BOX 3.11 SMALL ISLAND STATES, VULNERABILITY AND CLIMATE CHANGE

The future impact of sea level rise on small island states includes substantial coastal flooding, salination of soils and drinking water, and the destruction of coral reefs and mangrove stands vital for fishing and coastal protection. In extreme cases, low-lying atolls in the Pacific, including those of Kiritabi, the Marshall Islands and Tuvalu may be submerged.

Climate change may also bring greater risk of drought to Pacific small island states. In the 1997-1998 El Niño, Fiji lost half its sugar crop. Existing risk from tropical cyclones and related flooding may also be increased. Caribbean islands are not threatened by submergence, but are at high risk from sea level rise and climate change creating a more hazard-prone environment. Empirical evidence suggests an overall drying tendency for the eastern Caribbean. The Association of Small Island States has had some success in lobbying the international community. Through the United Nations Framework Convention on Climate Change (UNFCCC) and 1997 Kyoto Protocol, adaptation is starting to receive attention, in recognition that climate change impacts are increasing and changing hazard profiles today. Modest progress has been made with the establishment of a fund for non-Annex 1 countries and a special programme of assistance for least developed countries that will help eligible small island states.

In the Plan of Implementation of the World Summit on Sustainable Development, 2002, a special section on small island states encouraged the international community to assist in 'mobilizing adequate resources and partnerships for their adaptation needs relating to the adverse effects of climate change, sea level rise and climate variability, consistent with commitments under the United Nations Framework Convention on Climate Change'.

Source: World Disasters Report (2002), Challenger (2002), UN (2002)[37] plant and harvest. Risk of crop, and hence, livelihood failure increases. While rural communities may have adapted their livelihoods over centuries and developed sophisticated coping strategies to deal with local risks, unexpected hazards such as unseasonal storms or droughts invalidate those strategies and increase risk.

Combined with the additional uncertainty caused by economic globalisation, which may suddenly invalidate the economic viability of local production, climate change makes local risk coping strategies increasingly difficult and the option of successful risk management more challenging.

3.2 Cross-Cutting Themes in Disaster-Development

The themes to be discussed in this section are: violence and armed conflict, disease, governance and social capital.

These themes have been mentioned in the preceding discussions, but are critical to shaping patterns of disaster risk and therefore deserve additional scrutiny. The themes are no less important than urbanisation, rural livelihoods, globalisation or climate change. They are presented here to flag their cross-cutting influence.

A lack of internationally comparable and verifiable data on these themes, or the difficulty of meaningfully reducing complex processes into numerical values, forced their exclusion from the DRI model in its search for socio-economic variables that could be associated with natural disaster losses. Despite this, their influence on development and disaster risk seems clear and it is hoped that future runs of the DRI might be able to include such variables. This is a second reason for wanting to present an exposition of their relationship to disaster risk here.

3.2.1 Violence and armed conflict

During the 1990s a total of 53 major armed conflicts resulted in 3.9 million deaths (nearly 90 percent of them were civilians).[38]

In 2002, there were approximately 22 million international refugees in the world and another 20 million to 25 million internally displaced people. Even before additional risk factors, including gender, class, ethnicity, age or disability are taken into account, the very fact of being a refugee or an internally displaced person raises vulnerability.[39]

When the displaced settle in squatter settlements in cities, they are often exposed to new hazards because dangerous locations (river margins, garbage dumps, steep slopes) are the only places where they (and the urban poor) can find shelter. In other cases, internally displaced people and refugees are often forced to degrade their immediate environment to obtain resources such as firewood, even though this may magnify landslide, fire and flood hazard. The environmental impact in Guinea of 600,000 refugees fleeing from conflicts in Sierra Leone and Liberia in the late 1990s was considerable. In formalised camps, they often run the risks of epidemic disease.[40]

The economies of war fuel violent conflicts — control over natural resources exploitation and the production of illegal drug crops are dominant contexts — but are interwoven with social instability and economic poverty that diminish the capacity of people to cope with disaster risks.[41]

A vicious circle appears when as the state's capacity to address everyday hazard and disaster risk diminishes, so does its legitimacy in the eyes of its citizens — resulting in yet greater isolation, corruption and in some cases, ultimate collapse.[42]

Many areas suffering from complex political emergencies are also subject to periodic natural hazards.

The provisional analysis of drought undertaken in the DRI noted armed conflict and governance as factors that can turn low rainfall episodes into famine events. The 2002 food crisis in Southern Africa may have been triggered by drought. But in countries like Zimbabwe and Angola, the impact of the drought must be understood and responded to within the context of political instability and conflict.

At the turn of the 21st century, Afghanistan suffered three years of drought and a major earthquake on top of decades of armed conflict, creating a particularly acute humanitarian crisis.

The volcanic eruption in Goma, in eastern Democratic Republic of Congo, is a similar example of a rapid-onset natural hazard occurring within an area affected by ongoing conflict. In such contexts, there are currently more questions than answers about what should or could be reconstructed, and if and how institutions could provide a basis for reducing risk.

The fact that there are no self-evident answers is aggravated by the fact that few people are asking these big questions. The divisions between those working on natural disaster risk reduction and complex political emergencies and development have hindered the search for ways to address such situations. But these interrelationships could offer opportunities for reducing disaster risks. The case study of conflict and risk in Colombia in Box 3.12 presents a good example of common action.

Little or no attention has been paid to the potential of disaster management as a tool for conflict prevention initiatives.

At the international level, many examples exist of antagonistic nation states being brought together through the shared loss due to a disaster event, although such improvements are often temporary.

Following earthquakes in 1999, Greek-Turkish relations enjoyed some improvement with a jointly sponsored UN resolution on natural disasters made in November 2001 and high-level talks on Aegean issues in 2002.[43]

In Bosnia-Herzegovina, the relationship between disaster management and the need for local capacity building following conflict has been recognized. Since 2003, the central government's Ministry for Security has taken responsibility for natural disaster management and response in both the political-administrative entities in the country (Republika Srpska and the Federation of Bosnia and Herzegovina).[44]

In Colombia, violently opposed local communities in the Department of Meta have worked together to mitigate the impact of floods as a means not only of protecting livelihoods, but also of building trust and reconciliation.[45]

BOX 3.12 DISASTER RISK AND ARMED VIOLENCE IN COLOMBIA

In Colombia, the violent conflict that in its latest phase has affected the country for the last four decades, is a major factor in the configuration and accumulation of disaster risks. There are a large number of ways in which the conflict interacts with and aggravates already critical levels of disaster risk.

The illegal cultivation of coca and poppy in remote areas can lead to an increase in hydrometeorological hazard. The installation of coca cultivation in areas with fragile tropical forest ecosystems contributes to an increase in hydrometeorological hazard — notably flood, fire, landslide and drought. Additionally, coca cultivation, processing and export are a major source of income for armed irregular groups and thus a factor that 'fuels' the conflict in Colombia. In 2003, the areas under coca cultivation in Colombia had been reduced from 144,800 hectares to 102,000 hectares, partly a result of the policy of fumigating plantations. However, in the same period, dramatic increases in cultivation were detected by the United Nations Office on Drugs and Crime (UNODC) in the Departments of Guaviare, Narino y Arauco, showing that repression in some areas only pushes cultivation to new areas and leads to further environmental degradation.

The conflict has generated internal displacement and the Social Solidarity Network estimates that 964,904 people were displaced between 2000 and 2002. Internally displaced people from the conflict are often forced to occupy the most hazardous locations in the cities to which they move. Migrants can be even more socially and economically vulnerable than pre-existing low-income groups in the city. According to official sources, 73 percent of the displaced population comprises women and children. The displaced are particularly at risk to hazards such as floods and landslides in urban areas. According to the National Human Development Report 2003, some cities have seen their population significantly increase due to internal displacement. The displaced population in Quibdo in Choco Department, for example, reached the equivalent of 20 percent of the city's population at one stage.

The negative impact of hazard events such as floods on rural livelihoods is a force driving people into armed groups, illegal cultivation or migration and contributes to the reproduction of the conflict. According to the DesInventar database, some 1,546,585 hectares of agricultural land were affected by natural disasters in Colombia between 1993 and 2003, and more than 270,000 heads of livestock were lost. Losses on this scale seriously impact rural livelihoods, irrespective of the armed conflict.

In other words, a vicious circle exists where the conflict feeds hazard, exposure to hazard and human vulnerability in a process that generates risk. Risk in its turn feeds the conflict, which creates the conditions for yet greater hazard, exposure to hazard and human vulnerability.

Source: Cooperation Framework between the UNDP Bureau for Crisis Prevention and Recovery (BCPR) and UNDP Colombia (2003); National Human Development Report, (2003); DesInventar, Colombia database; Observatorio Sismico del Sur-Occidente, Universidad del Valle, Cali. (2003)

3.2.2 Changing epidemiologies

Epidemic diseases can be seen as disasters in their own right. They also interact with human vulnerability and natural disasters.

There is a great deal of variation in the relationships between disease, disaster and development. Following disaster, whether a population experiences a disease epidemic or not is influenced by the type of hazard and the environmental conditions in which it takes

BOX 3.13 AIDS AND DROUGHT IN SOUTHERN AFRICA

According to the Southern Africa Flood and Drought Network, rainfall totals during the 2002-2003 wet season were less than half normal levels across much of Swaziland, north-eastern South Africa and the southern-most provinces of Mozambique. In this region, risk from drought and other hazards exacerbates high levels of underlying stress powered by a regional health crisis. In 2002, 28 million people in Sub-Saharan Africa were living with AIDS.

The high incidences of HIV/AIDS combined with severe drought conditions are wreaking havoc on these countries already suffering from poverty. According to UNICEF, roughly 1.5 million Mozambicans are currently living with HIV/AIDS. Now that food is in short supply, many are developing full-blown AIDS and dying sooner as their bodies are weakened because of their poor nutritional intake. Some 300,000 children have already lost their mother or both parents to AIDS. While many orphans are looked after by extended families, those without support are particularly vulnerable to disease and economic exploitation in the struggle for survival.

It is this fight for survival that exposes people all the more to the harsh realities of HIV/AIDS and drought. Extreme poverty is only made worse by failed rural livelihoods and high food prices on the one hand, and the loss of income earners by AIDS and other diseases on the other. Where food is most scarce, nutritional status is weakened and HIV prevalence tends to be high. While women's empowerment and gender equality have been issues on the international development scene since the 1970s, the pathways through which HIV/AIDS is spread reflects the gendered politics of sex. As in most societies, women in eastern and southern African countries fight to gain equal status to men socially and in sexual relationships. Whether in a marriage that the woman relies upon for financial reasons, or in commercial sexual exchanges, the longer term and contingent possibility of HIV infection becomes subordinated to the more acute short-term necessities of economic survival.

In southern Africa, the national consequences of the drought — on top of chronic vulnerability caused by poverty and HIV/AIDS — is crippling. In combination, these three harsh realities intensify the negative impact of each and are having profound consequences for the human resources of this region — which is facing long-term degradation. As poverty and the impact of HIV/AIDS uncoils the traditional coping strategies, the risk of a hazard reinforcing a regional disaster has grown.

Source: UNDP, Expert Reviewer 2002

place, the particular characteristics of those people exposed to the disaster and their access to health services. Hazard events such as flooding or temperature increase in highland areas can extend the range of vector-born diseases such as malaria. Where people are not used to taking precautions, such as sleeping under a net, the disease can quickly spread.

In some cases, deaths caused by epidemics are higher than deaths caused as a direct result of the disaster, in other cases no deaths are recorded after a major disaster event. Whether the disease profile of a population makes individuals more or less susceptible to hazard and the impacts of a disaster depends on intervening factors, such as the quality of health services, nutrition, the demographics of the population and livelihood sustainability. In Bangladesh two floods show opposing relationships. In September 1991, a flood killing 100 people was associated with 1,700 deaths from diarrhoea or enteric epidemic. However, in September 1998, a flood causing 1,050 deaths was linked to 'only' 151 deaths from diarrhoea or enteric epidemic.[46]

In this section, the focus will primarily be on the relationship between HIV/AIDS and disaster. But other diseases, such as malaria, cholera, tuberculosis and diarrhoea, have important roles to play in shaping vulnerability and losses to disaster. Cholera can break out among displaced people following disaster. Malaria and dengue fever are common accompaniments of climatic hazards. Economic crisis and poverty also reduce people's coping capacities. During 2000, when Russia was hit by a particularly severe cold winter, the Red Cross reported that tuberculosis had reduced the capacity of the people to respond to the hazard.

In El Salvador, local health centres where parents in the past would have received antibiotics and timely treatment were destroyed in the 2002 earthquake. As a result, they must travel for hours to reach medical care. But because of the drought and low coffee prices, there is no surplus money for travel. Crop failure, due to drought and lack of income from wages on coffee farms, has produced hunger that reduces the children's resistance to infection.

A popular and successful strategy for reducing morbidity among low-income communities has been community-based health promotion. This strategy has great potential for piggybacking information and training in disaster risk reduction and emergency response in neighbourhoods where formal services are inadequate in their coverage.

In efforts to strengthen local adaptive capacity in countries affected by Hurricane Mitch, the Pan American Health Organisation (PAHO) worked through its network of community-level heath centres to promote local disaster preparedness with community members involved in key decision-making roles.[47]

In summary, development, disaster experience and health status are tightly coupled. A healthy population is more productive and likely to be less vulnerable to disaster-related hazards. Despite the powerful arsenal of vaccines and drugs that exist today, infectious diseases are on the increase, particularly in low- and medium-human development countries. They are attacking vulnerable groups and threatening to wipe out entire communities.

The lethal nature of these diseases, such as diphtheria, malaria, cholera, tuberculosis or HIV/AIDS, is being aided and abetted by the ongoing erosion of health systems, the spread of antibiotic resistance, disruption caused by conflict and disasters and above all, poverty.

HIV/AIDS and other diseases can exacerbate the disaster risks brought on by climate change, urbanisation, marginalisation and armed conflict. With HIV/AIDS, the able-bodied, adult workforce whom would normally engage in disaster-coping activities are too weak from the disease, or they are already dead. That leaves households composed of the elderly and very young, who lack labour capacity and knowledge. The staff of frontline public service agencies that might be expected to assist them may themselves also have had their ranks decimated from the disease. Cholera is a well-known disease of poverty and it is particularly deadly among populations weakened by either war or HIV/AIDS.

In 2001, approximately 36 million people were living with HIV and the predictions are that the number is set to rise drastically. According to UNAIDS, HIV/AIDS has emerged as the single greatest threat to development in many countries of the world. In Africa, AIDS impairs almost every activity of government, every sector of the economy, every part of everyone's life. In parts of southern Africa, infection rates are as high as 40 percent of the adult population — and still rising. Unchecked, HIV/AIDS will wipe out development gains where they have been made in Africa.

Rapid improvements are possible if good practice is built upon. In Thailand, Senegal and Cambodia, strong prevention campaigns have come close to containing the disease. Uganda has also shown strong signs of successfully combating the spread of HIV/AIDS.

The importance of transparency in disaster risk reduction is increasingly recognized. An interesting case is China's response to large epidemics such as AIDS. Estimates of the number of people living with HIV/AIDS in China remain very uncertain. Official figures in December 2001 reported the number of cumulative HIV infections to be only 30,736. UNAIDS estimates that there are more than 1 million HIV cases. Revised estimates from China have come much closer to the UNAIDS figures.[48]

3.2.3 Governance

Governance is seen by UNDP as the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences. It brings together the actions of state, non-state and private sector actors.

Governance has three legs: economic, political and administrative.

- Economic governance includes the decision-making process that affects a country's economic activities and its relationships with other economies. It clearly has major implications for equity, poverty and quality of life.
- Political governance is the process of decision-making to formulate policies, including national disaster reduction policy and planning.
- Administrative governance is the system of policy implementation and requires the existence of well-functioning organisations at the central and local levels. In the case of disaster risk reduction, it requires functioning enforcement of building codes, land-use planning, environmental risk and human vulnerability monitoring and safety standards.[49]

The characteristics of good governance — participation, rule of law, transparency, responsiveness, consensus orientation, equity, effectiveness, efficiency, accountability and strategic vision — are key for sustainable development and disaster risk reduction.

Good governance for disaster risk reduction

At the heart of good governance is a commitment to sharing decision-making power between the stakeholders in a process. This must be built on the political will to accept power-sharing and see the state as a facilitator in development. This contrasts with the conception of the government as the dominant actor shaping development and disaster risk management. Still,

BOX 3.14 THE STATE AND DISASTER PREVENTION: CUBA

In Chapter 2 of this Report, Cuba was identified as exhibiting very low relative vulnerability to tropical cyclones, despite having a high proportion of its population exposed to this hazard. Given Cuba's weak economy, this trend might appear especially surprising. Part of the explanation lies in Cuban social policy and disaster preparedness work.

Disaster reports from Cuba consistently report high economic and infrastructural losses, but low loss of life. In 2002, the International Federation of the Red Cross and Red Crescent Societies (IFRC) reported that hurricanes Isidore and Lili crossed the island less than two weeks apart. But thanks to well-organised evacuation procedures and shelter management, no deaths or injuries were reported. Success in saving lives under conditions of high economic stress is to be applauded. However, despite zero deaths and the evacuation of more than 600,000 people, hurricanes Isidore and Lili led to the damage or destruction of 57,000 homes, most of them in poor rural areas.

The hurricanes have also resulted in the Government's commitment to undertake an important housing reconstruction programme with a strong risk reduction component, with support from the UNDP and the international community. The programme introduces risk reduction approaches into urban development planning through five projects: the reconstruction of damaged buildings in Santa Clara and Cambaito; the renovation of Old Havana; the relocation of 200 families from a slum in La Mercedes; and the improvement of La Coloma, Pinar del Rio. The programme will enhance the capacities of both the national institutions dealing with housing, such as the National Housing Institute, and the communities with regard to local risk reduction issues. The programme is instrumental in closing the gap between the successful disaster response capacity and efficient evacuation system and disaster mitigation and prevention.

Source: Reliefweb (2002), Wisner (2001), www.onu.org.cu/vivienda/index.html

government remains a critical actor in development, based on its unique capacity as a mediator between private and public interests and as an actor with local, national and international connections.

In very fundamental ways, all the policy alternatives for ensuring that development contributes to managing and reducing disaster risk have to be underpinned by good governance. The failures of urban planning, building regulation, environmental control and regional development, mentioned in other sections of this chapter, can all be described as governance failures. Successful disaster risk reduction, at all levels, will depend on governance innovation.

Good governance is more complicated than simply downsizing the state. As Box 3.14 indicates with the example of Cuba, the state has — and here continues —to play a lead role in disaster risk reduction. As governance has become a catchword in development policy, there is danger of its uncritical application. As with other elements of development policy, enacting governance must take into account development history and cultural context.

While governments bear the primary responsibility with regard to the right to safety and security, they cannot and should not shoulder these tasks alone.

At national and international levels, civil society as an important governance actor is playing an ever more active role in forming policies to address risk. Civil society can also promote local participation, accountability and ownership. It is being increasingly recognised that disaster risk management at the local level is a key element in any viable national strategy to reduce disaster risks, building on the quality of community networks, the social fabric and effective municipal governance.

The private sector also has a role to play in moving towards sustainable development that incorporates an awareness of disaster risk. Unfortunately, there are very few recorded examples of corporate social responsibility that have engaged with the disaster risk-reduction agenda in developing countries.[50] There is great scope for encouraging the private sector to incorporate disaster risk issues into their corporate social responsibility planning.

Can external interventions build governance for risk reduction?

In contemporary, externally assisted capacity-building programmes for disaster risk management, a component of institutional strengthening is invariably included. It generally consists of strengthening a national organisation for emergency management, preparing a national disaster management plan, enacting a disaster management law or setting up training facilities.

A problem is that in these approaches, governance in the case of disaster risk management, has been focused narrowly as the creation of disaster specific legislation, administrative arrangements and institutional structures.

These efforts do not always necessarily result in enhanced capacity in disaster risk management. Though national organisations are set up, they are often excessively centralised and at times unable to effectively coordinate across other government sectors or with civil society. Similarly, centralised organisations can be excessively focused on emergency logistics, preparedness and response rather than risk reduction.

The existence of a national disaster organisation in the capital city may represent progress in countries where disaster risk-related organisations and legislation were previously weak or absent. But they may have little impact on risk-accumulation processes in remote provinces or districts.

Mainstreaming disaster risk reduction

One key challenge today is how to mainstream disaster risk management with development policy. The DRI makes such an agenda more possible by providing baseline data on risk, which then can be used to track the influence of development policy. But much remains to be done.

An example of good practice comes from the British Virgin Islands, one of seven countries in the Caribbean that are implementing a Comprehensive Disaster Management Strategy (CDMS) with support from USAID/OFDA, UNDP and the Caribbean Disaster Emergency Response Agency (CDERA).[51] The main objective of CDMS is to enhance sustainable development in the Caribbean by integrating disaster risk reduction into the development process of CDERA member states.

Also in the Caribbean region, the Caribbean Development Bank (CDB) is currently executing the Disaster Mitigation Facility for the Caribbean (DMFC) with 17 countries from 2001 to 2006. The DMFC has two strategic objectives: to strengthen the bank's institutional capacity for natural hazard management and to assist countries in adopting successful disaster mitigation policies and practices. The aim is to create a development planning framework and culture for effective natural hazard management through the incorporation of natural hazard mitigation into the project cycle.

Weaknesses in governance are frequently sited in assessments of rapid-onset disasters.

After every major disaster, the role of governments, NGOs, and other civil society actors is critically appraised. But the role of the private sector (for example, in underpinning land prices that produced geographies of risk or in assisting workers through the emergency and rehabilitation periods) is rarely assessed.

BOX 3.15 DECENTRALISED DISASTER RISK PLANNING: HAITI

Haiti is the only Least Developed Country in the Americas. When nearly 200 people died after Hurricane Georges in 1998, UNDP supported the government in the elaboration of a National Risk and Disaster Management Plan.

This National Plan was published in 2001 and established a highly decentralised Institutional National System on Risk and Disaster Management, in line with the importance accorded to participation of the population in the 1987 Haitian Constitution. It was recognised that the central government did not have the capacity to cover the entire country in a large-scale disaster scenario. But a lack of active district level disaster planning pointed to the need for supported decentralisation.

The participatory process of the preparation of the National Plan involved more than 30 institutions and eased the vital process of bonding between partners. Programme III of the Plan tackled local risk management. In this regard, the lack of a clear decentralization framework and operational local institutions led to a research-action exercise. This included a number of pilot projects by which local and national capacities were strengthened, particularly the Direction de la Protection Civile (DPC), which had core responsibility for improving training and monitoring skills. Several international organisations, such as UNDP, USAID/OFDA, the European Community Humanitarian Office (ECHO), Pan American Development Foundation (PADF), OXFAM and the Red Cross family, supported local risk and disaster management committees.

Several important gains have been made in the last four years. At the central level, the National Plan was approved and the process of legal reform was launched, including the reinforcement of the DPC and the consolidation of government-donor partnerships. At the local level, more than 90 local participatory committees have been created since 1999 and trained in high risk and poor areas outside Port-au-Prince. The proactive role of central government — directly or indirectly involved in most of these exercises — has provided more credibility and sustainability to community level interventions.

The increased number of committees, which include local authorities, civil society and private sector organisations, reflects the importance of risk and disaster management for the Haitian population. One lesson learned through this process is that where community-based mechanisms already existed for broader development work, it was more feasible and sustainable to factor risk management concerns in ongoing process — absorbing risk and disaster management functions — rather than creating new parallel community systems.

Source: Government of Haiti (2003), http://www.ht.undp.org/pnud-hai/projets/Bestpract.htm

Dealing with disasters is always a challenge for leaders. Swift and immediate response brings popular approval to the leadership. In extreme cases bad management of a disaster risk and event have resulted in leadership changes.

Popular discontent leading to the overthrow of the Somoza dictatorship in Nicaragua was fuelled by the

BOX 3.16 THE RELEVANCE OF GOVERNANCE: EVIDENCE FROM ZIMBABWE

On average, large-scale drought hits southern Africa once a decade. In 1992, the worst drought in living memory as it was called, parched the land from the Atlantic to the Indian Ocean. Despite a 75 percent crop loss, the grain-exporting country of Zimbabwe coped as the government reacted early. It had surplus maize from previous years, foreign exchange to import food, an efficient relief program in place and good will from donors. A well-planned relief operation averted a famine.

In 2002, after unseasonably heavy rain and a long dry spell, half of the population of 13 million needed food aid. Yet unlike 1992, reservoirs were full of water and there was plenty of grazing for cattle. Why were things worse? Ten years before, a drought induced by the El Nino weather phenomenon caused the crisis. This time, a combination of governance issues, economic crisis, widespread poverty and the spread of HIV/AIDS added human elements to a natural disaster.

Zimbabwe is the world's fastest-shrinking economy and declined at a rate of minus 10 percent in 2001. Poverty rates have doubled since 1992 and people's coping mechanisms are stretched to the limit. In the past decade, HIV/AIDS rates have soared to nearly 34 percent. As productive adults fall ill and die, households headed by orphans and grandmothers multiply.

Another factor playing a part in the crisis is commercial agriculture. Over the last two years, the amount of land planted and crops harvested by commercial farmers has decreased dramatically. Cereal production has fallen by two thirds since 1999. One million farm workers and their families have lost their jobs and homes — increasing the pressure in an already tense social climate.

The collapse of commercial agriculture means that, unlike 10 years ago, the country has no carry-over maize stocks to cushion the drought's impact. And the government's ability to import food is extremely low. Foreign exchange reserves are just US$ 65 million, enough to cover only half a month's imports. All of this is aggravated by the costs of supporting the country's military intervention in the Democratic Republic of Congo.

Source: Reliefweb C:\Documents and Settings\karl\Local Settings\Temporary Internet Files\Content.IE5\W9YB0PQR\1_ReliefWeb Zimbabwe's food crisis what went wrong[1].htm

theft of international funds provided for the rehabilitation of Managua, after a 1972 earthquake destroyed 80 percent of the houses.

Political systems recognise the need for strong intervention following a disaster. The challenge now is to increase the focus on disaster risk reduction as a central element of ongoing development policy. This should be a transitional point on the way to identifying development paths that can generate wealth without producing unacceptable levels of risk. Just what levels of risk are acceptable will be a political decision, requiring information on the disaster-development relationship and appropriate tools to aid transparent decision-making.

As with other development issues, disaster risk policy is sometimes hampered because of disjointed and uncoordinated policy-making. This very often has its roots in a fragmented governance structure.

Problems include competition or a failure to communicate between inter-governmental agencies and the state. Or in large countries, such as China or Brazil, between local, provincial and national tiers of government. That different agencies at the local and national levels hold responsibility for development policy serves to further fragment disaster-development policy.

A key problem caused by inadequate governance is the opportunity it allows for corruption in both the state and non-governmental sectors through a lack of transparency. Some political actors in disaster relief have been observed pursuing discriminatory policies in distributing relief and recovery assistance, favouring one segment of population over others. While this leads to the marginalisation of non-recipients (generally the most vulnerable), it also undermines the legitimacy of responsible organisations.

The example of Zimbabwe, shown in Box 3.16, may echo 1998 Nobel laureate Amartya Sen's argument that no substantial famine has ever occurred in any country with a relatively free press. In addition, data produced in the DRI analysis of drought identifies the Democratic People's Republic of Korea as a high-vulnerability state with respect to human loss from drought, even though it does not appear on the list of countries with large populations exposed to drought conditions.

Political will is critical at the national level to provide an enabling environment for good governance and disaster risk management. Such intention for reform is often most clearly expressed though legislative innovations.

In the last two decades, countries such as Algeria, El Salvador, Nicaragua, Haiti, Madagascar, Turkey, India and China, have demonstrated renewed political commitments to disaster risk reduction.[52] Within these reforms, legislation often remains a critical element in ensuring a solid ground for other focal areas such as institutional systems, sound planning and coordination, local participation and effective policy implementation.

In the mid-1990s, South Africa initiated a long process for reform with respect to disaster-related legislation, following destructive floods that affected thousands of households on the Cape Flats (see Box 3.17).

Unlike the reform of disaster legislation undertaken elsewhere in southern Africa, the South African experience has been completely owned and driven by South Africa-based partners. As a result, the pressure that accompanies an externally driven process to deliver amended legislation in one or two years (often unrealistic for achieving a broad-based buy-in) has not prevailed.

In the late 1990s, countries such as Nicaragua, El Salvador, Costa Rica and the Dominican Republic revised their legislation. This reform was the result of a fertile south-south cooperation effort initiated by Colombia and shared and developed in Central America after Mitch. The reforms generally increase inter-institutional coordination, institutional prerogatives for disaster risk reduction and offer opportunities for civil society participation.

But the road of legal reform is not easy, as other experiences seem to suggest. Haiti and Madagascar — two Least Developed Countries (LDCs) with high relative vulnerability to climatic hazards — are currently revising their laws regarding disaster risk reduction and opening windows for greater popular participation. Turkey and Algeria (after the recent earthquakes) have also undertaken a serious reform with a strong seismic and technical focus.

The critical issue is what should be achieved through improved governance. Institutional design, legislation and building codes provide 'technical' solutions in the short-term. But long-term institutional development requires addressing larger governance issues regarding the distribution and decentralisation of power, structures of decision-making and accountability, and participation of communities in the scheme of governance.

Governance for disaster reduction at the regional level

The emergence of regional organisations addressing risk management issues has been one of the salient characteristics of the last fifteen years. In addition to developing their own expertise and policy initiatives, regional organisations can provide continuity at the regional scale to help maintain national level progress in development and disaster risk management.

Regional organisations have proved particularly effective in addressing trans-boundary risk issues, for example, the work of the Mekong River Commission on flood risk in the Mekong River Basin. Regional organisations are also effective in areas where multiple countries are frequently affected by the same hazard events, such as hurricanes and cyclones in small island states in the Pacific or Caribbean, or drought in southern Africa or the Horn of Africa.

The emergence and consolidation of regional organisations has tended to reflect the maturity of disaster risk management as a key governance issue at the national level. Thus the level of development in Latin America and the Caribbean has tended to be relatively greater than in Asia and even more so than in Africa.

Regional organisations are playing a pivotal role in defining and shaping regional level risk management policies, in sharing knowledge between countries and between key agencies and individuals, and in supporting the development of national capacities.[53]

BOX 3.17 LEGISLATION CAN ENABLE DISASTER SENSITIVE DEVELOPMENT: SOUTH AFRICA

In the 1990s, South Africa initiated a long process for reform with respect to disaster-related legislation. Several key elements have characterised this process: local ownership of legislation; professional pressure for change; a deliberate, slow multi-stage process of change; widespread dissemination of preparatory discussion and policy documentation; commitment to transparent debate and consultation through parliamentary processes; continuity in individuals supporting the process; and a commitment to streamline incoming legislation with best international practice.

While legislative reform has been a lengthy process, it has gradually built the momentum for accepting change at political and functional levels across a range of government ministries. Moreover, the new Disaster Management Act will be enacted in the legal-administrative context of other recent legislation, including the Municipal Systems Act, the National Environmental Management Act and the Veld and Forest Fires Act.

The open deliberations surrounding the Disaster Management Act were critical to shaping the breadth of the final Act. The Act has significant inclusions with respect to vulnerability reduction as well as requirements for more extensive provincial and municipal consultation in disaster management. It also provides scope for applying legislation to disaster-prone areas, communities and households, thus allowing for greater differentiation in efforts, and calls attention to the importance of research and education as well as indigenous knowledge.

Within government, the relative stability of key national personnel driving the process has provided essential continuity. Success has also been built on a critical mass of disaster professionals with international exposure. Nevertheless, the Act reflects almost a decade of sustained effort.

Source: Holloway (2003)

BOX 3.18 THE ROLE OF REGIONAL ORGANISATIONS AND NETWORKS IN STRENGTHENING CAPACITIES FOR DISASTER REDUCTION

Regional organisations and networks are playing an increasingly important role in strengthening capacities for disaster reduction in different regions around the world. There are a number of different types of regional organisations:

- Regional intergovernmental organisations with a specific disaster reduction mandate, such as the Caribbean Disaster Emergency Response Agency (CDERA) and the Coordination Center for the Prevention of Natural Disasters in Central America (CEPREDENAC).
- Regional intergovernmental organisations that have included aspects of disaster reduction within a broad mandate, for example, the Organization of American States (OAS), Southern Africa Development Community (SADC), the South Pacific Applied Geoscience Commission (SOPAC) and the Stability Pact for South Eastern Europe.
- Academic or governmental organisations with a regional focus on disaster reduction, for example, the Asia Disaster Preparedness Center (ADPC) and the Asia Disaster Reduction Center (ADRC).
- Regional disaster reduction networks of academic and non-governmental organisations, such as the Network for Social Studies on Disaster Prevention in Latin America (LA RED), PeriPeri in southern Africa and Duryog Nivaran in South Asia.

Such regional organisations and networks are currently involved in a number of tasks and functions, which vary widely from one case to another. These include:

- Strengthening national capacities through training, programme support, technical assistance and resource mobilisation.
- Information sharing, documentation and comparative analysis of issues on a regional and sub-regional basis.
- Coordination of regional or sub-regional disaster reduction projects.
- Development of common regional or sub-regional policy platforms and the advocacy of regional policy initiatives in global forum.

Source: UNDP Expert Group Meeting on the Roles of Regional Organisations and Networks in Strengthening Capacities for Disaster Reduction, 2002.

3.2.4 Social capital and civil society

In recent years, the concept of social capital has provided additional insights into the ways in which individuals, communities and groups mobilise to deal with disasters.

Social capital refers to those stocks of social trust, norms and networks that people derive from their membership in different types of social collectives. Social capital — measured by levels of trust, cooperation and reciprocity in a social group — plays the most important role in shaping actual resilience to disaster shocks and stress.

When Hurricane Mitch struck Honduras in 1998, the district of La Masica on the Caribbean coast was able to mitigate losses through a process of local level risk management and early warning developed before the disaster struck. No deaths occurred in La Masica, in comparison to neighbouring watersheds with similar characteristics, where hundreds lost their lives.[54]

Civil society and social capital are no longer exclusively local institutions. International NGOs have built support within networks of individuals throughout the world who share similar concerns about risk. Even kinship-based networks are of an increasingly international orientation. This is shown (and demonstrated in Box 3.19) in the growing recognition of how remittances from relatives abroad are often the most important resource for disaster-affected people in meeting survival and reconstruction needs.

Local level community response remains the most important factor enabling people to reduce the risks

BOX 3.19 INTERNATIONAL SOCIAL CAPITAL

One of the reasons for strong international attention to the 2001 earthquake in Gujarat, India was the political and commercial strength of the non-resident Gujarati community in a number of developed countries. Shortly after the Gujarat earthquake, the non-resident population living in the United Kingdom managed to raise £2 million for recovery and reconstruction. In April 2001, the American India Foundation, an organisation of non-resident Indians based in the United States, organised a five-day visit to Gujarat and promised to raise US$ 50 million for relief and reconstruction work. Political representatives and governments in many of these countries were influenced by the strength of the Gujarati communities in sending relief materials. International assistance in the wake of the Gujarat earthquake, when compared with the 1999 cyclone in Orissa, India in which more than 10,000 people died, could predominantly be attributed to the skills in linking forms of social capital which the Gujaratis commanded.

The flow of remittances has become a widespread strategy for coping with poverty that has reduced the risk of many households. Following disaster, financial remittance flows from unaffected to affected areas has made a significant contribution to reconstruction. Following an earthquake in 2001, the Central Reserve Bank of El Salvador estimated that Salvadoreans living abroad sent home US$ 1.9 billion in remittances.

Migration is a well-established survival strategy across low development regions and countries in Africa, Asia, Latin America and the Caribbean. An overview of Africa's rural non-farm sector showed that in areas distant from major cities, migration earnings constituted 20 percent of total non-farm earnings. It was as high as 75 percent in areas close to cities. Worldwide, international remittance flows were estimated in the 1980s to total US$ 71 billion — exceeding official development aid.[55]

Source: Vatsa (2002)

associated with or cope with disaster. But community ties can be eroded by long-term or extreme social stress. Under conditions of extreme poverty, inter-household ties within the community break down as individual households can no longer maintain relationships. Social networks can also be strong but counter development, as in the case of drugs gangs or ethnically divided communities.[56]

Depletion of social capital is also an important contributing factor in complex emergencies. In this case, social unrest and displacement undermines social networks and traditional safety nets that exist at the community level, and may result in a natural disaster spiralling into complex political emergencies.

Social capital can also be eroded by development policy that purposefully or incidentally breaks local bonds of trust or friendship. Crises in social capital are found in former centrally planned societies as well as those within liberal political economies (see Box 3.20).

Despite economic wealth and political stability in Barbados, in the past civil society was not built up from the island's stock of social capital. This reached a low point in 1999 when only six electoral districts had an active local disaster group — out of a national system of community-based disaster prevention and response organisations organised around the island's 28 electoral districts.

Barbados is not alone in having difficulties in consolidating local social organisation to confront development and disaster risk. This indicates the need for a renewed effort to support local social organisation in the future.[57]

Building social capital and supporting meaningful participation by vulnerable groups and individuals in development is not easy. Principle characteristics of social vulnerability are political marginalisation and social exclusion. Encouraging social integration and political participation to enhance resilience and other quality of life goals is a major challenge to disaster and development policy.

In the past, many programmes sponsored by international organisations and developmental NGOs have claimed that their projects have built social capital by enabling local participation. All too often though, local participation has been captured by local elites and left the vulnerable behind. When vulnerable groups are included, there is always a danger that participation can drift into the shifting of development burdens from the state or NGOs and onto local actors, those with the least time, energy or resources to spare.

BOX 3.20 THE EROSION OF SOCIAL CAPITAL AND DISASTER RISK IN MONGOLIA

Known as Zud, the snow disasters in Mongolia in 1999-2001 that left millions of animals dead and threatened the livelihood and food security of the country's predominantly pastoral society are another good example of the impact of the depletion of social capital. The de-collectivisation of pastoral households in Mongolia eliminated a number of support mechanisms available to these households. During the socialist period, substantial safety nets were provided by herding collectives. But during this period of state-supported social security, all other risk management mechanisms traditionally practiced by communities weakened. In the early 1990s, when the process of liberalization started in Mongolia, most of the social security measures were withdrawn. Since the communities had lost their own traditional risk management practices that existed in the pre-socialist period, they had little preparedness and capacities at the individual or communal level. This led to one of the worst disasters in Mongolia's history.

Source: Bass, Batjargal and Swift, 2001

Examples of the successful and long-term strengthening of local communities do exist, but remain uncommon. A long-term commitment is needed, which is often beyond the funding and staffing cycles of many agencies. Perhaps more difficult is avoiding the trap of communities becoming dependent on well-meaning external agencies.

Following Hurricane Mitch, a pilot project to warp natural disaster prevention within the development agenda at the local level was initiated in Nicaragua in 2001. This UNDP project supported the work of the new Sistema Nacional para la Prevencion, Mitigacion y Atencion de Desastres (SNPMAD) in six municipalities; three in Nueva Segovia and three in Matagalpa.

In this programme, the government of Nicaragua undertook a participatory process of local development planning within a disaster reduction approach. Disaster reduction was factored into a range of planning sectors including infrastructure development, productive sectors, social sectors and environmental management. Disaster reduction was also formally taken into consideration in investment decisions for areas with a history of natural disasters, such as flooding and landslides. Following a risk-mapping exercise, areas of high disaster risk received additional support through protection measures, including incentives for environmental rehabilitation, the designation of safe areas for urban expansion and demarcation of zones for protection from human intervention.

This programme was itself a learning process. Key elements of success have included the realization that risk profiles and participatory processes in each municipality were different, so strategies should rely on local decision-making and be flexible in approach and implementation. In addition, local plans should be linked with central institutions to access support and blend with national development policy. The involvement of local stakeholders and the embracing of a gendered sensitivity to development, disaster risk management and participation were also key in maintaining local support and generating significant local outputs for disaster risk reduction.[58]

The most appropriate policies for enhancing the positive contribution of civil society will depend on the developmental context. For many countries in Africa, Latin America and Asia that have undergone structural adjustment and participatory development, the challenge may not be so much the creation of a non-governmental sector, as its coordination.

An overly strong civil society can undermine local and national government and undo democratic gains. This happens when private development agencies in civil society funded by the international community are perceived as overshadowing the state in driving local development.

In other cases, the state may still have an overriding control on civil society organisations and reduce their effectiveness and scope of operation. It is a fine balancing act, but the goal should be a strong civil society and a strong state working in partnership with a socially committed private sector.[59]

A final challenge for policies aimed at building social capital is the danger of undermining democratic institutions. It is all too easy to create an impression that non-state funding streams are more accessible, and locally far larger and more responsive, than local and state government agencies. Indeed, the main argument for funding civil society is weaknesses in the state sector. Over the long-term, funding civil society without strengthening the state simply reproduces the lopsided governance that interventions were designed to overcome. Working towards partnerships and transparency in funding, with support for good policy from state and non-state actors, may be a less rapid but ultimately more constructive approach to building local social capital to enhance resilience.

Disaster risk reduction also offers opportunities for embracing gender sensitivity in development policy and practice. For example, the skills and experience of women in building and maintaining local social networks can be critical for local risk reduction.

This said, the role of women in local decision-making often continues to be sharply constrained by social and economic status. It is not unusual to see women forming the majority of membership in an organisation, while men dominate in leadership positions.

For policy interventions seeking to include a participatory component, preliminary discussions to help map the social relationships within the community are essential if the vulnerable (who are also the socially excluded) are to be reached and helped to build their own levels of resilience through participation.

In Cox's Bazar, Bangladesh, the inclusion of women in disaster preparedness and development organisations (including education, reproductive health and micro-enterprise development groups) has been followed by a huge reduction in the numbers of women killed or affected by tropical cyclones.[60]

The importance of a gendered perspective on risk during the reconstruction period can be seen from the experiences of the civil society group Janpath after the Gujarat earthquake in 2001. Janpath is a network of activists and organisations that aim to enhance the status of women in Gujarati society as a means of building the foundations for more inclusive governance.[61]

3.3 How Can Integrating Disaster Risk Reduction and Development Planning Help to Meet the MDGs?

In Chapter 1, connections between each MDG and disaster risk management were made. Here, the discussion highlights opportunities for win-win policies that could help more people be free from preventable losses caused by disaster as part of a wider programme of meeting human development needs. MDGs 1, 3, 6, 7 and 8 are addressed as being of primary concern to disaster risk reduction.

MDG 1. Eradicating extreme poverty and hunger

There are many opportunities for interventions that could simultaneously reduce disaster risk and poverty and hunger.

- Strengthening and diversifying livelihoods.
- Encouraging responsible foreign investment and job creation.
- A flexible and participatory approach to urban planning.
- Building social security, including access to health and education.
- The provision of risk/loss spreading mechanisms for those excluded from insurance cover.

At levels from the individual to the national, the impact of disaster takes away the means of generating an income as well as any savings and assets. It is this aspect of disaster that means pro-poor development policy is also an opportunity for disaster risk reduction.

Many of the tools for delivering poverty-alleviation projects and programmes need simply to be modified to take account of disaster risk reduction. The added value of such work is to enhance the sustainability of poverty and hunger alleviation.

In development planning, many countries and international funding agencies include elements of environmental and social impact assessment for large projects. These assessments could take into account the potential impact of developments on disaster risk. This would allow for greater transparency in the power of large infrastructure developments to reshape where people live and what they do to make a living, and so to contribute to changing patterns of disaster risk. This information could then enable more informed claims from those impacted by disaster.

MDG 3. Promote gender equality and empower women

Gender influences the types of hazard to which an individual is exposed and an individual's access to resources with which to build resilience to hazard and to recover from disaster. Where structural constraints in society result in the exclusion of women from decision-making or economic security, risk will be unevenly spread. The continued exclusion of women from all levels of political decision-making is one of the greatest lost opportunities for human development and disaster risk management.

Eliminating disparities in primary and secondary education is the quantitative target set for this MDG. But there are many other ways in which women's full participation in society can be measured at the local level.

The long-term goals for development and disaster risk reduction must be to empower women and to encourage a self-questioning of the social structures within which women and girls live their lives. Also, to work with women and girls and provide the tools for moving towards greater equality with men in household, familial and wider social relationships.

Enabling a greater voice for the views of women in development will allow women to identify priorities for development. In enabling women to confront disaster risk, reforms in land and dwelling ownership, inheritance and employment rights are likely to be as important as the needs to strengthen the social justice concerns of women in accessing health, education and legal services.

Highlighting gender in development and disaster risk reduction raises a broader issue of inclusiveness in decision-making. To promote resilience, inclusive and consultative processes are needed that engage those most at risk. Often those most at risk are the most resourceful members of society, but also the least included in economic and political life. This will include women, but also child-led households, elderly people caring for grandchildren, ethnic and religious minorities, people weakened by chronic illness and social classes and casts with low social status.

MDG 4. Reducing child mortality

Children are at greater risk of being affected, injured or killed by disaster impacts than adults. For example, an estimated 114,000 school-aged children were made homeless by the Marmara earthquake in Turkey in 1999.[62]

It is perhaps the indirect impacts of disaster that have the greatest toll on children and interact with national mortality levels. Most important here is the loss of livelihoods that can lead to extreme poverty and homelessness for children left behind.

Appropriate safety nets, such as help for extended families with capacity to absorb orphans or well run orphanages, can support many children. But for those children born into families whose livelihoods and homes have been taken away by disaster impacts, the chances of survival in the first years of life will be reduced.

MDG 6. Combating HIV/AIDS, malaria and other diseases

For many people, natural hazard stress and shock is felt as one of many pressures. As the preceding discussion highlighted, HIV/AIDS and other diseases can undermine individual and collective coping capacity, just as disaster impacts can take away development gains and livelihoods, making people more vulnerable to illness.

Interventions to strengthen basic health care provision, family health care and preventative health planning can play central roles in strengthening society and building capacity with which to resist natural hazards.

Innovative development policy is required for those instances where natural hazard coincides with high rates of illness. Ways of providing subsistence, security and education for the children of families where adults may be dead or made weak from illness are difficult to find. This is even more so when rural livelihoods are under stress from drought conditions or crops and houses and tools have been swept away by floods.

Synergy exists between the aims of development and disaster risk reduction. The importance of integration is heightened amid chronic illness.

MDG 7. Ensuring environmental sustainability.

One of the clearest signals of a crisis in environment-human relations is natural disaster. Soil degradation, biodiversity loss, over-fishing, deforestation or drinking water scarcity undermine rural livelihoods and pave the way for vulnerability to environmental hazard.

In cities, pollution of waterways and the air and inadequate provision of drinking water, sanitation or solid waste management systems shape patterns of illness that run down resistance to everyday hazards. In rural and urban contexts, risk accumulation that ends in disaster is often closely tied to problems of environmental sustainability. Strategies to enhance environmental sustainability will make a contribution to breaking the chain of accumulated risk.

The man-made and natural environments are themselves at risk from disaster. Tropical cyclones and earthquakes can destroy natural assets and cultural treasures.

Geographical inequity describes much of disaster risk tied to environmental sustainability. The preceding discussion of global climate change highlighted the link between wealth creation for some, at the expense of increases in disaster risk for others in distant places. It is because of this that international cooperation is needed to support mitigation of climate change and for those societies forced to adapt to its impacts.

In the foreseeable future, it will not be possible to separate those aspects of hydrometeorlogical hazards that can be explained by climate change from background fluctuations. But the responsibility of industrialised countries for climate change is undeniable. Support for adapting to climate change and coping with its adverse impacts is an argument for increased international attention for disaster risk reduction.

MDG 8. Developing a global partnership for development

The most important components of this goal relate to trade, debt relief and aid. Success rests to a large extent on the willingness of developed countries to meet their commitments. The 2001 Ministerial Meeting of the World Trade Organization (WTO) in Doha, Qatar placed the needs and interests of the developing countries at the heart of WTO negotiations. However, in 2003, the subsequent stalemate in the Cancun round of WTO negotiations showed greater political will, collaborative thinking and action is required at the international level to allow developing countries to trade on a level playing field.

More progress has been made in debt relief under the Heavily Indebted Poor Countries (HIPC) initiative. Some 26 countries have now entered this process. The HIPC process is reinforced by international financial agencies that have integrated disaster lending into their portfolios.

Official Development Assistance (ODA) climbed in 2002 after nearly a decade in decline, but remains well below the target of 0.7 percent of donor countries GDP. Yet the amount of money provided for emergency and distress relief is small and fluctuates in response to annual crises. However, as a proportion of ODA, emergency and distress relief has steadily increased from 1.9 percent in 1986 to 3.2 percent in 1991, and reaching a peak of 7.8 percent in 1999. It has since declined to 6.3 percent in 2001.[63] Within this percentage, the funds oriented towards disaster risk management remains minimal.

Increases in assistance finance may reflect an evolving change in international donor priorities. As likely is a response to increasing disaster losses as the disaster-development relationship becomes ever more tightly connected, and human and economic exposure to disaster risk grows.

ISDR has succeeded in building regional and international partnerships for disaster risk reduction and in disseminating good practice. Similarly, negotiations around the United Nations Framework Convention on Climate Change (UNFCCC), most recently centred on the Kyoto Protocol, also provide a focus for international attention that can directly address the concerns of disaster risk reduction.

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Chapter 4
CONCLUSIONS AND RECOMMENDATIONS

The aim of this Report is to map out an agenda for change in the way disaster risk is perceived within the development community. It presents a range of opportunities for moving development pathways towards meeting the MDGs by integrating disaster risk reduction into development planning.

The Report argues that disaster risk is a product of inappropriate development choices, just as much as it is a threat for future development gains.

This Chapter summarises key findings from the analysis of disaster risk and the discussion of disaster-development linkages undertaken in the Report.

The summary leads into six recommendations for further action. Each proposal is kept broad, drawing from the evidence presented in the preceding chapters. Each recommendation supports a specific agenda for reform in the management of development processes and disaster risk, which will need to be unpacked and further developed in each specific regional and national context.

At the beginning of Chapter 1, four questions concerning the disaster-development relationship were posed. The first two questions guided attention to the mapping of disaster risk and its relationship with development. By way of a summary, we return to them again in section 4.1. The final two questions sought ways for refining development policy and disaster risk assessment tools to enhance the practice of disaster risk reduction. These are addressed through the presentation of recommendations in section 4.2.

4.1 Development and Disaster Risk

4.1.1 How are disaster risks and human vulnerability to natural hazards distributed globally between countries?

The DRI exercise undertook the first global level assessment of natural disaster risk, calibrated according to the risk of death between 1980 and 2000.

Four natural hazard types (tropical cyclones, earthquakes, floods and droughts) responsible for 94 percent of the deaths triggered by natural disaster were examined. The population exposed and relative vulnerability of countries to each hazard were calculated. The drought DRI was presented as a work in progress at this stage.

Results are summarised below in global terms and for each hazard type. In global terms and for the four hazard types, disaster risk was found to be considerably lower in high-income countries than in medium- and low-income countries.

Earthquake
High relative vulnerability was found in countries such as the Islamic Republic of Iran, Afghanistan and India. Other medium-development countries with sizeable urban populations, such as Turkey and the Russian Federation, were also found to have high relative vulnerability. As well as countries such as Armenia and Guinea that had experienced an exceptional event in the reporting period.

Tropical cyclone
High relative vulnerability was found in Bangladesh, Honduras and Nicaragua, all of which had experienced a catastrophic disaster during the reporting period. Other countries with substantial populations located on coastal plains were found to be highly vulnerable, for example India, the Philippines and Viet Nam.

Flood
Flooding was recorded in more countries than any other hazard. High vulnerability was identified in a wide range of countries and is likely to be aggravated by global climate change. In Venezuela, high vulnerability was due to a single catastrophic event. Other countries with high vulnerability to floods included Somalia, Morocco and Yemen.

Drought
African states were indicated as having the highest vulnerability to drought. Methodological challenges prevent any firm country-specific findings from being presented for this hazard. The assessment strongly reinforced field study evidence that the translation of drought into famine is mediated by armed conflict, internal displacement, HIV/AIDS, poor governance and economic crisis.

For each hazard type, small countries and in particular, small island developing states, had consistently higher relative exposure to hazard. And in the case of tropical cyclones, this was translated into high relative vulnerability.

4.1.2 What are the development factors and underlying processes that configure disaster risks and what are the linkages between disaster risk and development?

The measurement of hazard-specific relative vulnerability for each country flagged the importance of mediating development processes in the translation of natural hazard into disaster risk.

In many countries, despite large exposed populations deaths were low (Cuba and Mauritius for tropical cyclones), suggesting development paths that contained disaster risk in various ways. For other countries, deaths were very high (Honduras and Nicaragua for tropical cyclones), indicating development paths that had led to the accumulation of catastrophic levels of disaster risk.

The analysis of socio-economic variables, available with international coverage, and recorded disaster impacts enabled some initial associations between specific development conditions and processes with disaster risk. This work was undertaken for earthquake, tropical cyclone and flood hazard. A lack of appropriate variables limited the confidence that could be placed on the analysis of drought. Consequently, no findings for this hazard are presented here.

Losses to earthquakes were associated with countries experiencing rapid urban growth and high physical exposure. For tropical cyclone, losses were associated with a high percentage of arable land and high physical exposure. Vulnerability factors associated with flood were low GDP per capita, low local density of population and high physical exposure.

Further analysis was structured around two development factors shaping contemporary disaster risk: rapid urbanisation and rural livelihoods.

Rapid urbanisation configures disaster risk through a range of factors: the founding of cities in hazard-prone locations, the concentration of population in hazard-prone locations, social exclusion and poverty, the complex interaction of hazard patterns, the generation of physical vulnerability, placing cultural assets at risk, the spatial transformation of new territories, and access to loss mitigation mechanisms.

In general, disaster risk considerations are rarely factored into urban and regional planning and the regulation of urban growth has been ineffective in managing risk. Economic globalisation concentrates economic functions in cities that might be at risk and promotes the speedy flow of international capital — heightening inequality and instability, but also providing opportunities for building capacity and resilience.

In rural areas, livelihoods become at risk due a range of factors: poverty and asset depletion, environmental degradation, market pressures, isolation and remoteness, the weakness or lack of social services and climatic fluctuations and extremes. Global climate change makes rural livelihoods more risk-prone by increasing uncertainty.

The configuring of risk by contemporary patterns of urbanisation and rural livelihoods needs to be viewed alongside other critical development pressures. Violence and armed conflict displaces people and disrupts social and economic development. Changing epidemiologies, especially of HIV/AIDS, malaria and tuberculosis, bring new configurations of hazard. Changing governance regimes offers possibilities for the integration of international with national and local action to reduce disaster risk. The increased role played by civil society in development and disaster risk reduction highlights the capacity of local actors to organise and confront disaster risk.

The Report argues that meeting the MDGs will be made more difficult if disaster risk is not integrated into development planning. More positively, if the MDGs are met this could result in a substantial reduction of international disaster risk. Whether this is the case depends on the extent to which synergies in the disaster risk and development agendas are recognised and acted upon.

The next section advances recommendations for building a closer synthesis between disaster risk and development planning.

4.2 Recommendations

Recommendations 4.2.1 to 4.2.5 propose an agenda for change in broad terms. A final section, 4.2.6, presents a more detailed set of recommendations to enhance the data collection and analysis of disaster risk that should underpin the process of integration. They emanate from the experience of undertaking the DRI.

4.2.1 Governance for risk management

Appropriate governance for disaster risk management is a fundamental requirement if risk considerations are to be factored into development planning, and if existing risks are to be successfully mitigated.

A number of key elements in governance regimes were highlighted in the Report. They deserve reiteration as critical areas for reform in building national and global disaster risk reduction capacity and in mainstreaming disaster risk management.

The detailed changes in elements of governance advocated here can be interpreted as an outcome of the influence of a particular body of rules and values, that place importance on equity in the distribution of risk, and security and widespread participation in decision-making. These are key tenets of UNDP's perspective on international development and inform the basic orientation of this Report.

There is a need for institutional systems and administrative arrangements that link public, private and civil society sectors and build vertical ties between local, district, national and global scale actors.

Legislative reform is necessary but on its own, not a sufficient tool for increasing equity and participation. Legislation can set standards and boundaries for action, for example, by defining building codes or training requirements and basic responsibilities for key actors in risk management. But legislation on its own cannot induce people to follow these rules. Monitoring and enforcement are needed.

Legislation has its strength in societies where most activities take place in the formal sector and are visible to administrative oversight. In many high-risk nations and locations, monitoring and enforcement — and even widespread knowledge — of legislation is not achievable in the short- to medium-term because of financial and human resource constraints.

Fortunately, the principles of equity and participation in disaster risk management are not solely dependent on legislative reform. Much of the discussion in Chapter 3 sets out key pathways through which good governance can be enacted beyond legislative standards. The strategies described outline ways in which inclusive decision-making could be encouraged so that the knowledge and views of all stakeholders in development and disaster risk management could become involved.

The key challenge in building governance structures for human development and risk reduction is to play off efficiency with equity. Decisions often have to be made quickly, but rapid decision-making can factor in participatory approaches if planned appropriately. Enhancing the influence of local actors, through their participation in the local governance of risk, offers great potential for increasing the sensitivity and responsiveness of development planning to disaster risk.

The ISDR/UNDP Framework to Guide and Monitor Disaster Risk Reduction has the potential to make risk governance more transparent. If taken up globally, international comparisons will help refine and target policies to reduce risk and build a structured approach to the identification of good practice.

4.2.2 Mainstreaming disaster risk into development planning

Development needs to be regulated in terms of its impact on disaster risk.

For many projects, especially large industrial developments, environmental and social impact assessment and risk assessment provide a ready framework for building disaster risk assessment into development planning. What is missing is a detailed procedure for identifying, categorising and placing some appropriate value on disaster risk. Again, the technical tool kit exists to build such a framework. In addition to quantitative environmental and social impact and risk assessments, and insurance risk assessment methods, more qualitative methods for judging investment risk could be applied. What is missing is the political will to build a more holistic assessment of development impact into development planning.

Assessing disaster risk will put the spotlight on environmental and social externalities, sometimes at temporal and spatial distance from specific developments. Making disaster risk reduction explicit in planning a development could enable a broad participatory decision-making process, in which levels of acceptable risk can be debated on a case-by-case basis. National and municipal governments will need to be lead actors in this process, perhaps aided by international actors.

Some examples of existing best practice can be pointed to. The World Bank, through its Disaster Management Facility, has begun to incorporate disaster risk into its lending considerations. Up to 1999, US$ 6.5 billion in loans included some form of mitigation to reduce disaster vulnerability within a larger development project.[1] Innovative urban planning for rapidly expanding cities has shown the need for flexibility in applying planning regulations, but also the great need to apply planning guidance quickly as cities grow. The aims are simple. For example, by keeping access roads and fire breaks between housing blocks to enhance security from urban environmental risk, fire and communicable disease. These tasks require a rethinking of the professional role of urban planners and the legitimacy of peri-urban satellite settlements, many of which might not have formal land rights. Creative thinking and political support are needed to move this agenda forward, but the seed is there.

Perhaps the greatest challenge with mainstreaming disaster risk into development planning is geographical equity. This is a problem shared with environmental management and environmental impact assessment. How to attribute responsibility for disaster risk experienced in one location, but created by actions in another location?

Examples of this dilemma include the degradation of fisher-people's livelihoods and health from the pollution of waters by urban sewerage or industrial practices, or the contributions of individuals and industrial production to global climate change.

Attributing responsibility is particularly problematic when degradation and risk is the consequence of multiple actions from multiple locations spread over time. This is an ongoing area of concern for the wider environmental management community with opportunities for cross-fertilisation in policy innovation.

The observation in this Report is that environmental impact assessment should be extended to include a risk analysis component.

Factoring risk into disaster recovery and reconstruction

The argument made for mainstreaming disaster risk management is doubly important during reconstruction after disaster events.

It has long been argued that reconstruction efforts need to learn from the disaster experience and factor risk-reduction strategies into the rebuilding of the physical and social fabric after a disaster. Unfortunately, there are still many examples where reconstruction means the rebuilding of pre-disaster risk or perhaps worse — an incomplete effort that leaves many without the basic necessities for maintaining a livelihood or their physical or psychological health. With more than thirty years of international experience in disaster reconstruction, many examples of good practice are available but need to be more widely applied.

And further work is required. Tools need to become mainstreamed within disaster reconstruction programmes as well as ongoing development. Reconstruction is often a politically opportune moment to introduce change into development procedures or goals. It can offer a more easily justified moment to introduce disaster risk at the programme and project levels.

4.2.3 Integrated climate risk management

Building on capacities that deal with existing disaster risk is an effective way to generate capacity to deal with future climate change risk.

Over the long-term, climate change will manifest as a difference in baseline weather parameters. But more importantly, this change is likely to be experienced as an increase in both the frequency and magnitude of extreme hydrometeorological hazards, such as tropical cyclones, floods and droughts. Efforts to track and respond to both elements of change can learn a great deal from the expertise and tools already developed within the natural disaster community.

Particular strengths exist in different world regions. For example, the European and North American rural development agencies could learn from work developed in Africa and Asia on tracking livelihood sustainability and slow onset disaster that is linked to changing environmental baselines (for example in drought vulnerability assessment). Similarly, there is much technological skill that could be transferred from the global North to the global South to aid the monitoring of physical processes, and to build appropriate governance regimes to maximise opportunities for adaptation and risk reduction.

As the climate change community continues to place more emphasis on adaptation in addition to the established discussion on mitigation, so the natural disaster community should play an enhanced role.

It is important that the mitigation agenda is not overshadowed by adaptation. The Kyoto Protocol has advanced a set of policy tools that aim to make national development strategies sensitive to their contribution to global climate change risk. Following the same logic, this Report argues for development planning to take up decision-making and information tools that will build sensitivity to disaster risk processes. At the local level in particular, this will require a focus on building capacity for adaptation as proactive risk management.

Climate change will affect most aspects of life. Therefore, it is also important that guiding principles be established for ensuring the mainstreaming of climate change concerns within ongoing human development practices. Key sectors of economic planning — agriculture, tourism, land-use planning, public health, environmental management and basic infrastructure provision — will all need to take climate change into consideration. But mainstreaming efforts might also need to incorporate foreign relations and immigration or emigration policy, as well as resettlement schemes linked to restructuring of the economy. In all of these efforts, lessons gained from natural disaster risk management can form a rapidly accessible resource from which to build tool kits for adaptation.

4.2.4 Managing the multifaceted nature of risk

Natural hazard is one among many potential threats to life and livelihood.

Often, those people and communities most vulnerable to natural hazards are also vulnerable to other sources of hazard. Livelihood strategies for many people are all about playing off risks from multiple hazards sources — economic, social, political, environmental. From this perspective, the increase in perceived risk accruing to an individual or group from not investing time or energy in natural hazard risk reduction, may be an accepted cost in the face of more immediate needs for security from economic collapse, social violence and conflict. When choices are limited, energy is spent on coping with the most immediate of threats.

Analysis in Chapter 2 has shown the value of an integrated approach to risk assessment as a step towards integrated risk reduction. This is not a new idea. Complex political emergencies have for some time been recognised as containing many different drivers of risk, with natural hazard as one possibility. Some key hazards were identified in Chapter 3 — disease (HIV/AIDS, malaria, tuberculosis), landmines and internally displaced people. To this list, we could add small arms, terrorism and crime as risk elements that play out with vulnerability to natural hazard.

From a disaster risk reduction perspective, multi-hazard approaches are uncommon. Perhaps with the exception of work on drought and rural crisis that includes political emergencies and HIV/AIDS. There is a need to explore the relationships between natural hazards with other sources of hazard in the accumulation of risk as a precursor to developing an integrated disaster risk reduction approach.

National level Poverty Reduction Strategy Papers (PRSPs) offer a timely opportunity for factoring multiple-hazard perspectives into development planning.

4.2.5 Compensatory risk management

In addition to reworking the disaster-development relationship, which this Report hopes to make a contribution towards, a legacy of risk accumulation exists today and there is a need to improve disaster preparedness and response.

The agenda proposed in this Report is one of reform in the disaster risk sector and a reorientation towards the long-term management of disaster risk within sustainable development. This is needed over the medium-term to contribute towards the meeting of the Millennium Development Goals. But the time-span for change is likely to be best measured in decades and generations rather than years.

Within this long-term agenda of reform, existing risks remain to be managed. Indeed, development actions of yesterday and today will continue to shape the accumulation of disaster risk for the foreseeable future. Chapter 3 of this Report outlined an array of good practices that can be used to reset the balance between development and disaster risk. Ongoing disaster risk needs to be addressed using the whole gamut of existing good practices.

Large populations remain at risk with only partial access to disaster risk management tools. Such tools include those aimed at reducing exposure to hazard events through preparedness planning and early warning systems; tools that spread losses through insurance mechanisms, including mechanisms developed for low-income groups and informal settlement dwellers; and tools to help people bear disaster impacts, including policies aimed at enhancing livelihood sustainability. This is by no means an exhaustive list and there remains great scope for the exchange of best practice and for innovation.

As local contexts continue to filter the impacts of global climate change and economic globalisation, there will be an ongoing need for innovation and learning to cope with the changing manifestation of disaster risk at the local level.

4.2.6 Gaps in knowledge for disaster risk assessment

A first step towards more concerted and coordinated global action on disaster risk reduction must be a clear understanding of the depth and extent of hazard, vulnerability and disaster loss.

Where data on sub-national distributions of disaster losses exists, it suggests that a large number of small- and medium-sized disasters and sub-disaster scale loss events associated with natural hazards are unfolding below the level of global observatories. The critical policy significance of these events is their contribution to the accumulation of risk and situations where livelihoods and health are eroded to a point at which individuals or communities become susceptible to large-scale loss.

Global databases and risk assessments would carry additional value if local and sub-national databases using uniform data collection and analysis frameworks were available. The lack of such databases makes it impossible to accurately trace the changing geography of risk and track factors shaping the production of vulnerability and hazard, both within countries and between scales. A focus on global-scale trends and distributions of risk is useful, but tells only part of the development and disaster risk story.

Below the national level exist a rapidly growing array of tools to measure vulnerability and hazard as well as record disaster events and loss for many countries and communities. These tools have been developed with particular local contexts in mind. The number and variety of tools available suggests that a next stage in the maturing of disaster risk assessment could be attempts to combine information and begin to piece together the jigsaw of local human development and disaster risk experiences at the sub-national and national levels. The possibility of knowledge accumulated from the bottom up meeting global assessments of risk and vulnerability offers an exciting prospect for verifying assumptions and findings made at both levels for disaster and development policy-making.

The mainstreaming of disaster risk assessment into the ongoing development planning processes can build on the wealth of methodologies already available and on administrative structures already in place at the local, national and global scales.

A great deal of data is collected or known at the local scale, but structures are not in place for the centralised collation of this material at the national, let alone global scales. Local governments, line ministries of central governments and networks of non-governmental and community-based organisations all have roles to play in the developing of shared reporting conventions and methods that will maximise the amount of data that can be used for strategic policy-making.

In many cases individual networks of organisations are already commencing the task of reforming data collection (such as the IFRC), but broader cooperation is needed. Some important steps forward have been made in networking disaster risk datasets and examples are provided in this Report. The journey is, however, in its early stages. The prospects for data collection to support data-informed disaster-development policy-making are exciting.

Specific recommendations towards this end are to:

1. **Enhance global indexing of risk and vulnerability, enabling more and better intercountry and interregional comparisons.**

A number of global level projects have begun to map intercountry and interregional comparisons of risk and vulnerability. There is scope here to share methodological experiences and data.

A future goal, but one that should be addressed in this initial period of modelling, is to construct models around a uniform central language of assumptions and definitions in order to build multiple-risk and vulnerability assessments.

Broadening the array of data collected nationally for global comparisons to include key information needed for risk assessment (number of trained paramedics, number and capacity of active community disaster response groups, etc.) and vulnerability factors (armed conflict, governance, social capital, epidemiology). This would increase the quality of global level assessments. The process of preparation of the DRI shows just how far we are from being able to draw a complete picture of comparative national risk.

2. **Support national and sub-regional risk-indexing to enable the production of information for national decision makers.**

The DRI is moving towards building a global picture of disaster risk. Bringing this work together with sub-national assessments will provided added value. If disaster risk management is to move from a reactive agenda of disaster response to embrace disaster risk-sensitive development planning, national level data is essential. This is needed to target policy and track shifting patterns of hazard and vulnerability. Vulnerability will be shaped by a myriad of forces —such as the global economy, global climate change, internal migration patterns, local environmental resource use and community development interventions — that constantly reconfigure geographies of risk.

3. **Develop a multi-tiered system of disaster reporting.**

The vision is of a unified global system of disaster reporting that connects nationally maintained country databases to a global database that is administered through international institutions and made accessible to the public. A number of stages would be required to make this a reality. A preliminary survey of existing databases to find out what information is already available at the national level, and then make this information available at the global level, would be appropriate. An agreed system for generating a global identifier for each disaster event would be needed. Reporting standards and software would have to be developed to promote data compatibility across national datasets. Skills training would be needed to establish databases in countries where they are not already present.[2]

It is particularly important to establish and standardise a methodology for estimating the socio-economic losses associated with medium- and small-scale disaster events. Such a method exists that works very well for larger-scale disasters, but it could be simplified for more localized applications. In general, economic losses need to be more routinely assessed and reported.

None of these requirements are unachievable and the opportunities offered by such a dataset for strategic international and national disaster policy planning are considerable.

4. Support context-driven risk assessment.

The dynamic qualities of forces shaping risk mean that assessment tools need constant refinement. This is demonstrated by the recent recognition of urban areas as places of high risk. This realisation began a revision of assessment and intervention tools initially developed for rural vulnerability work. Some excellent advances have been made in this regard. Keeping track of new places and social groups at risk is only half of the story. As policy perspectives or background socio-economic structures and physical systems change through time, so will assessment methods need to evolve. Sensitivity to context is a priority for locally meaningful assessment tools, but this needs to be weighed against the need to generate data for sharing along the assessment production chain.

A Final Word

The aim of this Report has been to map out the ways in which development can lead to disaster, just as disaster can interrupt development. The DRI work has shown that billions of people in over 100 countries are periodically exposed to at least one of the hazards studied, with an average of 67,000 deaths annually (184 deaths each day). The high number of people exposed to natural hazard shows the scale of connection between disasters and development. Recorded deaths provide a tip-of-the-iceberg measurement of the extent to which past development decisions have prefigured risk.

The medium-term goal of meeting the MDGs and the longer–term goal of moving towards more sustainable pathways for development need to take disaster risk into account. The Recommendations have highlighted a number of emerging agendas in disaster risk management that offer great potential for integrating disaster risk and development planning. They also point at achievable policy and project actions that can be undertaken to reduce risk in development.

Most fundamental is the role of governance at all scales from the local to the global. A balance between equity and efficiency in the distribution of decision-making power and in making decisions will need to be kept. A concern for governance dovetails into more generic development planning policy. Like many of the proposals, the argument is for a change in emphasis and a broadening of development worldviews to take disaster risk seriously, rather than a call for development planning perspectives to be rewritten. While it may be true that core elements of dominant development paradigms are the root causes for development prefiguring risk, this Report has focused on what can be achieved within existing development approaches.

A particular opportunity for mainstreaming disaster risk reduction into development planning is provided during the reconstruction periods after large-scale disaster events. These are periods where social and political structures as well as physical infrastructure can be rebuilt to enhance quality of life and reduce future disaster risk.

Natural disaster risk reduction can provide a useful basis for adapting to climate change. Bringing the disaster and climate change risk agendas and communities together should be a priority. This will be facilitated by the proactive, adaptive mode of risk reduction championed in this Report, which has much in common with the orientation of policy work on adaptation to climate change.

We live our lives in the context of multiple everyday risks. The periodic nature of natural disaster risk means it is often easily overlooked until it is too late and accumulated risk provokes disaster. Local risk reduction will need to be sensitive to the multiple sources of competing risks people face. Governance regimes need to work to reconcile the pressing need to respond to frequent and everyday risks, while avoiding the creeping vulnerability that can lead to disaster risk.

The focus of this report has been on proactive strategies for reducing future risk. However, today we live with the accumulated risk of past development pathways. Disaster preparedness and response should not be seen in any lesser light. Our argument is to compliment compensatory risk management with a prospective or adaptive approach that can support development without building future disaster risks.

The policy agendas supported in this Report require refined and more complete data. Current global efforts signify a substantial step in the right direction towards producing a globally accessible disaster database with national and sub-national resolution. Equally, the sub-national databases reviewed in this Report provide examples of existing good practice that could be usefully replicated among societies at high disaster risk.

The DRI exercise has contributed by making the first global assessment of disaster risk exposure and human vulnerability. The process of mapping disaster risk as presented in this Report has only just begun. But the message is clear. The work of linking disaster risk reduction to development planning offers great potential for advancing the cause of human development.

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1. Gilbert and Kreimer 1999. "Learning from the World Bank's Experience of Natural Disaster Assistance," Urban Development Division, Working Paper Series 2, World Bank.
2. ISDR Working Group 3 on Risk Vulnerability and Impact Assessment. *Improving the Quality, Coverage and Accuracy of Disaster Data: A Comparative Analysis of Global and National Datasets.* 24 October 2002.

TECHNICAL ANNEX

The Technical Annex provides supporting material on methodologies and results to supplement the main body of the Report. In particular, it provides background on the statistical work undertaken in the development of the Disaster Risk Index (DRI).

This is a detailed account of the work that was carried out in the DRI, the challenges that require further attention and the potential that exists for further work.

T.1 Definition of Statistical Terms

In the Glossary, we have included a set of key terms which are referred to throughout the Report. In order to aid comparability, in most cases we stay close to those used in the ISDR Secretariat publication *Living in Risk.* At the same time, the development of the DRI required the adoption of specific working definitions that guided the statistical analysis undertaken.

In this section, we present an extract of terms from the Glossary followed by the specific working definition of the term used in the development of the DRI.

Natural Hazard: Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. Hazardous events vary in magnitude, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.[1]

In the DRI: Natural hazards refer exclusively to earthquake, tropical cyclone, flood and drought. Only frequencies and area of extent were considered in the model. Magnitude is taken into account indirectly when possible. Secondary hazards triggered by the primary hazards mentioned above (for example, landslides triggered by earthquakes) are subsumed in the primary hazard.

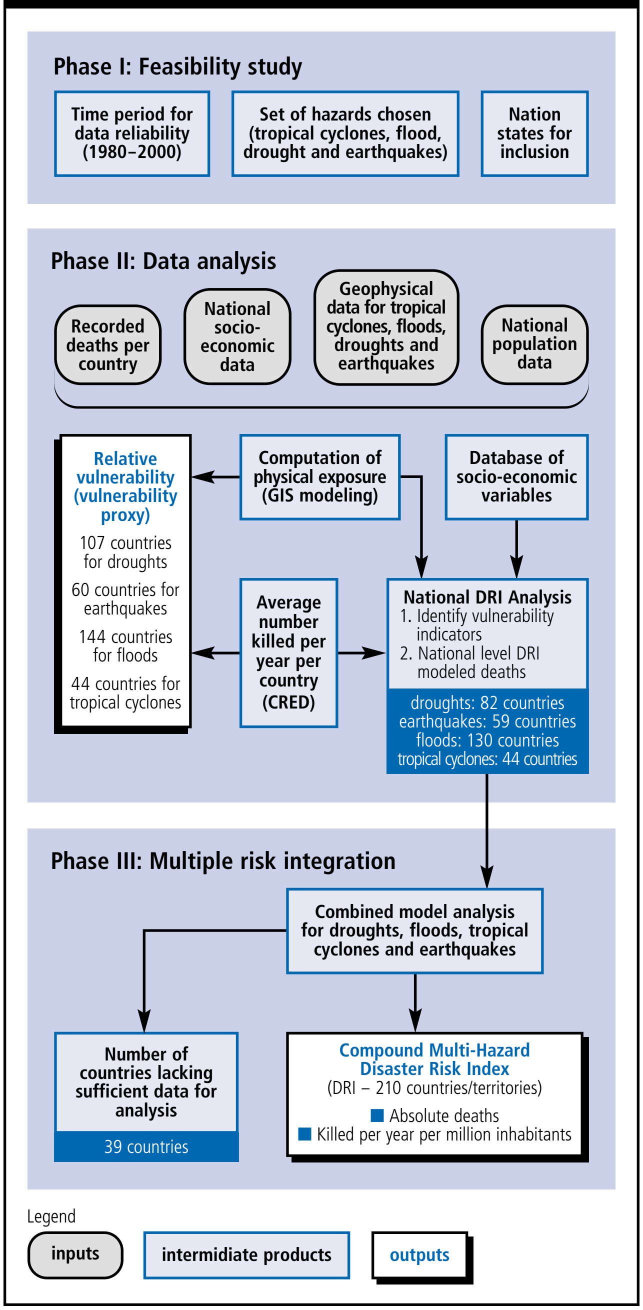
Physical Exposure: Elements at risk, an inventory of those people or artefacts that are exposed to the hazard.[2]

In the DRI: Physical exposure refers to the number of people located in areas where hazardous events occur combined with the frequency of hazard events.

Human Vulnerability: A human condition or process resulting from physical, social, economic and environmental factors, which determine the likelihood and scale of damage from the impact of a given hazard.

In the DRI: Human vulnerability refers to the different variables that make people more or less able to absorb the impact and recover from a hazard event. The way vulnerability is used in the DRI means that it *also* includes anthropogenic variables that may increase the severity, frequency, extension and unpredictability of a hazard.

FIGURE T.1 FLOW CHART OF THE GLOBAL RISK AND VULNERABILITY TREND PER YEAR (GRAVITY) PROJECT



Natural Disaster: A serious disruption triggered by a natural hazard causing human, material, economic or environmental losses, which exceed the ability of those affected to cope.

In the DRI: Disasters are a function of physical exposure and vulnerability.

Risk: The probability of harmful consequences or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. Risk is conventionally expressed by the equation Risk = Hazard + Vulnerability.

In the DRI: Risk refers exclusively to loss of life and is considered as a function of physical exposure and vulnerability.

T.2 Sourcing Data

T.2.1 EM-DAT Database

The DRI exercise is calibrated against the mortality data in the EM-DAT global disaster database. It is important to be clear about the data collection and management methods employed by EM-DAT.

The Centre for Research on the Epidemiology of Disasters (CRED) maintains the EM-DAT database at the University of Louvain in Belgium. Events that conform to a consistent definition of a disaster are included in the database. Such events meet at least one of the following criteria: 10 or more people reported killed; 100 people reported affected; a call for international assistance; and/or a declaration of a state of emergency. Information on losses comes from secondary sources (government reports, the International Federation of the Red Cross and Red Crescent Societies (IFRC) and other disaster relief agencies, Reuters, reinsurance company assessments) and is cross-checked where possible. These criteria exclude smaller loss events which are not considered disasters.

One important quality of EM-DAT is its management by an independent academic institution that encourages public access and scrutiny of the dataset. Great care is taken to verify disaster reports and emphasis is placed on the higher confidence that can be placed on the accuracy of deaths over those injured, made homeless or affected by disaster, although information is also made available for these categories.

Two other global disaster databases are maintained by the Munich Re Group and Swiss Reinsurance Company, but are not publicly available. A study by CRED (commissioned by the ProVention Consortium[3]) carried out a comparison of EM-DAT, Swiss Re and Munich Re natural disasters databases for four countries (Honduras, Mozambique, India and Viet Nam) between 1985 and 1999. Although the report stated that all three databases furnish the world community with 'acceptable levels of data on disasters',[4] it discovered significant variations among these datasets in both the events recorded and losses reported.

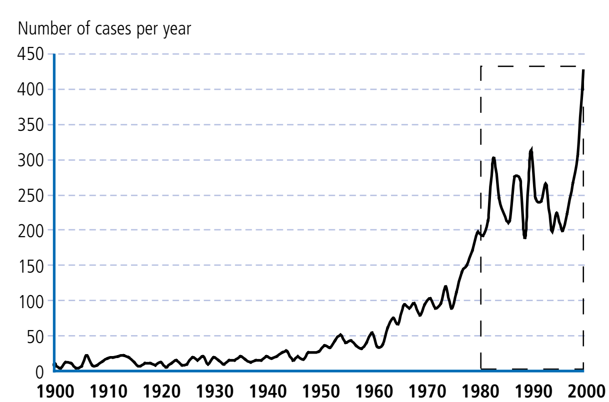
These differences were explained by differences in recording practice: what date each event is given, differences in classificatory methodology for each hazard type (a problem if one hazard triggers another) and the multiple entry of a single disaster event. As a result, the study found considerable differences between the datasets in the number of people affected (66 percent) and to a lesser extent the number of deaths (37 percent) and physical damage (35 percent). This is not surprising, since the definition of people affected varies enormously from disaster to disaster and from reporting source to reporting source. It is the most difficult impact variable to quantify and for this reason has not been used in the DRI work. The report also showed that the differences between the databases reduced significantly with time. This reflects EM-DAT's practice of reviewing its databases to incorporate updated information as it becomes available, even years after an event. A main weakness with global disaster data is the lack of standardised methodologies and definitions. This weakness is being addressed through the development of a unique global identifier for disaster reporting, the GLIDE system discussed in Chapter 2.

As mentioned above, EM-DAT explicitly excludes events where the loss is below defined threshold levels. A study undertaken on behalf of the ISDR Working Group 3 on Risk, Vulnerability and Impact Assessment, compared national disaster databases developed using the DesInventar methodology with the EM-DAT databases in four countries (Colombia, Chile, Panama and Jamaica). In all four countries, small-scale disasters with losses below the EM-DAT threshold represented a variable proportion of total disaster loss. Additionally, the national databases contained data on a number of medium-scale disasters that were above the EM-DAT threshold, but which were not captured by international reporting. It is impossible to arrive at a firm conclusion from a four-country study regarding what percentage of total disaster loss is not captured by international reporting, and in any case this will vary from country to country. Again, the adoption of a unique identifier such as GLIDE in both national and global databases like EM-DAT should progressively improve the consistency of disaster reporting.

Given that the DRI is calibrated against mortality data from EM-DAT, under- or over-reporting of this variable in EM-DAT would affect the DRI results. However, the DRI takes into account the varied reporting for individual disasters by basing its analysis on average losses over a 20-year period (1980-2000). The EM-DAT database provides a very good sample of total disaster loss in this period with a national level of resolution.

This period provides a reasonable length of time to account for fluctuation in the occurrence of most hazard types and also coincides with the most reliable period of data collected in EM-DAT. Figure T.2 shows the total number of disasters recorded by EM-DAT from 1900 to 2000. The upward trend at first suggests an exponential increase in disaster frequency. However, improvement in disaster reporting is a substantial

FIGURE T.2 DISASTERS RECORDED BY EM-DAT



Source: EM-DAT: The OFDA/CRED International Disaster Database contributing factor.[5] While one cannot rule out that the number of hydrometeorological hazard events may have increased, the upward trend in reported disasters is more likely to be tied to improvements in telecommunication technology and the increasingly global coverage of different information networks. This makes the reporting and recording of disaster losses more possible today than in the past.

T.2.2 Choice of hazard types

The decision to limit the DRI to earthquake, tropical cyclone, flood and drought was based on two factors. First, the dominance of these hazard types in being associated with lives lost to disaster in past records (94.43 percent). Secondly, the availability of usable geophysical and hydrometeorological data to model each hazard's comparative extent and potential severity of impact. Data had to be available at the global level but detailed enough to map risk within each country.

During a preliminary investigation, volcanic eruptions were also considered. They were finally excluded because of the complexity of modelling the spatial extent of volcanic hazard events. Other types of hazards that may lead to disasters and influence the process of human development, such as technological and biological hazards, are not covered by the DRI, nor are natural hazards with more prominence at the local scale such as landslides. These could be included in the future when global datasets of events with national resolution come into use.

T.2.3 Choice of country cases

The DRI exercise aims to include all sovereign states in its analysis. This is compromised in two ways. First, there are varying levels of data availability. The decision here was to include all states from the outset, but discount those with inadequate data from detailed analysis. This partly accounts for the uneven number of states entered into the hazard-specific analyses. Secondly, a number of territories are classified as dependent territories or overseas departments. Such dependencies are often small islands or enclaves geographically distant from, but politically and administratively tied to, sovereign states such as France, the United Kingdom, USA or China. Overseas territories and sovereign states often exhibit very different socio-economic and environmental characteristics and hazard profiles. Where possible such territories have been analysed in their own right.

T.2.4 Outline formula and method for estimating risk and vulnerability

The formula used for modelling risk combines its three components. Risk is a function of hazard occurrence probability, the element at risk (population) and vulnerability. The equation below was made for modelling disaster risk.

0 (hazard) x population x vulnerability = 0 (risk)

The three factors used to construct this statistical explanation of risk were multiplied with each other. This meant that if the hazard was null, then the risk was null. The risk was also null if nobody lived in an area exposed to hazard (population = 0). The same situation held if the population was invulnerable (vulnerability = 0, induce a risk = 0).

From this, a simplified equation of risk[a] was constructed:

EQUATION 1 RISK

EQ1 $$R = H \cdot Pop \cdot Vul$$

Where
R is the risk (number of killed people.
H is the hazard, which depends on the frequency and strength of a given hazard
Pop is the population living in a given exposed area
Vul is the vulnerability and depends on the socio-politial-economical context of this population

Hazard multiplied by the population was used to calculate physical exposure.

EQUATION 2 RISK EVALUATION USING PHYSICAL EXPOSURE

EQ2 $$R = PhExp \cdot Vul$$

Where
PhExp is the physical exposure, i.e. the frequency and severity multiplied by exposed population

Physical exposure was obtained by modelling the area affected by each recorded event. Event frequency was computed by counting the number of events for the given area, divided by the number of years of observation (in order to achieve an average frequency per year). Using the area affected, the number of people in the exposed population was extracted using a Geographical

a. The model uses a logarithmic regression, the equation is similar but with exponent to each of the parameters.

EQUATION 3 ESTIMATION OF THE TOTAL RISK

EQ3

$$Risk_{Tot} = \sum(Risk_{Flood} + Risk_{Earthquake} + Risk_{Volcano} + Risk_{Cyclone} + ...Risk_n)^b$$

Information System (GIS). The population affected multiplied by the frequency of a hazard event for a specified magnitude provided the measure for physical exposure.

Socio-economic variables that could be statistically associated with risk were identified by replacing the risk in the equation with deaths reported in EM-DAT. A statistical analysis was then run to identify links between socio-economic and environmental variables, physical exposure and observed deaths.

The magnitude of events was taken into account by drawing a threshold above which an event is included. In the case of earthquakes, the threshold was placed at 5.5 on the Richter scale. Then the magnitude was partially taken into account by approaching the size of the area affected in relation to the magnitude, for the computation of physical exposure. Estimating event magnitude for use in global assessments is an area where there is great scope for improvement.

Scores for aggregated hazard deaths were calculated at the national level. Expected losses due to natural hazards were equal to the sum of all types of risk faced by a population in a given area. This is summarised in Equation 3 above.

The multi-hazard risk for a country required calculating an estimate of the probability of the occurrence and severity of each hazard, the number of persons affected by it, and the identification of the population's vulnerability and coping capacities. This is very ambitious and not achievable with present data constraints. However the aim is to provide an approach built on existing data that will be refined in subsequent runs of the DRI.

T.3 Choice of Indicators

T.3.1 Spatial and temporal scales

The DRI exercise was performed on a country-by-country basis for the 249 countries defined in the GEO reports.[6]

The socio-economic variables used in the analysis of risk needed to be available to cover the 21-year period under analysis. This period was from 1980 to 2000. The starting date was set at 1980 because access to information (especially on victims) was not considered reliable or comparable before this year. The variables introduced in Equation 2 were aggregate figures (sum or average) of the available data for that period, with the following major exceptions:

- Earthquake frequencies were calculated over a 36-year period, due to the longer return period of this type of disaster. The starting date for the first global coverage on earthquakes measurement is 1964.
- Cyclones frequencies were based on annual probabilities provided by the Carbon Dioxide Information Analysis Center (CDIAC).[7]
- HDI was available for the following years: 1980, 1985, 1990, 1995 and 2000. However, algorithms were applied for computation of every year between 1980 and 2000.
- Population by grid cell (for physical exposure calculations) was available for 1990 and 1995.
- The Corruption Perception Index (CPI) was available for 1995 to 2000.

T.3.2 Risk indicators

Risk can be expressed in different ways (for example by the number of people killed, percentage killed or percentage killed as compared to the exposed population). Each measure has advantages and inconveniences (see Table T.1 on the following page).

The DRI work used two indicators for each hazard type: the number of killed and killed per population. The third indicator is used to indicate relative vulnerability. Exposed populations to different hazards should not be compared as stated in the Report without standardisation.

T.3.3 Vulnerability indicators

Table T.2 (see following page) hows those socio-economic and environmental variables chosen to represent eight separate categories of vulnerability.

b. In the case of countries marginally affected by a hazard type, the risk was replaced by zero if the model could not be computed for this hazard.

TABLE T.1 ADVANTAGES AND DISADVANTAGES OF RESPECTIVE RISK INDICATORS

Indicators for risk	Advantages	Inconveniences
Number of killed	Each human being has the same 'weight.'	10,000 people killed split between 10 small countries does not appear in the same way as 10,000 killed in one country. Smaller countries are disadvantaged.
Killed/Population	Allows for comparisons between countries. Less populated countries have the same weight as more populated countries.	The 'weight' of each human being is not equal, e.g. one person killed in Honduras equals 160 killed in China.
Killed/Population exposed	Regional risk is highlighted, even though the population affected is a smaller portion of the total national population.	This may highlight local problems that are not of national significance and give the wrong priority for a selected country.

TABLE T.2 VULNERABILITY INDICATORS

Categories of Vulnerability	Indicators	Drought	Flood Earthquakes Cyclones	Source[c]
Economic	Gross Domestic Product per inhabitant at purchasing power parity	X	X	WB
	Human Poverty Index (HPI)	X		UNDP
	Total debt service (% of the exports of goods and services)		X	WB
	Inflation, food prices (annual %)		X	WB
	Unemployment, total (% of total labour force)		X	ILO
Type of economic activities	Arable land (in thousand hectares)		X	FAO
	% of arable land and permanent crops		X	FAO
	% of urban population		X	UNPOP
	% of agriculture's dependency for GDP	X		WB
	% of labour force in agricultural sector	X		FAO
Dependency and quality of the environment	Forests and woodland (in % of land area)		X	FAO
	Human-Induced Soil Degradation (GLASOD)	X	X	FAO/UNEP
Demography	Population growth		X	UNDESA
	Urban growth		X	GRID[d]
	Population density		X	GRID[e]
	Age dependency ratio		X	WB
Health and sanitation	% of people with access to improved water supply (total, urban, rural)	XXX		WHO/UNICEF
	Number of physicians (per 1,000 inhabitants)		X	WB
	Number of hospital beds		X	WB
	Life expectancy at birth for both sexes		X	UNDESA
	Under-five-years-old mortality rate	X		UNDESA
Early warning capacity	Number of radios (per 1,000 inhabitants)		X	WB
Education	Illiteracy rate		X	WB
Development	Human Development Index (HDI)	X	X	UNDP

Source: UNDP/UNEP

c. FAOSTAT, the database of the Food and Agriculture Organisation (FAO); GRID, the Global Resource Information Database of UNEP; WB, World Development Indicators of the World Bank; Human Development Report of UNDP; ILO, International Labour Office; UNDESA, the UN Dept. of Economic and Social Affairs/Population Division. Most of the data were reprocessed by the UNEP Global Environment Outlook Team. Figures are available at the GEO Data Portal (UNEP), http://geodata.grid.unep.ch
d. Calculated from UN Dept. of Economic and Social Affairs data.
e. Calculated from UNEP/GRID spatial modelling based on CIESIN population data.

TABLE T.3 DATA SOURCES FOR HAZARDS	
Hazard type	**Data source**
Earthquakes	Council of the National Seismic System (as of 2002), *Earthquake Catalog,* http://quake.geo.berkeley.edu/cnss/
Cyclones	Carbon Dioxide Information Analysis Centre (1991), *A Global Geographic Information System Data Base of Storm Occurrences and Other Climatic Phenomena Affecting Coastal Zones,* http://cdiac.esd.ornl.gov/
Floods	U.S. Geological Survey (1997), *HYDRO1k Elevation Derivative Database,* http://edcdaac.usgs.gov/gtopo30/hydro/
Droughts (physical drought)	IRI/Columbia University, National Centres for Environmental Prediction Climate Prediction Centre (as of 2002), CPC *Merged Analysis of Precipitation (CMAP),* monthly gridded precipitation, http://iridl.ldeo.columbia.edu/

TABLE T.4 DATA SOURCES FOR VICTIMS, POPULATION AND VULNERABILITY VARIABLES	
Theme	**Data source**
Victims (killed)	Université Catholique de Louvain (as of 2002), *EM-DAT: The OFDA/CRED International Disaster Database,* http://www.cred.be/ (for droughts, victims of famines were also included on a case by case basis by UNDP/BCPR)
Population (counts)	CIESIN, IFPRI, WRI (2000), *Gridded Population of the World (GPW), Version 2,* http://sedac.ciesin.org/plue/gpw/; UNEP, CGIAR, NCGIA (1996), *Human Population and Administrative Boundaries Database for Asia,* http://www.grid.unep.ch/data/grid/human.php
Vulnerability factors	
Human Development Index (HDI)	UNDP (2002), *Human Development Indicators,* http://www.undp.org/
Corruption Perceptions Index (CPI)	Transparency International (2001), *Global Corruption Report 2001,* http://www.transparency.org/
Soil degradation (% of area affected)	ISRIC, UNEP (1990), *Global Assessment of Human-Induced Soil Degradation (GLASOD),* http://www.grid.unep.ch/data/grid/gnv18.php
Other socio-economic variables	UNEP/GRID (as of 2002), *GEO-3 Data portal,* http://geodata.grid.unep.ch/ (data compiled from World Bank, World Resources Institute, FAO databases)

The list of factors to be considered for the analysis was set on the basis of the following criteria:

- *Relevance.* Select vulnerability factors (outputs orientated, resulting from the observed status of the population) not based on mitigation factors (inputs, action taken). For example, school enrollment rather than education budget.
- *Data quality and availability.* Data should cover the 1980-2000 period and most of the 249 countries and territories.

Examples of variables that were rejected for these two reasons were the percentage of persons affected by AIDS, the level of corruption and the number of hospital beds per inhabitant.

T.3.4 Data sources

Data sources ranged from universities and national scientific institutions to international data series collected by international organisations. Table T.3 presents the data sources used to obtain data on hazards.

Table T.4 presents the data sources used to obtain data on victims, population and vulnerability variables.

T.4 The Computation of Physical Exposure

T.4.1 General description

Two methods are available for calculating physical exposure. First, by multiplying hazard frequency by the population living in each exposed area. The frequencies of hazards were calculated for different strengths of event, and physical exposure was computed as in Equation 4.

EQUATION 4 COMPUTATION OF PHYSICAL EXPOSURE

EQ $$PhExp_{nat} = \sum F_i \cdot Pop_i$$

Where

$PhExp_{nat}$ is the physical exposure at national level

F_i is the annual frequency of a specific magnitude event in one spatial unit

Pop_i is the total population living in the spatial unit

A second method was used when data on the annual frequency of return of a specific magnitude event was not available. In this case (earthquake), physical exposure was computed by dividing the exposed population by the numbers of years when a particular event had taken place as shown in Equation 5.

EQUATION 5 PHYSICAL EXPOSURE CALCULATION WITHOUT FREQUENCY

EQ5 $$PhExp = \sum \frac{Pop_i}{Y_n}$$

Where
Pop_i is the total population living in a particular buffer, the radius of which from the epicentre varies according to the magnitude
Y_n is the length of time in years
PhExp is the total physical exposure of a country, in other words the sum of all physical exposure in this country

EQUATION 6 COMPUTATION OF CURRENT PHYSICAL EXPOSURE

EQ6 $$PhExp_i = \sum \frac{Pop_i}{Pop_{1995}} \cdot PhExp_{1995}$$

Where
$PhExp_i$ is the physical exposure of the current year
Pop_i is the population of the country at the current year
Pop_{1995} is the population of the country in 1995
$PhExp_{1995}$ is the physical exposure computed with population as in 1995

Once the area exposed to a hazard was computed — using UNEP/GRID-Geneva methods for earthquakes, floods and cyclones and using a method for drought from the International Research Institute for Climate Prediction (IRI) — then the exposed population was calculated for each exposed area. This number was then aggregated at the national level to come to a value for the number of exposed people over the last 21 years for each hazard type.

Depending on the type of hazard and the quality of data, different methods were applied to estimate the size of populations exposed to individual hazards. Population data was taken from CIESIN, IFPRI and WRI Gridded Population of the World (GPW, Version 2) at a resolution of 2.5’[f] (equivalent to 5 x 5 km at the equator). This was supplemented by the Human Population and Administrative Boundaries Database for Asia (UNEP) for Taiwan and CIESIN Global Population of the World Version 2 (country level data) for ex-Yugoslavia. These datasets reflect the estimated population distribution for 1995. Since population growth is sometimes very high in the 1980-2000 period, a correction factor using country totals was applied in order to estimate current physical exposures for each year as follows (see Equation 6).

Due to the resolution of the dataset, the population could not be extracted for some small islands. This has meant some small islands had to be left out of parts of the analysis. This is a topic for further research (see recommendations in the Conclusions of the Technical Annex).

The main challenge lay in the evaluation of areas exposed to particular hazard frequency and intensity. At the global scale, data was not complete. Expert opinion was used to review the process of building datasets. Of the four hazards studied, only in the case of floods was it necessary to design a global dataset. This was constructed by linking CRED information with USGS watersheds. Drought maps were provided by IRI. For the other hazards, independent global datasets had already been updated, compiled or modelled by UNEP/GRID-Geneva and were used to extract population. The Mollweide equal-area projection was used when calculations of areas were needed.

T.4.2 The case of earthquake

A choice was made to produce seismic hazard zones using the seismic catalogue of the Council of the National Seismic System. The earthquakes records of the last 21 years (1980-2000) were grouped in five magnitude classes using a buffer with a radius from the epicentre that varied according to the magnitude class (see Table T.5).

The values in Table T.5 show estimated ground-motion duration for specific acceleration and frequency ranges, according to magnitude and distance from the epicentre.[8] Numbers in bold in Table T.5 show the duration for a particular acceleration and frequency range between the first and last acceleration excursions on the record greater than a given amplitude level (for example, 0.05 g).[9]

f. GPW2 was preferred to the ONRL Landscan population dataset despite its five times lower spatial resolution (2.5’ against 30”) because the original information on administrative boundaries and population counts is almost two times more precise (127,093 administrative units against 69,350 units). Furthermore, the Landscan dataset is the result of a complex model which is not explained thoroughly and which is based, among other variables, on environmental data (land-cover). That makes it difficult to use for further comparison with environmental factors (circularity).

TABLE T.5 LIMITS OF THE RADIUS FOR EARTHQUAKES HAZARD

Distance (km)	Magnitude						
	5.5	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**
10	8	12	19	26	31	34	35
25	4	9	15	24	28	30	32
50	2	3	10	22	26	28	29
75	1	1	5	10	14	16	17
100	0	0	1	4	5	6	7
125	0	0	1	2	2	3	3
150	0	0	0	1	2	2	3
175	0	0	0	0	1	2	2
200	0	0	0	0	0	1	2

Source: [Bolt et al. 1975] Acceleration > 0.05 g = ~ 0,49 m/s2, frequency > 2 Hz

According to these figures, a specific buffer distance was defined for each class of magnitude to limit the area affected by ground motions: 75 km for Magnitude ≤ 6.2, 125 km for M = 6.3 – 6.7, 150 km for M = 6.8 – 7.2, 175 km for M = 7.3 – 7.7, 200 km for M ≥ 7.8. This approach did not take into account local conditions, for instance soil or geo-tectonic characteristics.

Assuming the limitations inherent in a mortality-based conceptual model, there were three key challenges to calculating the earthquake risk index.

The first and most difficult challenge was the necessity to use a restricted time-frame for analysis of risk (1980-2001). Twenty years is a short time-span to analyze the occurrence of geological phenomena such as earthquakes, which are low frequency/high impact events. For this reason, risks are overestimated by the model for some countries and underestimated for others. Armenia provides an example of a high-impact single earthquake in a small-sized country (29,000 square kilometres), with a high population density (117 per square kilometre). The earthquake that affected this former Soviet Republic in 1998 killed 25,000 people, left 514,000 people homeless and prompted the evacuation of almost 200,000 people. The high losses recorded in this event appear to exaggerate Armenia's long-term calculated risk value, in comparison with countries known to be at risk but where no event took place during the time period used to calculate the risk model. An example of this is the Algerian earthquake in 2003, which is later than the period used in the DRI exercise. In order to partly overcome such limitation, frequency was derived using data from 1964-2000 in order to take advantage of the time-span available globally.

Secondly, in the delimitation of areas at risk from individual earthquake zones, it was not possible to consider intervening factors (such as soil types and geology) in the transmission of earthquake energy. In explaining the ground motions of earthquakes and therefore the severity of impact, soil conditions play a major role. Inclusion of this data would have allowed for a more accurate delimitation of areas and thus populations exposed to earthquake risks of various magnitudes and intensities. While values for peak ground acceleration were available from the Global Seismic Hazard Assessment Programme, they did not allow for the calculation of frequencies. Consequently, the analysis was based solely on magnitude values that were taken from the Council of the National Seismic System (CNSS).

FIGURE T.3 POPULATION, INTENSITY AND PHYSICAL EXPOSURE FOR EARTHQUAKES

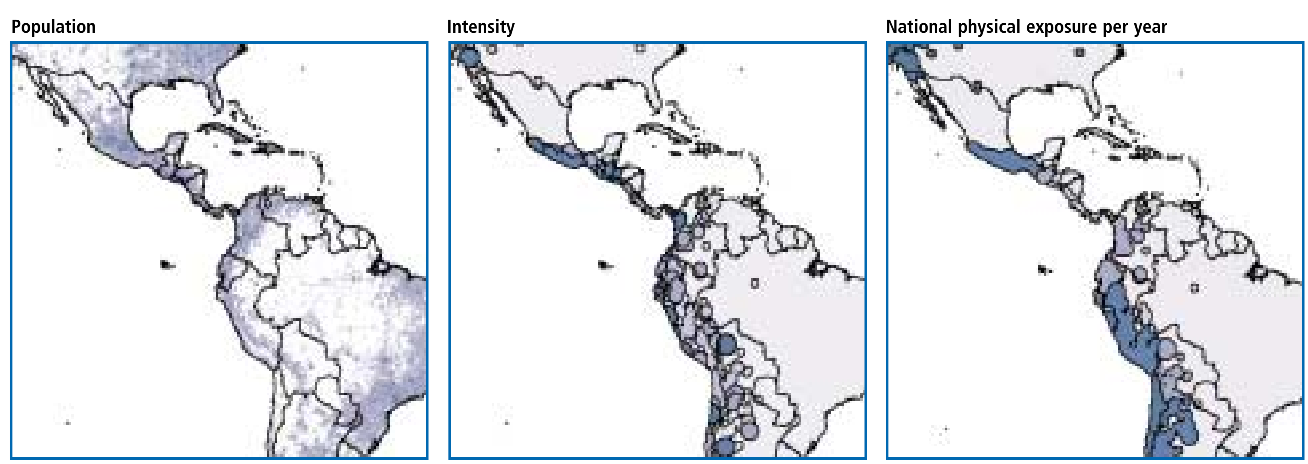


TABLE T.6 WIND SPEEDS AND APPELLATIONS

Wind speeds	Name of the phenomenon
≥ 17 m/s	Tropical storms
≥ 33 m/s	Hurricanes, typhoons, tropical cyclones, severe cyclonic storms (depending on location)
≥ 65 m/s	Super-typhoons

A third and more generic challenge for the risk model was the lack of casualty and death data and a lack of underlying socio-economic and environmental data for some countries. This is particularly problematic for mapping global earthquake risk because some gaps in national level data led to the exclusion of some countries — known to be at particularly high risk from earthquakes — from the calculation of the vulnerability indicators. This was the case for Afghanistan, Sudan, Tajikistan and Guinea. Future improvements in statistical records will enhance the scope of future assessments.

T.4.3 The case of tropical cyclone

The data used to map tropical cyclone hazard areas were produced by the Carbon Dioxide Information Analysis Centre.[10] The spatial unit is a 5 x 5 decimal degrees cell. Return probabilities were based on tropical cyclone activity over a specific record period. Exceptions were made for several estimated values attributed to areas that may present occasional activity, but where no tropical cyclones were observed during the record period.

The Saffir-Simpson tropical cyclones classification is based on the maximum sustained surface wind. Systems with winds of less than 17 m/s are called Tropical Depressions. If the wind reaches speeds of at least 17 m/s, the system is called a Tropical Storm. If the wind speed is equal to or greater than 33 m/s, the system is named, depending on its location:[g] Hurricane, Typhoon, Severe Tropical Cyclone, Severe Cyclonic Storm or Tropical Cyclone. Systems with winds reaching speeds of 65 m/s or more are called Super-typhoons.[11]

The CDIAC provided the probability of occurrence for these three types of events. The average frequency (per year) was computed using Equation 7.

To obtain physical exposure, a frequency per year was derived for each cell. Cells were divided to follow country borders, then population was extracted and multiplied by frequency in order to obtain the average yearly physical exposure for each cell. This physical exposure was then summed by country for the three types of cyclones.

Physical exposure to tropical cyclones of each magnitude was calculated for each country using Equation 5.

There is room for improving the human exposure calculation by more accurate delimitation of exposed population zones for tropical cyclone tracks. Even though accurate zoning was possible for many tropical cyclone-prone countries, data on tracks, central pressure and sustained winds were not available for some heavily populated and high-risk countries, such as India, Bangladesh and Pakistan. While these data exist they were not accessible.

T.4.4 The case of flood

The only global database on floods that was identified was the Dartmouth Flood Observatory, but this database did not cover the time period under study. Due to the lack of information on the duration and severity of floods, only one class of intensity was made. Using the EM-DAT database, a geo-reference of each recorded flood was produced and the watershed related to each flood event was identified. Watersheds affected were mapped for the period 1980-2000. A frequency was derived for each watershed by dividing the total number of events by 21 years. The watersheds were then split to follow country borders. Next, population was extracted and multiplied by the event frequency. The average yearly physical exposure was then summed at a country level using Equation 3.

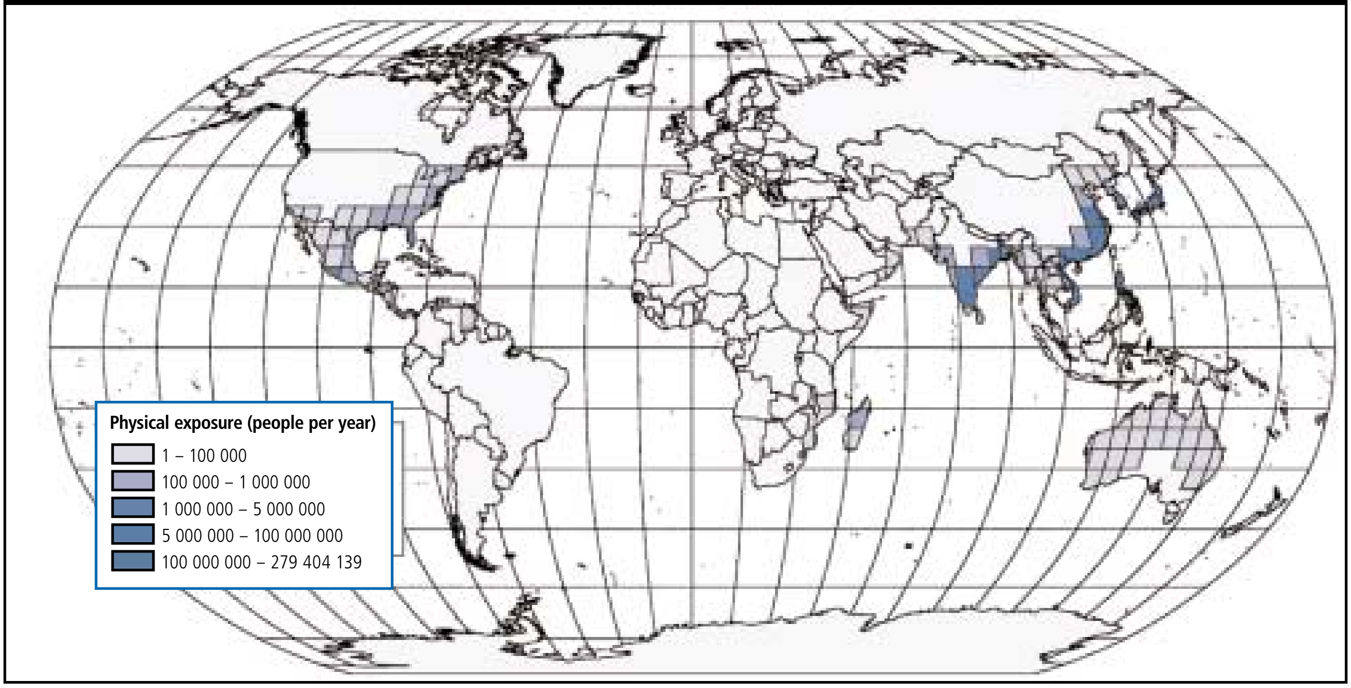
EQUATION 7 FROM PROBABILITY TO ANNUAL FREQUENCY FOR CYCLONES

EQ7 $$E(x) = \lambda = -\ln(1 - P(x \geq 1))$$

Where
E(x) is the statistical expectation, i.e. the average number of events per year = λ
P(x) is the probability of occurrence

g. Hurricane: North Atlantic Ocean, Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean east of 160E; Typhoon: Northwest Pacific Ocean west of the dateline; Severe tropical cyclone: Southwest Pacific Ocean west of 160E and Southeast Indian Ocean east of 90E; Severe cyclonic storm: North Indian Ocean; Tropical cyclone: Southwest Indian Ocean; Source: NOAA/AOML, FAQ: *Hurricanes, Typhoons and Tropical Cyclones,* http://www.aoml.noaa.gov/hrd/tcfaq/tcfaqA.html#A1

FIGURE T.4 AN EXAMPLE OF PHYSICAL EXPOSURE FOR TROPICAL CYCLONES



Source: Carbon Dioxide Information Analysis Centre: A Global Geographic Information System Database of Storm Occurrences and Other Climactic Phenomena Affecting Coastal Zones; CIESIN, IFPRI, WRI: Gridded Population of the World (GPW), Version 2 (population); Compilation and computation by UNEP/GRID-Geneva

Assuming the limitations inherent in a mortality-based conceptual model there were two key challenges to measuring flood risk.

First, there remains a need for refining the calculation of human exposure and vulnerability to floods in the formulation of the DRI. The use of watersheds affected by floods to delimit hazard exaggerates the extent of flood-prone areas, subsequently exaggerating human exposure and diminishing proxies of vulnerability.

Second, in the absence of historical flood event data, annual probabilities of floods should be based on hydrological models rather than being inferred from the flood entries in the EM-DAT database.

T.4.5 The case of drought

Identification of drought

The data used in this analysis consisted of gridded monthly precipitation data for the globe for the period 1979-2001. This dataset was based on a blend of surface

FIGURE T.5 POPULATION, FREQUENCY AND PHYSICAL EXPOSURE FOR FLOODS

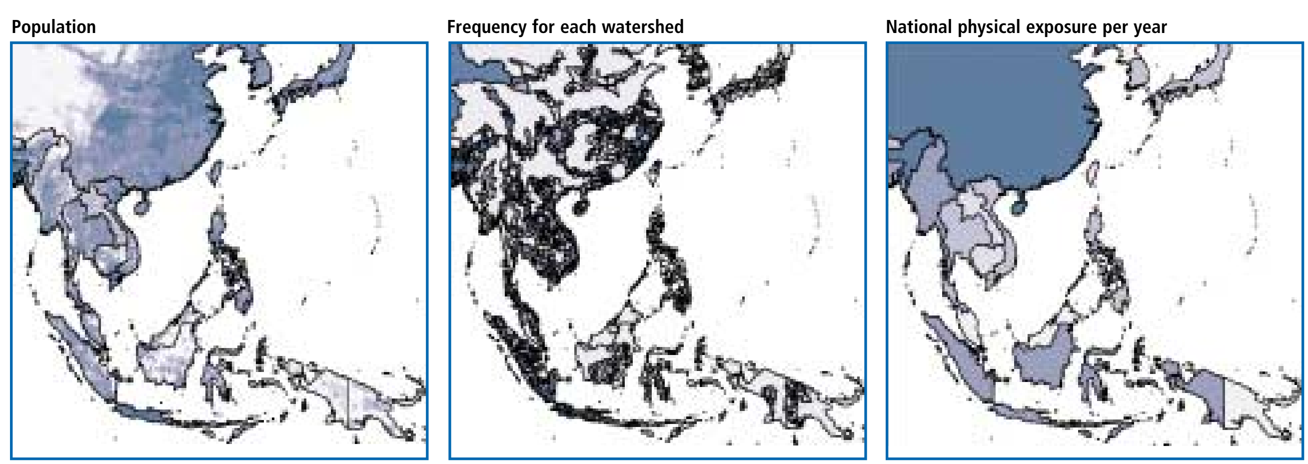


TABLE T.7 DEFINITION OF DROUGHT

Duration	Severity
3 months	90% of median precipitation 1979-2001 (-10%)
3 months	75% of median precipitation 1979-2001 (-25%)
3 months	50% of median precipitation 1979-2001 (-50%)
6 months	90% of median precipitation 1979-2001 (-10%)
6 months	75% of median precipitation 1979-2001 (-25%)
6 months	50% of median precipitation 1979-2001 (-50%)

station observations and precipitation estimates drawn from satellite observations. The first step in assessing exposure to meteorological drought was to compute, for each calendar month, the median precipitation for all grid points between the latitudes of 60S and 70N over the base period 1979-2001 (the 23-year period for which the data was available). Next, for each grid-point, the percent of the long-term median precipitation was computed for every month during the period January 1980 to December 2000. For a given month, grid-points with a long-term median precipitation of less than 0.25 mm/day were excluded from the analysis. Such low median precipitation amounts can occur either during the 'dry season' at a given location or in desert regions. In both cases our definition of drought does not apply.

A meteorological drought event was defined as having occurred when the percent of median precipitation was at or below a given threshold for at least three consecutive months. The different thresholds considered were 50 percent, 75 percent and 90 percent of the long-term median precipitation, with the lowest percentage indicative of the most severe drought according to this method. The total number of events during the period 1980-2000 were thus determined for each grid-point and the results plotted on global maps.

Computation of physical exposure

Using the IRI/Columbia University dataset, physical exposure was estimated by multiplying the frequency of hazard by the population living in an exposed area. The events were identified using different measurements, based on severity and duration as described in Table T.7. For each of the following six definitions, the frequency was then obtained by dividing the number of events by 21 years, thus providing an average frequency of events-per-year.

Physical exposure was computed, as in Equation 5, for each drought definition. The statistical analysis selected the best fit. This was achieved with droughts of three months duration and 50 percent decrease in precipitation.

EQUATION 8 ESTIMATE OF KILLED

EQ8 $$K = C \cdot (PhExp)^{\alpha} \cdot V_1^{\alpha_1} \cdot V_2^{\alpha_2} \dots \cdot V_p^{\alpha_p}$$

Where
- K is the number of persons killed by a certain type of hazard
- C is the multiplicative constant.
- PhExp is the physical exposure: population living in exposed areas multiplied by the frequency of occurrence of the hazard
- V_i are the socio-economic parameters
- α_i is the exponent of Vi , which can be negative (for ratio)

T.5 Statistical analysis: Methods and results

T.5.1 Defining a multiplicative model

The statistical analysis is based on two major hypotheses. First, that risk can be understood in terms of the number of victims of past hazardous events. Secondly, that the equation of risk follows a multiplicative model as in Equation 8.

Using logarithmic properties, the equation was re-formulated as in Equation 9. This equation creates a linear relationship between logarithmic sets of values. This allows significant socio-economic parameters V_i (with transformations when appropriate) and exponents α_i to be determined using linear regressions.

T.5.2 Detailed process

Data on victims

Numbers of killed were derived from the EM-DAT database and computed as the average number killed per year during the 1980-2000 period.

EQUATION 9 LOGARITHM PROPERTIES

EQ9 $$\ln(K) = \ln(C) + \alpha(PhExp) + \alpha_1 \ln(V_1) + \alpha_2 \ln(V_2) + \dots \alpha_p \ln(V_p)$$

Filtering the data

The statistical models for each disaster type were based on subsets of countries, from which were excluded:

- Countries with no physical exposure or any victims reported (zero or null values).
- Countries where it was not possible to confirm data on physical exposure (e.g. the case of Kazakhstan for floods) or socio-economic factors.
- Countries with low physical exposure (less than 2 percent of the total population) because socio-economic variables were collected at a national scale. The exposed population needs to be of some significance at a national level to reflect a relationship in the model.
- Countries without all the selected socio-economic variables.
- Eccentric values, when exceptional events or other factors would clearly show abnormal levels of victims, such as Hurricane Mitch in Nicaragua and Honduras or droughts in Sudan and Mozambique.

Transformation of socio-economic variables

For statistical analysis the socio-economic variables being tested had to be converted into 21-year averages and then transformed into a logarithm value. For some of the variables, the logarithm was computed directly. For those expressed as a percentage, a transformation was applied in order that all variables would range between -∞ and +∞. For others, no logarithmic transformation was needed. For instance, 'population growth' already behaves in a cumulative way and could be put directly into the calculation.

EQUATION 10 TRANSFORMATION FOR VARIABLES RANGING BETWEEN 0 AND 1

EQ10 $$V_i' = \frac{V_i}{(1 - V_i)}$$

Where

V_i' is the transformed variable (ranging from -∞ to +∞)

V_i is the socio-economic variable (ranging from 0 to 1)

Choice between variables

One important condition when computing regressions is that the variables included in the model should be independent, i.e. the correlation between two sets of variables is low. This is clearly not the case with HDI and GDPcap purchasing power parity (further referred to as GDPcap), which are highly correlated. GDPcap was used more than HDI because HDI was not available for several countries. In order to keep the sample as complete as possible, a choice between available variables was made choosing variable datasets that were as independent from each other as possible. This choice was performed by the use of both matrix-plot and correlation-matrix (using low correlation, hence low p-value, as the selection criteria).

The stepwise approach

For each type of hazard, numerous stepwise (back and forth steps) linear regressions were performed in order to identify significant socio-economic variables. The validation of each regression result was carried out using R2, variance analysis and detailed residual analysis.

Once the model was derived, the link between modelled estimated-killed and number-of-killed observed from EM-DAT was provided by both graph plots and computation of Pearson correlation coefficients.

If one can intuitively understand that physical exposure is positively related with the number of victims, and that GDPcap is inversely related with the number of victims (the lower the GDP, the higher the number of victims), this is less obvious for other variables such as the percentage of arable land. This method multiple logarithmic regression allows the estimation of the α_i coefficients. Their signs provided information to show if the variables were in a numerator or denominator position and hence the positive or inverse relationship between the variable and modelled deaths.

This model allowed the identification of parameters leading to higher/lower risk, but should not be used as a predictive model. Small differences in the logarithm scale can induce large ones in the modelled number of deaths.

The results following this method were surprisingly high and relevant, especially considering the independence of the data sources and the coarse resolution of the data at the global scale.

T.5.3 Mapping Risk

A judgement was made between the different risk indicators (i.e. killed, killed per million inhabitant, killed per population exposed).

T.5.4 Earthquake

Statistical model

The multiple regression was based on 48 countries. The best-fit regression line followed Equation 11 (see following page).

EQUATION 11 MULTIPLE LOGARITHMIC REGRESSION MODEL FOR EARTHQUAKES

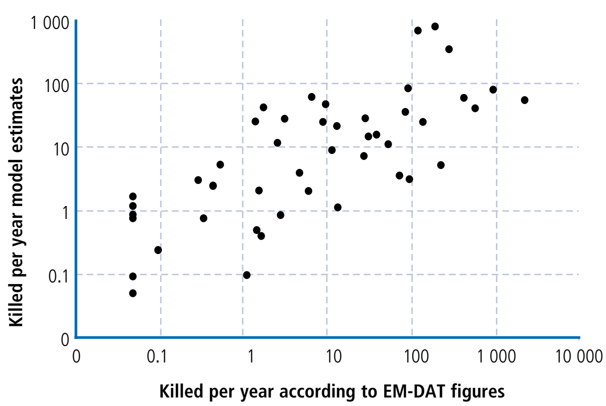
EQ11 $$\ln(K) = 1.26\ln(PhExp) + 12.27 \cdot U_g - 16.22$$

Where
K is the number of killed from earthquakes
PhExp is the physical exposure to earthquakes
U_g is the rate of urban growth (rates do not request transformation as it is already a cumulative value)

TABLE T.8 EXPONENT AND P-VALUE FOR EARTHQUAKE MULTIPLE REGRESSION

48 countries	B	p-value[h]
Intercept	−16.22	0.000000
PhExp	1.26	0.000000
U_g	12.27	0.047686
R= 0.75, R^2= 0.56, adjusted R^2= 0.54		

FIGURE T.6 SCATTER PLOT OF THE OBSERVED NUMBER OF PEOPLE KILLED BY EARTHQUAKES (EM-DAT) AND THE MODEL PREDICTIONS



Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

The variables retained by the regression include physical exposure and the rate of urban growth. Explained variance is smaller than for flood or cyclones (R^2=0.544), however considering the small length of time taken into account (21 years as compared to the long return period of earthquakes), the analysis delineates a reasonably good relation. Physical exposure is of similar relevance than for previous cases, relevant p-value. Urban growth is also highly negatively correlated with GDP and HDI. Thus, a similar correlation (but slightly inferior) could have been derived using HDI or GDP.

T.5.5 Tropical cyclone

Statistical model

The multiple regression was based on 32 countries and the best-fit regression line followed Equation 12.

The plot delineates a clear linear distribution of the data as seen in Figure T.7.

The parameters highlighted show that physical exposure, HDI and the percentage of arable land were associated with cyclone hazards.

The GDPcap is strongly correlated with the HDI or negatively with the percentage of urban growth. In most of the cases, the variable GDPcap could be replaced by HDI as explained previously. However, these results show with confidence that poor countries and countries with low human development index rank are more vulnerable to cyclones.

With a considerable part of variance explained by the regression (R^2 = 0.863) and a high degree of confidence in the selected variables (very small p-value) over a sample of 32 countries, the model achieved is solid.

In the model, the consequences of Hurricane Mitch could easily be depicted. Indeed, Honduras and Nicaragua were far off the regression line (significantly underestimated). This is explained by the high impact of Mitch compared to other hurricanes. The extreme values given by this event led to Honduras and Nicaragua being rejected from the model.

EQUATION 12 MULTIPLE LOGARITHMIC REGRESSION MODEL FOR TROPICAL CYCLONE

EQ12 $$\ln(K) = 0.63\ln(PhExp) + 0.66\ln(\overline{Pal}) - 2.03\ln(\overline{HDI}) - 15.86$$

Where
K is the number of killed from cyclones
PhExp is the physical exposure to cyclones
$\overline{Pal}$ is the transformed value of percentage of arable land
$\overline{HDI}$ is the transformed value of the Human Development Index

h. In broad terms, a p-value smaller than 0.05 shows the significance of the selected indicator, however this should not be used blindly.

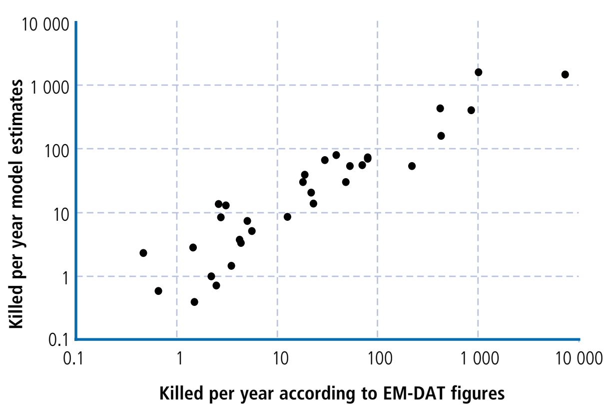
TABLE T.9 EXPONENT AND P-VALUE FOR CYCLONES MULTIPLE REGRESSION

21 countries	B	p-value[i]
Intercept	−15.86	0.00000
ln(PhExp)	0.63	0.00000
$\ln(\overline{Pal})$	0.66	0.00013
$\ln(\overline{HDI})$	−2.03	0.00095
R= 0.93, R^2= 0.86, adjusted R^2= 0.85		

TABLE T.10 EXPONENT AND P-VALUE FOR FLOOD INDICATORS

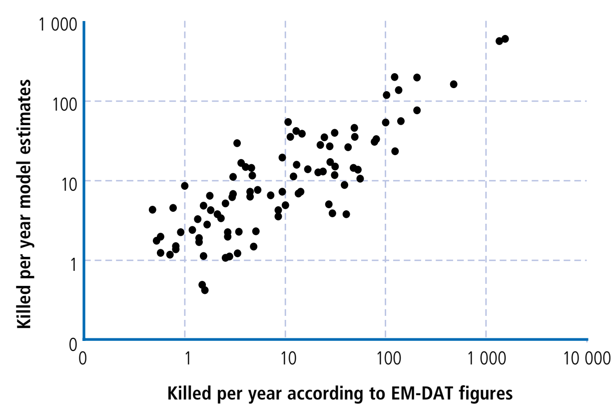
90 countries	B	p-value[i]
Intercept	−5.22	0.00000
ln(PhExp)	0.78	0.00000
$\ln(GDP_{cap})$	−0.45	0.00002
ln(Density)	−0.15	0.00321
R= 0.84, R^2= 0.70, adjusted R^2= 0.69		

FIGURE T.7 SCATTER PLOT OF THE OBSERVED NUMBER OF PEOPLE KILLED BY TROPICAL CYCLONE (EM-DAT) AND THE MODEL PREDICTIONS



Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

FIGURE T.8 SCATTER PLOT OF THE OBSERVED NUMBER OF PEOPLE KILLED BY FLOOD (EM-DAT) AND THE MODEL PREDICTIONS



Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

T.5.6 Flood

Statistical model

The multiple regression was based on 90 countries. The best-fit regression line followed Equation 13.

Due to space constraints, only a selection of countries was included in the above scatter plot. A comprehensive list of countries affected by floods is provided below:

Albania, Algeria, Angola, Argentina, Australia, Austria, Azerbaijan, Bangladesh, Benin, Bhutan, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Chad, Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Czech Republic, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, France, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, India, Indonesia, Iran (Islamic Republic of), Israel, Italy, Jamaica, Japan, Jordan, Kenya, Lao People's Democratic Republic, Malawi, Malaysia, Mali, Mexico, Republic of Morocco, Mozambique, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Republic of Korea, Republic of Moldova, Romania, Russian Federation, Rwanda, Saudi Arabia, Sierra

EQUATION 13 MULTIPLE LOGARITHMIC REGRESSION MODEL FOR FLOOD

EQ13 $$\ln(K) = 0.78\ln(PhExp) + 0.45\ln(GDP_{cap}) - 0.15\ln(D) - 5.22$$

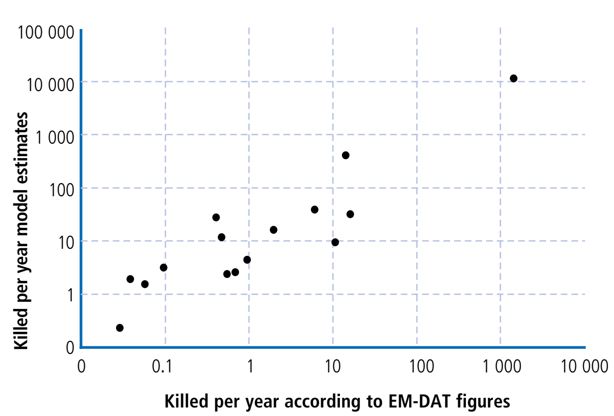
Where
- K is the number of killed from floods
- PhExp is the physical exposure to floods
- GDP_{cap} is the normalised Gross Domestic Product per capita (purchasing power parity)
- D is the local population density (i.e. the population affected divided by the area affected)

i. In broad terms, a p-value smaller than 0.05 shows the significance of the selected indicator, however this should not be used blindly.

TABLE T.11 EXPONENT AND P-VALUE FOR DROUGHT MULTIPLE REGRESSION

Predictor	Coef	SE Coef	T	p-value[j]
Constant	14,390	3,411	4.22	0.001
PhExp3_5	1.2622	0.2268	5.57	0.000
$WAT_{TOT}^{(1n)}$	-7,578	1,077	-7.03	0.000
S = 1,345, R-Sq = 0.812, R-Sq(adj) = 0.78				

FIGURE T.9 SCATTER PLOT OF THE OBSERVED NUMBER OF PEOPLE KILLED BY DROUGHT (EM-DAT) AND THE MODEL PREDICTIONS



Source: The EM-DAT OFDA/CRED International Disaster Database and UNEP/GRID-Geneva

Leone, Slovakia, South Africa, Spain, Sri Lanka, Thailand, Tunisia, Turkey, Uganda, Ukraine, United Kingdom of Great Britain and Northern Ireland, United Republic of Tanzania, United States of America, Viet Nam, Yemen and Zimbabwe.

The variables selected by the statistical analysis are physical exposure, GDP_{cap} and local density of population. GDP_{cap} being highly correlated with HDI, this later could have been chosen as well. The GDP_{cap} was chosen due to slightly better correlation between the model and the observed killed, as well as because of lower p–value. Regression analysis supposes the introduction of non-correlated parameters, thus preventing the use of all these variables.

The part of explained variance (R^2 = 0.70) associated with significant p-value (between 10^{-23} and $2 \cdot 10^{-3}$) on 90 countries is confirming a solid confidence in the selection of the variables (see Table T. 10 on the previous page).

T.5.7 Drought

Statistical model

The regression analysis was performed using the six different exposure datasets derived from IRI drought maps. In general, the models were based on three-month thresholds to give better results. The dataset based on a drought threshold set at three months, at 50 percent below the median precipitation between 1979-2001, was finally selected as the exposure data.

The multiple regression was based on 15 countries. The best-fit regression line followed Equation 14.

Rejected countries: Swaziland and Somalia (WAT_{TOT} value inexistent), North Korea (reported WAT_{TOT} of 100 percent is highly doubtful), Sudan and Mozambique (eccentric values, suggesting other explanation for deaths).

The small p–values observed suggest a relevant selection of the indicators among the list of available datasets. It is to be noted that the high coefficient for WAT_{TOT} (–7.578) denotes a strong sensitivity to the quality of the data. This implies that even a change of 1 percent in total access to water would induce significant change in the results. This would be especially so for small values where small changes have bigger influence in proportion.

The model could not be used for predictive purposes. Inconsistencies were found in the data that require further verification.

EQUATION 14 MULTIPLE LOGARITHMIC REGRESSION MODEL FOR DROUGHT

EQ14 $$\ln(K) = 1.26\ln(PhExp3\_50) - 7.58\ln(WAT_{TOT}) + 14.4$$

Where

K is the number of killed from droughts

PhExp3_50 is the number of people exposed per year to droughts. A drought is defined as a period of at least three months less or equal to 50 percent of the average precipitation level (IRI, CIESIN/IFPRI/WRI)

WAT_{TOT} is the percentage of population with access to improved water supply (WHO/UNICEF)

j. In broad terms, a p-value smaller than 0.05 shows the significance of the selected indicator, however this should not be used blindly.

The variables associated with disaster risk through statistical analysis were physical exposure and the percentage of population with access to improved water supply. A strong correlation was established (R^2 = 0.81) indicating the solidity of the method as well as the reliability of these datasets for such a scale of analysis.

Figure T.9 shows the distribution (on a logarithmic scale) of expected deaths from drought and as predicted from the model. A clear regression can be drawn. It should be noted that if Ethiopia were to be excluded, the correlation would fall to (R^2 = 0.6). However, the offset and the slope of the regression line do not change significantly, reinforcing the robustness of the model.

As far as 1.26 is close to 1, the number of killed people grows proportionally to physical exposure. Also, the number of killed people decreases as a percentage of population when improved water supply grows. This latter variable should be seen as an indicator of the level of development of the country, as it was correlated to other development variables, such as the under-five mortality rate (Pearson correlation r = –0.64) and Human Development Index (r = 0.65).

Some countries with large physical exposure did not report any deaths to drought (United States of America, Viet Nam, Nigeria, Mexico, Bangladesh, Iran, Iraq, Colombia, Thailand, Sri Lanka, Jordan, Ecuador). This could be for a number of reasons. Either the vulnerability is null or extremely low, e.g. USA and Australia, or the number of reported killed from food insecurity is placed under conflict in EM-DAT, e.g. Iraq and Angola. For other countries, further inquiry might be necessary.

T.6 Multiple Risk Integration

So far, the precision and quality of the data as well as the sensitivity of the model do not allow the ranking of countries for disaster risk.

T.6.1 Methods

How to compare countries and disasters

A multiple-hazard risk model was made by adding expected deaths from each hazard type for every country. In order to reduce the number of countries with no data that would have to be excluded from the model, a value of 'no data' for countries without significant exposure was replaced by zero risk of deaths. Countries were considered as not affected if the two following conditions were met: a physical exposure smaller than 2 percent of the national population AND an affected population smaller than 1,000 per year.

Some 39 countries were excluded from the analysis. Despite this, it is known that each was exposed to some level of hazard and 37 countries with recorded disaster deaths were in EM-DAT. This list of countries identifies places where improvement in data collection is needed to allow their integration in future work. Reasons that individual countries were excluded were: countries marginally affected by a specific hazard, countries affected but without data; and countries where the distribution of risk could not be explained by the model (for example, for drought in Sudan, where food insecurity and famine is more an outcome of armed conflict than of meteorological drought as defined in the model).

Once the countries to be included in the model were identified, a Boolean process was run to allocate one of five statistically defined categories of multi-hazard risk to each country. Figure T.10 illustrates the different steps taken to incorporate values into a multiple-risk index. Once this process had been completed, three different products were available:

- A table of values for the countries that include the data for relevant hazards or countries without data but marginally affected (210 countries).
- A list of countries with missing data (countries with reported deaths but without appropriate data).
- A list of countries where the model could not be applied (indicators do not capture the situation in these countries, case of countries not explained by the model, or rejected during the analysis because the indicators are not relevant to the situation).

Multiple risk computation

Multiple risk was computed using the succession of formulae as described in Equation 15 (see following page).

Between each addition, the whole process described in Figure T.10 (see following page) needed to be run in order to identify those countries where a value represented by zero needed, either to be replaced by a value calculated from the selected hazard model, or if not, the country was placed in the 'not-relevant' or 'no data' lists (see below).

EQUATION 15 COMPUTATION OF MULTIPLE RISK BY SUMMING CALCULATED DEATHS AS MODELLED FOR RISK FOR CYCLONE, FLOOD, EARTHQUAKE AND DROUGHT

EQ15

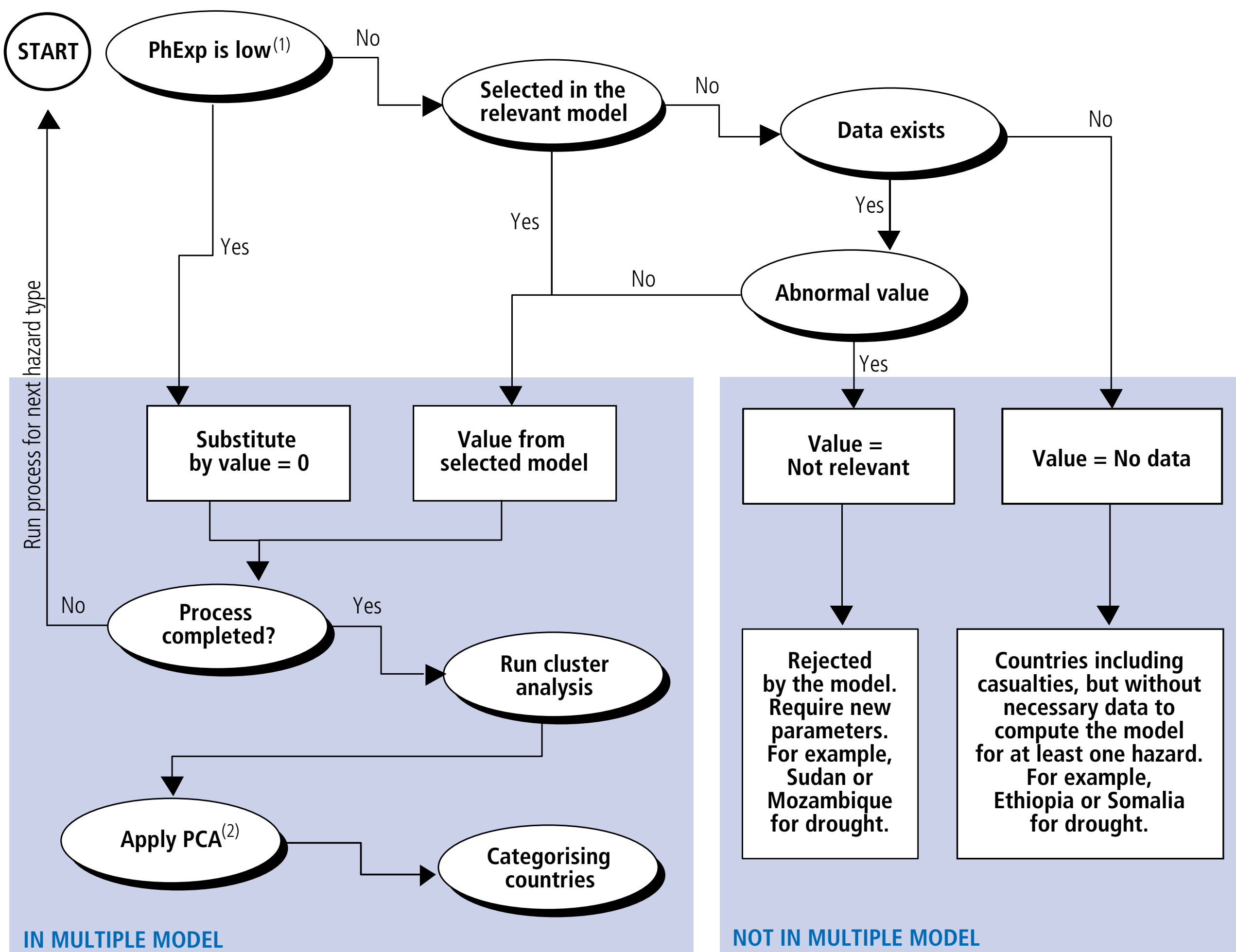
$$K_{cyclones}\left(PhExp^{0.63}_{cyclones} \cdot \overline{Pal}^{0.66} \cdot \overline{HDI}^{-2.03} \cdot e^{-15.86}\right) + K_{floods}\left(PhExp^{0.78}_{floods} \cdot GDP^{-0.45}_{cap} \cdot D^{-0.15} \cdot e^{-5.22}\right) +$$

$$K_{earthquakes}\left(PhExp^{1.26}_{earthquakes} \cdot U_g^{12.27} \cdot e^{-16.27}\right) + K_{droughts}\left(PhExp3\_50^{1.26} \cdot WAT_{TOT}^{-7.58} \cdot e^{14.4}\right)$$

Where

e	is the Euler constant (=2.718…)	GDP_{cap}	is the Gross Domestic Product per capita at purchasing power parity
PhExp	is the physical exposure of selected hazard	D	is the local density (density of population in the flooded area)
HDI	is the Human Development Index	U_g	is the Urban growth (computed over three-year period)
		WAT_{TOT}	is the access to safe drinking water

FIGURE T.10 MULTIPLE RISK INTEGRATION



(1) Physical exposure is considered as marginal if smaller than 1,000 per year
(2) PCA: Principal Component Analysis, used to combine killed per year and killed per population in one component.

In order to examine the fit between model multi-hazard risk and recorded deaths, data from both sources were categorised into five country risk classes. A cluster analysis minimising the intra-class distance and maximising the inter-classes (K-means clustering method) was performed. This meant that a purely statistical process had been used to identify severities of risk from the model and deaths as recorded by EM-DAT.

In order to take both risk indicators (killed and killed per inhabitant) into account, a Principal Component Analysis (PCA) was performed to combine the two. Then a distinction was made between countries smaller than 30,000 km squared and with population density higher than 100 inhabitants per km squared.

T.6.2 Results

Modelled countries without reported deaths
The multi-hazard DRI was computed for 210 countries. This includes 14 countries where no recorded deaths were reported in the last two decades from EM-DAT: Barbados, Croatia, Eritrea, Gabon, Guyana, Iceland, Luxembourg, Namibia, Slovenia, Sweden, Syrian Arab Republic, The former Yugoslav Republic of Macedonia, Turkmenistan and Zambia.

No data, abnormal values and specific cases
Through the Principal Component Analysis transformation, inferior and superior thresholds were identified. This was performed on both observed and modelled deaths. For 14 countries, a value was calculated in the multi-hazard risk model even though no deaths had been recorded by EM-DAT in the 1980-2000 period. On the other hand, 37 countries where deaths were recorded could not be modelled, either because of a lack of data or because they did not fit with the model assumptions. These countries were: Afghanistan, Azerbaijan, Cuba, Democratic People's Republic of Korea, Democratic Republic of the Congo, Djibouti, Dominica, France, Greece, Liberia, Malaysia, Montserrat, Myanmar, New Caledonia, Portugal, Solomon Islands, Somalia, Spain, Sudan, Swaziland, Taiwan, Tajikistan, Vanuatu, Yugoslavia, Antigua and Barbuda, Armenia, Guadeloupe, Guam, Israel, Martinique, Micronesia (Federated States of), Netherlands Antilles, Puerto Rico, Reunion, Saint Kitts and Nevis, Saint Lucia, United States Virgin Islands.

Countries absent of both EM-DAT and Model
Two countries were absent from both EM-DAT and the model: Anguilla (a dependency of the United Kingdom) and Bosnia-Herzegovina.

EM-DAT-DRI multi-hazard risk comparison results
The results of the comparison of modelled and EM-DAT multi-hazard deaths are presented and discussed in Chapter 2. For more information, including country specific variables, researchers are encouraged to visit the Report website.

T.7 Technical Conclusions and Recommendations

T.7.1 The DRI – A work in progress

The DRI is a statistically robust tool
The results generated by the DRI method were statistically robust with a high level of confidence. This is especially the case considering the independence of the data sources and the coarse resolution of the data available at the global scale. The statistically strong links — both between observed and modeled deaths and between socio-economic variables associated with human vulnerability and levels of risk — that were found in the DRI study are not often found in similar studies that analyse geophysical datasets and socio-economic data. The model has succeeded in opening the great potential for future national level disaster risk assessments. It provides the first, solid statistical base for understanding and comparing countries' disaster risk and human vulnerability.

The DRI is not a predictive model
This is partly a function of a lack of precision in the available data. But it also shows the influence of local context. The risk maps provided in this research allow a comparison of relative risk between countries, but cannot be used to depict actual risk for any one country. Sub-national risk analysis would be required to inform development and land-use planning at the national level.

How to link extreme and everyday risk?
Extraordinary events by their very nature do not follow the normal trend. Hurricane Mitch in 1998, the rains causing landslides in Venezuela in 1999 or the 1988 earthquake in Armenia were off the regression line. This is due to the abnormal intensity of such events. These events are (hopefully) too rare to be usefully included in a two-decade period of study. Incorporating this level of intensity can only be done on an event-per-event approach.

T.7.2 Ways forward

Socio-economic variables
Results showed that global datasets can still be improved both in terms of precision and completeness. However, they already allow the comparison of countries. Other indicators — such as a corruption, armed conflict or

political events — would be interesting to test in the model in the future.

Floods

Geophysical data can be improved. The watersheds used to estimate flood physical exposure were based on a 1 km cell resolution for elevation. A new global dataset on elevation from radar measures taken from a National Aeronautics and Space Administration (NASA) space shuttle is expected in 2004. It consists of a 30m resolution grid for the USA and 90m resolution for global coverage. This dataset will allow the refining of estimated areas exposed to flood risk. This advance will be especially welcome for the central Asian countries, where the quality of globally accessible available data was low.

Earthquakes

If information on soil (i.e. Quaternary rocks) and fault orientations can be generated, it would be possible to compute intensity using a modified Mercali scale, with much higher precision for delineating the affected area. Alternatively, a method for deriving frequency based on the Global Seismic Hazard Map from the GSHAP[13] could be used.

Cyclones

Once data from the North Indian Ocean is available, a vector approach should be applied using the PreView Global Cyclone Asymmetric Windspeed Profile model developed by UNEP/GRID-Geneva. This method computes areas affected, based on central pressure and sustainable winds.

Drought

Other precipitation datasets with higher spatial resolution could be usefully tested. The use of geo-climatic zones might be useful in order to take into account the usual climate of a specific area. Indeed, a drop of 50 percent precipitation might not have the same consequence on a humid climate as on a semi-arid area. The use ofthe Global Humidity Index (from UNEP/GRID UEA/CRU) might help in differentiating these zones. Measuring food insecurity (by using information on conflict and political status) would be also a significant improvement as compared to meteorological drought. Alternatively, drought could be measured in terms of crop failure through use of satellite imagery. This will be closer to drought as it impacts on food security.

The case of small islands and archipelagos

In some cases, small islands and archipelagos were too small to be considered by the GIS-automated algorithms. This was typically the case for population data. The raster information layer for population could not be used to extract the population of small islands. For single island countries, the problem might be overcome by using the population of the country, but for others this was not possible. Indeed, when superimposing cyclone tracks on top of archipelagos, the population is needed for each island. A manual correction is needed, but could not be performed due to the time-frame of the study. The compilation of socio-economic variables was also not complete for the islands. This might be improved by collaborating with agencies such as the South Pacific Applied Geoscience Commission (SOPAC) and Economic Commission for Latin America and the Caribbean (ECLAC) as both agencies are currently working on indicators for island vulnerability.

For all these reasons, the case of small island states and archipelagos would need a separate study.

Death as an indicator for risk

To what extend are deaths proportional to the significance of total losses, including losses of livelihood? In the case of earthquakes, where no early warning exists, this might be a good proxy. But it will depend on whether the earthquake epicentre is located in a rural or urban area. For tropical cyclone and flood, deaths are usually much smaller in relation to losses of houses, infrastructures and crops. In drought, the relationship is even more exaggerated. A much higher number of people are affected through the slow erosion of rural livelihoods and the possible influence of intervening factors, such as armed conflict, economic or political crisis, or epidemic disease such as HIV/AIDS. This makes separating the impact of drought from other factors a big challenge.

The ideal would be to have access to records of livelihood losses in order to calibrate the severity of one hazard type as compared to another (while considering the magnitude of a hazard). Other approaches for obtaining a structured assessment of comparative risk by country could include an assessment on the comparative severity of hazard using local and expert knowledge, or using relief and aid organisation budget data as a proxy for risk severity.

Extending to other hazards

Volcanic eruptions. The variability of volcanic hazards was too complex to be entered into a general model. Volcanic hazard ranges from lahars linked with precipitation level, seismicity, topography and soils characteristics, to tephra falls influenced by the prevailing wind direction and strength, and phreatomagmatic eruption. Despite this complexity, much data is available for volcanic hazard and each active volcano is well described. Data needed for a global assessment of volcanic risk probably exists. But a finer resolution for elevation is needed. It would be necessary to include data on the shape and relief of volcanoes, computing slopes and hazard from lahars. Remote sensing analysis for local assessment of danger and population distribution would also be required.

Tsunamis and landslides. Some countries are not well represented by the model because they are affected by hazards that are not of global significance. This is the case of Papua New Guinea and Ecuador, both affected by tsunamis, respectively 67.8 percent and 14.3 percent of national deaths. Landslides also cause significant losses in Indonesia (13 percent), Peru (33 percent) and Ecuador (10 percent) of recorded disaster-related deaths. As a result, the multi-hazard DRI is under evaluated for these countries.

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1. Burton et al. 1993, p.34.
2. Coburn et al. 1991, p. 49.
3. Guha-Sapir, Debatathi and Below, Regina (2002) "Quality and Accuracy of Disaster Data: A Comparative Study of 3 Global Datasets," WHO Centre for Research on the Epidemiology of Disasters, University of Louvain School of Medicine for the Disaster Management Facility of the World Bank, Brussels.
4. Idem, p.14.
5. For a more detailed argument see the CRED-EM-DAT database http://www.cred.be/ and IFRC World Disaster Reports.
6. UNEP, 2002.
7. Birdwell & Daniel, 1991.
8. Bolt et al. 1975.
9. Bolt et al. 1975.
10. Birdwell & Daniel, 1991.
11. Landsea, 2000.
12. Giardini, 1999.

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Appendix
INTERNATIONAL INITIATIVES AT MODELLING RISK

This Appendix presents a review of international indicator projects dealing with risk and development. These projects are presented under four headings: Disaster Risk Reduction, Disaster Risk Reduction and Environmental Management, Environmental Management and Sustainable Development, and Sustainable Human Development. Every effort was made to ensure this list was a complete at the time of publication — apologies to any groups or individuals working on projects that have not been included.

A.1 Disaster Risk Reduction

Identification of Global Natural Disaster Hotspots

The Hotspots project aims to generate a global natural disaster risk assessment. Risks of human and economic losses will be estimated through spatial analysis by assessing the exposure of a global set of element at risk — people, infrastructure and economic activities – to all major natural hazards — droughts, floods, storms, earthquakes, volcanoes and landslides. The analysis will be based on the actual geographic distributions of these phenomena rather than on national level statistics. Risks of losses among the elements at risk posed by each hazard individually, will be aggregated across varying time scales to arrive at the aggregate, multi-hazard risk. A series of case studies will be undertaken as the second component of the Hotspots project to complement the global-scale analysis.

For more information please see the websites
www.proventionconsortium.org files/hotspots2002/dilley.pdf and
http://doherty.ldgo.columbia.edu/CHHR/Hotspot/hotspotmain.html

HAZUS

Undertaken by the United States Federal Emergency Management Agency (FEMA), Hazards U.S. (HAZUS) uses Geographic Information Systems (GIS) technology to compute estimates of damage and losses that could result from earthquake events. To support FEMA's mitigation and emergency preparedness efforts, HAZUS is being expanded into HAZUS-MH, a multi-hazard methodology with new modules for estimating potential losses from wind and flood (coastal and riverine) hazards.

For additional information regarding HAZUS please visit the following websites:
www.nibs.org/hazusweb/ and
www.fema.gov/hazus/index.shtm

Tyndall Climate Change/Disaster Risk Index

The UK based Tyndall Centre for Climate Change Research uses data relating to natural disasters for the assessment of recent historical and current risk associated with climatic variability. Current risk associated with extreme climate events is used as a proxy for risk associated with climate change in the future. The data used is derived from EM-DAT with population data from the World Bank. The results of the risk study will be examined within the context of considerations of vulnerability. Once high-risk countries have been identified it will be necessary to examine the vulnerability of different population groups at a sub-national scale in order to target resources for capacity building; adaptation funds will be useless if they are not employed in a process driven fashion that takes into account the particular geographical, political, economic and social circumstance of the vulnerable groups in question.

For more information please see:
www.tyndall.ac.uk/publications/working_papers/working_papers.shtml

A.2 Disaster Risk Reduction and Environmental Management

Environmental Vulnerabilities Index

The South Pacific Applied Geoscience Commission (SOPAC) Environmental Vulnerability Index (EVI) is among the first tools being developed to focus environmental management at the same scale that environmentally significant decisions are made, and to focus these on outcomes. The method uses 54 indicators to assess the vulnerability of the environment at the national scale. The EVI has been designed to reflect the status of a country's environmental vulnerability, the extent that the natural environment is prone to damage and degradation. It does not address the vulnerability of the social, cultural, or economic environment, nor the environment that has become dominated by these same human systems.

For more information regarding the EVI please visit the following website: www.sopac.org

Small Islands Developing States Index

Paragraphs 113 and 114 of the Programme of Action for the Sustainable Development of Small Island Developing States that was endorsed by the General Assembly in 1994 by resolution 49/122 call for the development of a vulnerability index for Small Island Developing States (SIDS). Accordingly, the UN Department of Economic and Social Affairs (UNDESA) undertook initial studies in 1996 in order to provide a conceptual framework for the development of a vulnerability index. This index is still in the development stage. In the Caribbean, ECHO has developed a Composite Vulnerability Index to compare losses to natural disaster events in the region. During 2002-2003, the Economic Commission for Latin America and the Caribbean/Caribbean Development and Cooperation Committee (ECLAC/CDCC) has explored potential methodologies for a social vulnerability index for Caribbean SIDS.

For further information regarding the Small Island Developing States Index, please visit the website: www.un.org/esa/sustdev/aboutsids.htm

For the ECHO Composite Vulnerability Index please see: www.disaster.info.desastres.net/dipecho/

The Water Poverty Index

The Water Poverty Index assesses communities and countries by water scarcity, examining both physical and socio-economic factors. The Index is based on the formulation of a framework that incorporates six variables: resources, access, capacity, use, environmental and geospatial. Of 147 countries with relatively complete data, most in the top half are either developed or richer developing countries.

For further information please visit the website: www.nerc-wallingford.ac.uk/research/WPI/

A.3 Environmental Management and Sustainable Development

Bellagio Principles: Guidelines for the Practical Assessment of Progress Toward Sustainable Development

These principles deal with four aspects of assessing progress toward sustainability. Principle 1 establishes a vision of sustainable development. Principles 2 through 5 deal with the content of any assessment and the need to merge a sense of the overall system with a practical focus on current priority issues. Principles 6 through 8 deal with key issues of the process of assessment, while Principles 9 and 10 deal with the necessity for establishing a continuing capacity for assessment.

For additional information please visit the following website: http://iisd.ca/measure/bellagio1.htm

Dashboard of Sustainability Indicators

The Dashboard of Sustainability was presented at the World Summit on Sustainable Development (WSSD) in Johannesburg. It is based on the UN Commission on Sustainable Development (CSD) indicator set and contains 19 social, 20 environmental, 14 economic and 8 institutional indicators. It includes data for over 200 countries. The latest version, RioJo, allows a comparison of the global situation at the time of the Rio Summit in 1992 with the current state of the world.

For more information please visit the IISD homepage: www.iisd.org

Ecological Footprint Accounts

Ecological Footprint Accounts document humanity's demands on nature. A population's Ecological Footprint is the biologically productive area needed to produce the resources used and absorb the waste generated by that population. Ecological Footprint Accounts calculate the combined size of these areas. The average world citizen has an Ecological Footprint of 2.3 global hectares (5.6 acres), the average German's is 4.7 global hectares (12 acres), and the average American's is 9.6 global hectares (24 acres).

For more information please see the website: www.redefiningprogress.org/programs/sustainability/ef/

Environmental Sustainability Index

The Environmental Sustainability Index (ESI) works towards the development of a measure of overall progress of global environmental sustainability. Currently incorporating 142 countries, the 2002 ESI scores are based upon a set of 20 core indicators. The ESI tracks the relative success of each country in the five core components of environmental systems: reducing stress, reducing human vulnerability, social and institutional capacity, and global stewardship.

For more information please see the following websites: www.weforum.org, www.ciesin.columbia.edu, www.yale.edu/envirocenter

Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment undertakes an analysis of the capacity of an ecosystem to provide goods and services important for human development. The fundamental unit of interest is the ecosystem itself. The approach taken is to assess the capacity of the system to provide various goods and services and then to evaluate the trade-offs among those goods and services.

For more information regarding the Millennium Ecosystem Assessment please visit the following website: www.millenniumassessment.org/en/about/index.htm

Pilot Environmental Performance Index

The Environmental Performance Index (EPI), launched in 2002, permits national comparisons on efforts to manage a narrow set of common policy objectives concerning air and water quality, climate change and ecosystem well-being. The EPI enables benchmarking of progress towards meeting immediate national policy objectives, facilitates judgements about environmental performance, and can be used to identify important differences in performance that may warrant intervention and investigation.

For more information please see the following websites: www.weforum.org, www.ciesin.columbia.edu, www.yale.edu/envirocenter

A.4 Sustainable Human Development

The Human Development Index

UNDP's Human Development Index (HDI) measures a country's achievements in three aspects of human development: longevity, knowledge and a decent standard of living. Although the HDI is a useful tool it is not enough to measure a country's level of development. A fuller picture of a country's level of human development requires analysis of other human development indicators and information.

For further information please visit the following UNDP website: http://hdr.undp.org

The Human Poverty Index

UNDP's Human Poverty Index for developing countries (HPI-1) measures deprivations in the same three aspects of human development as the HDI (longevity, knowledge and a decent standard of living). The Human Poverty Index for industrialised countries (HPI-2) includes social exclusion. Many National Human Development Reports now break down the HPI by district level or language group to identify the areas or social groups within the country most deprived in terms of human poverty. The results can be dramatic, creating national debate and helping to reshape policies.

For more information please visit the following webpage: http://hdr.undp.org/statistics/faq.cfm

The Human Insecurity Index

The Index of Human Insecurity is a classification system that distinguishes countries based on how vulnerable or insecure they are. The index uses indicators of sustainable development, although parallels with indicators of human well-being and social indicators are evident.

For more information please visit the following website: www.gechs.org/aviso/avisoenglish/six_lg.shtml

Freedom House Index

Freedom in the World is an institutional effort by Freedom House to monitor the progress and decline of political rights and civil liberties in 192 nations and in major related or disputed territories. The Survey rates each country on a seven-point scale for political rights and civil liberties and divides the world into three broad categories: "Free", "Partly Free", and "Not Free".

For more information please visit the Freedom House homepage: www.freedomhouse.org

Transition Index

This index offers analysis of the transition to market economies and macroeconomic performance in Central and Eastern Europe and the Commonwealth of Independent States (CIS), drawing on the European Bank for Reconstruction and Development's (EBRD) experience as an investor in the region. Country-by-country assessments include macroeconomic tables, output and expenditure, and foreign direct investment. They also provide key data on liberalisation, stabilisation, privatisation, enterprise reform, infrastructure, financial institutions and social reform.

For more information please visit the EBRD homepage: www.ebrd.com

Human Rights Indicators

This project measures the commitment of governments to respect and fulfil human rights. Four factors are part of their assessment of commitment: an index measuring commitment to international and regional human rights standards by governments, an index of civil and political human rights violations by governments, an index approximating commitment to fulfilment of economic, social and cultural rights, and an index measuring in a preliminary way, commitment to gender equality by governments.

For more information regarding the Human Rights Indicators please visit the Danish Centre for Human Rights webpage: www.humanrights.dk/departments/PP/PA/Concept/Indicato/

AIDS Program Effort Index

The AIDS Program Effort Index (API) measures the amount of effort put into national AIDS programs by both domestic and international organisations. The API was implemented in 40 countries in 2000.

For more information regarding the API please visit the following website: www.tfgi.com/Api_final.doc

GLOSSARY OF TERMS

The explanations offered here are not formal UNDP definitions. To aid comparability, these definitions are similar to those used in the ISDR Secretariat publication, *Living with Risk: A Global review of Disaster Reduction Initiatives.*

Armed conflict: A contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths.[1]

Civil society: A realm of political action lying between the household and the state but excluding for profit private sector organisations. Civil society organisations are commonly exemplified by non-governmental and community-based developmental organisations, but also include a wide range of other groups including sports clubs, interest groups, trade unions etc.

Coping capacity: The manner in which people and organisations use existing resources to achieve various beneficial ends during unusual, abnormal and adverse conditions of a disaster phenomenon or process.

Disaster risk management: The systematic management of administrative decisions, organisation, operational skills and abilities to implement policies, strategies and coping capacities of the society or individuals to lessen the impacts of natural and related environmental and technological hazards.

Disaster risk reduction: The systematic development and application of policies, strategies and practices to minimise vulnerabilities, hazards and the unfolding of disaster impacts throughout a society, in the broad context of sustainable development.

Empowerment: A process in which individuals learn by their own actions to become fully engaged in shaping their development potential. The process is necessarily self-led, but benefits from facilitation by supporting actors.

Human vulnerability: A human condition or process resulting from physical, social, economic and environmental factors, which determine the likelihood and scale of damage from the impact of a given hazard.

Governance: Governance is the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions, through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences.

Income poverty: A status whereby a lack of financial resources limits the ability of an individual or household to meet basic needs. What is included in basic needs is culturally determined so that different levels of financial status may be described as conveying relative forms of income poverty.

Livelihood: The means by which an individual or household obtains assets for survival and self-development. Livelihood assets are the tools (skills, objects, rights, knowledge, social capital) applied to enacting the livelihood.

Natural disaster: A serious disruption triggered by a natural hazard causing human, material, economic or environmental losses, which exceed the ability of those affected to cope.

Natural disaster, slow onset: A disaster event that unfolds alongside and within development processes. The hazard can be felt as an ongoing stress for many days, months or even years. Drought is a prime example.

Natural disaster, rapid onset: A disaster that is triggered by an instantaneous shock. The impact of this disaster may unfold over the medium- or long-term. An earthquake is a prime example.

Natural hazards: Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.

Physical exposure: Elements at risk, an inventory of those people or artefacts that are exposed to a hazard.

Risk: The probability of harmful consequences, or expected loss of lives, people injured, property, livelihoods, economic activity disrupted (or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions. Risk is conventionally expressed by the equation:
Risk = Hazard x Vulnerability

Resilience: The capacity of a system, community or society to resist or to change in order that it may obtain an acceptable level in functioning and structure. This is determined by the degree to which the social system is capable of organising itself, and the ability to increase its capacity for learning and adaptation, including the capacity to recover from a disaster.

Social capital: A shorthand term used to describe a combination of social norms (such as trust), relationships (such as reciprocity) and ties (such as hierarchical clientalism or horizontal group bonds) held by an individual or predominant within a social arena.

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs.

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Statistical Annex

DISASTER RISK INDEX TABLES

TABLE 1 DISASTER RISK INDEX SUMMARY TABLE, 1980 - 2000

	Number of people killed per year	Average number of people killed per million inhabitants	Average HDI 1980-2000	Gross Domestic Product Purchasing Power Parity, 1990	Percentage of population infected by HIV/AIDS virus, 2001	Control of corruption 2002	Average percentage of people affected by conflicts per year, 1980 - 2000
Country Name (alphabetical order)	Killed per Year	Killed per million	HDI_{av}*	GDPcap (ppp)	%	Corruption	%population
Afghanistan	820.00	49.06	--	--	--	-1.35	98
Albania	0.76	0.25	0.725	2 843	--	-0.85	0
Algeria	150.71	6.02	0.693	4 502	0.04	-0.70	37
Angola	1.38	0.13	0.422	1 581	2.59	-1.12	79
Antigua and Barbuda	0.33	5.26	--	7 270	--	-0.84	0
Argentina	12.57	0.38	0.842	7 721	0.37	-0.77	0
Armenia	1 190.67	323.68	0.745	3 565	0.06	-0.72	0
Australia	9.95	0.59	0.936	17 271	0.06	1.91	0
Austria	1.48	0.19	0.921	18 664	0.12	1.85	0
Azerbaijan	2.29	0.29	0.738	4591	0.02	-1.07	0.8
Bahamas	0.24	0.89	0.82	14 521	2.29	1.41	0
Bahrain	--	--	0.824	12 088	--	0.95	0
Bangladesh	7 930.95	68.84	0.47	1 004	0.01	-1.12	4
Barbados	0.00	0.00	0.864	11 252	--	1.29	0
Belarus	0.33	0.03	0.782	7 031	0.15	-0.78	0
Belgium	0.43	0.04	0.935	19 411	0.08	1.57	0
Belize	0.67	3.21	0.776	3 633	1.23	-0.25	0
Benin	4.67	0.94	0.42	706	1.94	-0.61	0
Bhutan	10.57	5.44	0.477	882	--	0.91	0
Bolivia	20.43	3.12	0.648	1 826	0.05	-0.82	0
Bosnia and Herzegovina	0.00	0.00	--	--	--	-0.60	27
Botswana	1.48	1.26	0.577	4 911	20.91	0.76	0
Brazil	106.00	0.72	0.75	5 562	0.35	-0.05	0
Brunei Darussalam	--	--	0.857	14 727	--	0.32	0
Bulgaria	0.19	0.02	0.772	5 797	--	-0.17	0
Burkina Faso	2.10	0.24	0.32	636	4.26	-0.04	0
Burundi	0.86	0.14	0.309	722	6.00	-1.02	16
Cambodia	48.52	4.24	0.541	980	1.30	-0.90	75
Cameroon	1.76	0.13	0.506	1 561	6.05	-1.10	0
Canada	5.10	0.18	0.936	20 122	0.18	2.03	0
Cape Verde	1.52	4.92	0.708	2 926	--	0.33	0
Central African Republic	0.33	0.11	0.372	1 060	6.61	-1.02	3.6

TABLE 1 DISASTER RISK INDEX SUMMARY TABLE, 1980 - 2000

	Number of people killed per year	Average number of people killed per million inhabitants	Average HDI 1980-2000	Gross Domestic Product Purchasing Power Parity, 1990	Percentage of population infected by HIV/AIDS virus, 2001	Control of corruption 2002	Average percentage of people affected by conflicts per year, 1980 - 2000
Country Name (alphabetical order)	Killed per Year	Killed per million	HDI_{lav}*	GDPcap (ppp)	%	Corruption	%population
Chad	147.38	25.89	0.359	766	1.82	-1.02	43
Chile	32.95	2.47	0.825	4 981	0.11	1.55	0
China	2 173.10	1.88	0.718	1 394	0.09	-0.41	0
Colombia	134.43	3.76	0.765	7 195	0.33	-0.47	100
Comoros	2.81	6.15	0.51	1 716	--	-0.73	0
Congo	0.10	0.04	0.502	760	3.60	-0.94	6
Costa Rica	8.48	2.61	0.821	5 288	0.27	0.88	0
Cote d'Ivoire	1.33	0.11	0.426	1 552	4.74	-0.86	0
Croatia	0.00	0.00	0.803	7 133	0.00	0.23	4
Cuba	7.24	0.68	--	--	0.03	-0.13	0
Cyprus	0.10	0.13	0.877	12 784	--	0.89	0
Czech Republic	1.38	0.13	0.844	--	0.00	0.38	0
Democratic People's Republic of Korea	12 887.76	605.90	--	--	--	-1.18	0
Democratic Republic of the Congo	3.05	0.07	0.429	1 290	2.53	-1.42	18
Denmark	0.86	0.17	0.921	19 513	0.09	2.26	0
Djibouti	8.57	17.66	0.447	--	--	-0.73	23.4
Dominica	0.14	1.99	--	--	--	0.52	0
Dominican Republic	22.19	3.11	0.722	3 361	1.47	-0.39	0
Ecuador	58.95	5.59	0.726	2 781	0.16	-1.02	0
Egypt	58.43	0.98	0.635	2 509	0.01	-0.29	0
El Salvador	103.52	19.01	0.701	2 969	0.38	-0.54	44
Equatorial Guinea	--	--	--	1 052	1.26	-1.89	0
Eritrea	0.00	0.00	0.416	--	1.44	0.04	70
Estonia	--	--	--	7 957	0.56	0.66	0
Ethiopia	14 330.33	272.57	0.321	486	3.26	-0.35	24
Fiji	7.29	10.08	0.757	3 804	0.04	0.12	0
Finland	0.00	0.00	0.925	17 797	0.02	2.39	0
France	15.86	0.28	0.924	17 966	0.17	1.45	0
Gabon	0.00	0.00	0.617	5 241	--	-0.55	0
Gambia	2.52	2.98	0.398	1 488	0.61	-0.83	0
Georgia	18.10	3.38	0.742	9 101	0.02	-1.03	0
Germany	2.52	0.03	0.921	18 224	0.05	1.82	0
Ghana	9.95	0.65	0.542	1 368	1.65	-0.40	0
Greece	14.76	1.44	0.881	11 464	0.08	0.58	0
Grenada	0.00	0.00	--	4 567	--	0.71	0
Guatemala	58.24	6.34	0.626	2 824	0.58	-0.71	76
Guinea	13.86	2.27	0.397	1 520	--	-0.58	3
Guinea-Bissau	0.05	0.06	0.339	686	1.39	-0.61	0
Guyana	0.00	0.00	0.704	2 858	2.29	-0.50	0
Haiti	93.14	13.72	0.467	1 638	3.51	-1.70	0
Honduras	732.90	143.61	0.634	2 074	0.87	-0.78	0
Hungary	2.52	0.25	0.829	9 447	0.03	0.60	0
Iceland	0.00	0.00	0.932	21 343	0.08	2.19	0
India	2 931.81	3.51	0.571	1 400	0.39	-0.25	3
Indonesia	373.90	2.06	0.677	1 952	0.05	-1.16	1
Iran (Islamic Republic of)	2 393.14	40.29	0.714	3 878	0.03	-0.38	22
Iraq	0.95	0.05	--	--	0.00	-1.43	71
Ireland	1.81	0.51	0.916	12 687	0.06	1.67	0
Israel	0.90	0.17	0.893	13 450	--	1.08	99
Italy	242.86	4.27	0.909	17 438	0.19	0.80	0
Jamaica	6.57	2.81	0.738	3 261	0.67	-0.46	0
Japan	351.29	2.87	0.928	20 183	0.01	1.20	0

TABLE 1 DISASTER RISK INDEX SUMMARY TABLE, 1980 - 2000

	Number of people killed per year	Average number of people killed per million inhabitants	Average HDI 1980-2000	Gross Domestic Product Purchasing Power Parity, 1990	Percentage of population infected by HIV/AIDS virus, 2001	Control of corruption 2002	Average percentage of people affected by conflicts per year, 1980 - 2000
Country Name (alphabetical order)	Killed per Year	Killed per million	HDI_{lav}*	GDPcap (ppp)	%	Corruption	%population
Jordan	1.33	0.35	0.714	3 304	--	0.00	0
Kazakhstan	5.86	0.35	0.742	6 095	0.04	-1.05	0
Kenya	19.29	0.78	0.514	977	7.99	-1.05	0
Kiribati	0.00	0.00	--	--	--	-0.44	0
Kuwait	0.10	0.06	0.818	--	--	1.06	0
Kyrgyzstan	2.86	0.62	0.707	3 608	0.01	-0.84	0
Lao People's Democratic Republic	5.95	1.36	0.476	900	0.03	-1.25	6
Latvia	--	--	--	8 487	--	0.09	0
Lebanon	1.19	0.44	0.758	1 870	--	-0.34	25
Lesotho	1.90	1.13	0.541	1 087	17.25	-0.28	0
Liberia	0.48	0.22	--	--	--	-0.98	28
Libyan Arab Jamahiriya	0.00	0.00	0.77	--	0.13	-0.82	0
Liechtenstein	--	--	--	--	--	1.29	0
Lithuania	0.29	0.08	0.803	8 534	0.04	0.25	0
Luxembourg	0.00	0.00	0.924	21 363	--	2.00	0
Madagascar	58.33	4.65	0.462	818	0.13	0.14	0
Malawi	23.76	2.43	0.397	445	7.86	-0.91	0
Malaysia	17.29	0.89	0.774	4 739	0.19	0.38	0
Maldives	0.00	0.00	0.739	3 611	--	0.04	0
Mali	1.81	0.20	0.378	582	0.95	-0.32	0
Malta	--	--	0.866	8 742	--	0.80	0
Marshall Islands	0.00	0.00	--	--	--	-0.02	0
Mauritania	107.05	52.63	0.437	1 167	--	0.23	0
Mauritius	0.33	0.31	0.765	5 597	0.06	0.53	0
Mexico	629.19	7.26	0.79	6 383	0.13	-0.19	0
Micronesia (Federated States of)	0.24	2.33	--	--	--	-0.44	0
Moldova, Republic of	3.05	0.71	0.699	5 216	0.13	-0.89	0
Mongolia	4.81	2.00	0.569	1 804	--	-0.14	0
Morocco	40.29	1.48	0.596	2 888	0.04	-0.04	0
Mozambique	4 827.71	327.51	0.323	521	6.33	-1.01	46
Myanmar	10.90	0.25	0.551	--	0.62	-1.37	74
Namibia	0.00	0.00	0.601	4 411	10.63	0.21	40
Nepal	242.52	13.58	0.48	883	0.24	-0.30	0
Netherlands	0.10	0.01	0.931	17 407	0.10	2.15	0
New Zealand	0.81	0.24	0.913	14 190	0.03	2.28	0
Nicaragua	173.95	39.84	0.635	1 721	0.11	-0.44	33
Niger	4.57	0.56	0.274	738	--	-1.10	0
Nigeria	17.43	0.17	0.455	764	2.99	-1.35	0
Norway	0.05	0.01	0.939	19 527	0.04	2.00	0
Oman	1.24	1.04	0.747	--	0.05	1.03	0
Pakistan	292.05	2.61	0.498	1 394	0.06	-0.73	0
Panama	4.24	1.70	0.784	3 871	0.88	-0.24	0
Papua New Guinea	12.76	3.30	0.534	1 580	0.34	-0.90	0
Paraguay	5.19	1.17	0.738	3 922	--	-1.22	0
Peru	110.62	5.22	0.743	3 251	0.20	-0.20	70
Philippines	1 059.86	17.49	0.749	3 332	0.01	-0.52	100
Poland	2.95	0.08	0.828	5 684	--	0.39	0
Portugal	7.29	0.73	0.874	11 176	0.31	1.33	0
Qatar	--	--	0.801	--	--	0.92	0
Republic of Korea	123.48	2.86	0.875	8 880	0.01	0.33	0
Romania	11.14	0.49	0.772	6 219	0.03	-0.34	0
Russian Federation	132.14	0.90	0.775	10 079	0.46	-0.90	0
Rwanda	2.29	0.34	0.395	952	6.29	-0.58	23

TABLE 1 DISASTER RISK INDEX SUMMARY TABLE, 1980 - 2000

	Number of people killed per year	Average number of people killed per million inhabitants	Average HDI 1980-2000	Gross Domestic Product Purchasing Power Parity, 1990	Percentage of population infected by HIV/AIDS virus, 2001	Control of corruption 2002	Average percentage of people affected by conflicts per year, 1980 - 2000
Country Name (alphabetical order)	Killed per Year	Killed per million	HDI_{av}*	GDPcap (ppp)	%	Corruption	%population
Saint Kitts and Nevis	0.29	6.91	--	6 334	--	0.40	0
Saint Lucia	2.76	21.74	--	4 360	--	0.40	0
Saint Vincent and the Grenadines	0.14	1.37	--	3 631	--	0.40	0
Samoa	1.00	6.28	0.701	4 325	--	-0.06	0
Sao Tome and Principe	0.00	0.00	--	--	--	-0.25	0
Saudi Arabia	1.52	0.13	0.754	9 401	--	0.57	0
Senegal	8.90	1.22	0.423	1 199	0.27	-0.17	6
Seychelles	0.24	3.08	--	--	--	0.52	0
Sierra Leone	4.05	1.02	0.258	894	3.71	-0.82	24
Singapore	--	--	0.876	12 783	0.08	2.30	0
Slovakia	2.67	0.49	0.831	9 028	--	0.28	0
Slovenia	0.00	0.00	0.874	--	0.01	0.89	3.7
Solomon Islands	5.00	15.42	--	1 801	--	-0.86	0
Somalia	148.62	19.88	--	--	0.47	-1.19	3
South Africa	62.38	1.67	0.702	8 282	11.42	0.36	22
Spain	13.24	0.34	0.908	12 848	0.31	1.46	0
Sri Lanka	27.86	1.66	0.735	2 036	0.03	-0.14	65
Sudan	7 160.00	275.43	0.439	803	1.35	-1.09	65
Suriname	--	--	0.758	2 508	0.89	0.19	0
Swaziland	26.33	34.77	0.583	3 630	17.60	-0.26	0
Sweden	0.00	0.00	0.936	18 284	0.04	2.25	0
Switzerland	0.76	0.11	0.924	24 154	0.27	2.17	0
Syrian Arab Republic	0.00	0.00	0.7	2 215	--	-0.29	4
Taiwan	134.33	6.36	--	--	--	0.81	0
Tajikistan	82.95	14.64	0.66	2 796	0.00	-1.07	15
Thailand	108.76	1.91	0.757	3 835	1.05	-0.15	11
The former Yugoslav Republic of Macedonia	0.00	0.00	0.766	5 011	--	-0.73	0
Togo	0.14	0.04	0.489	1 400	3.22	-0.68	0
Tonga	0.38	3.97	--	--	--	-0.44	0
Trinidad and Tobago	0.24	0.19	0.798	6 035	1.73	-0.04	0
Tunisia	8.43	1.11	0.714	3 900	--	0.35	0
Turkey	972.24	16.46	0.735	4 834	--	-0.38	3
Turkmenistan	0.00	0.00	0.73	5 962	--	-1.21	0
Tuvalu	0.00	0.00	--	--	--	--	0
Uganda	12.86	0.66	0.435	746	2.50	-0.92	45
Ukraine	3.48	0.07	0.742	6 694	0.51	-0.96	0
United Arab Emirates	--	--	0.809	20 204	--	1.19	0
United Kingdom of Great Britain & Northern Ireland	9.76	0.17	0.923	16 706	0.06	1.97	2
United Republic of Tanzania	22.24	0.75	0.436	453	4.03	-1.00	0
United States of America	253.57	0.97	0.934	23 447	0.32	1.77	0
Uruguay	0.10	0.03	0.828	6 177	0.19	0.79	0
Uzbekistan	4.95	0.22	0.698	--	0.00	-1.03	0
Vanuatu	5.10	33.30	--	2 445	--	-0.44	0
Venezuela	1 449.38	70.54	0.765	5 050	--	-0.94	0
Viet Nam	573.14	8.36	0.682	--	0.17	-0.68	10
Yemen	119.00	9.57	0.468	567	0.05	-0.69	4
Yugoslavia	4.86	0.48	--	--	--	-0.80	0
Zambia	0.00	0.00	0.427	837	10.94	-0.97	0
Zimbabwe	5.05	0.47	0.554	2 336	17.51	-1.17	0

TABLE 1 DISASTER RISK INDEX SUMMARY TABLE, 1980 - 2000

	Number of people killed per year	Average number of people killed per million inhabitants	Average HDI 1980-2000	Gross Domestic Product Purchasing Power Parity, 1990	Percentage of population infected by HIV/AIDS virus, 2001	Control of corruption 2002	Average percentage of people affected by conflicts per year, 1980 - 2000
Tributarians Territories (alphabetical order)	Killed per Year	Killed per million	HDI_{av}*	GDPcap (ppp)	%	Corruption	%population
American Samoa	1.19	27.78	--	--	--	--	0
Anguilla	0.00	0.00	--	--	--	--	0
Bermuda	0.00	0.00	--	--	--	1.29	0
British Virgin Islands	0.00	0.00	--	--	--	--	0
Cocos (Keeling) Islands	--	--	--	--	--	--	0
Cook Islands	1.19	65.09	--	--	--	--	0
French Guiana	0.00	0.00	--	--	--	--	0
French Polynesia	0.33	2.02	--	18 594	--	--	0
Guadeloupe	0.43	1.09	--	--	--	--	0
Guam	0.05	0.34	--	--	--	--	0
Macau, China	0.00	0.00	--	14 080	--	-0.07	0
Martinique	0.48	1.33	--	--	--	--	0
Montserrat	0.52	48.73	--	--	--	--	0
New Caledonia	0.29	1.76	--	19 745	--	--	0
Netherlands Antilles	0.10	0.49	--	--	--	--	0
Niue	0.00	0.00	--	--	--	--	0
Puerto Rico	25.81	7.22	--	--	--	1.19	0
Reunion	2.90	4.87	--	--	--	--	0
Tokelau	0.00	0.00	--	--	--	--	0
Turks and Caicos Islands	0.00	0.00	--	--	--	--	0
United States Virgin Islands	0.52	4.49	--	--	--	--	0
Wallis and Futuna	0.29	21.18	--	--	--	--	0

Source:
Columns 1 and 2: EM-DAT: The OFDA/CRED International Disaster Database
Column 3: calculated by UNDP/BCPR and UNEP/GRID-Geneva for this report. For details, see note below
Column 4: calculated by UNDP/BCPR and UNEP/GRID-Geneva from World Development Indicators (World Bank), "ppp", purchasing power parity
Column 5: UNAIDS "Report on the global HIV/AIDS epidemic July 2002. For details, see http://www.unaids.org/barcelona/presskit/barcelona%20report/contents.html
Column 6: World Bank estimates (From +2.5 maximum control of corruption to -2.5 minimum control of corruption).
World Bank Governance Matters III: updated indicators for 1996-2002. For more details see http://www.worldbank.org/wbi/governance
Column 7: Armed Conflict 1946-2001, International Peace Research Institute, Oslo (PRIO), For more detailed information see http://www.prio.no/cwp/armedconflict

***Note:** Human Development Index has been adjusted as follows: $HDI_{av} = (\text{Sum } K_i HDI_i)/(\text{Sum } K_i)$
Where "K" is the number of people killed by this disaster, "i" is the year and HDI_i is the HDI linearly extrapolated from the standard 5-year interval HDI.

TABLE 2 DISASTER RISK FOR DROUGHTS, 1980 - 2000

Country Name	Average number of events per year	Number of people killed per year	Average number of people killed per million inhabitants	Average physical exposure per year	Physical exposure in percentage of population	Relative Vulnerability	Percentage of total population with access to safe water
	Event per year	Killed per year	Killed per million	People per year	%	Killed per million exposed	%
Democratic People's Republic of Korea	0.10	12 857.14	579.43	763174	3.44	16 846.94	--
Mozambique	0.43	4 764.29	357.06	878 635	6.58	5 422.37	60.0
Ethiopia	0.57	14 303.19	286.24	2 756 273	5.52	5 189.32	23.0
Sudan	0.48	7 142.86	294.05	2 478 870	10.20	2 881.50	71.0
Mauritania	0.33	106.81	57.86	172 159	9.33	620.41	37.0
Chad	0.33	142.86	27.87	514 050	10.03	277.91	27.0
Somalia	0.24	29.57	4.14	726 181	10.17	40.72	--
Madagascar	0.24	9.52	0.78	324 977	2.66	29.31	45.5
Uganda	0.29	5.48	0.29	242 373	1.30	22.59	47.0
Papua New Guinea	0.14	4.67	1.16	436 919	10.83	10.68	42.0
China	0.86	161.90	0.14	26 855 212	2.31	6.03	73.0
Guinea	0.14	0.57	0.10	161 647	2.73	3.54	46.5
Kenya	0.29	4.05	0.16	1 219 322	4.97	3.32	44.5
Indonesia	0.29	60.29	0.34	29 982 870	16.77	2.01	72.5
Burundi	0.10	0.29	0.05	269 943	4.28	1.06	65.0
Pakistan	0.05	6.81	0.05	9 811 893	6.95	0.69	86.0
India	0.38	19.52	0.02	3 3701 757	3.91	0.58	83.0
Brazil	0.43	0.95	0.01	10 345 734	6.89	0.09	84.5
Philippines	0.24	0.38	0.01	8 240 940	13.39	0.05	87.0

Source: Columns 1, 2 and 3: EM-DAT: The OFDA/CRED International Disaster Database; Columns 4, 5, and 6: calculated by the IRI of Columbia University, UNDP/BCPR and UNEP/GRID-Geneva for this report. For details, see technical annex; Column 7: UNEP/GRID-Geneva, calculated from WHO figures. For more details see http://geodata.grid.unep.ch

TABLE 3 DISASTER RISK FOR EARTHQUAKES, 1980 - 2000

	Average number of events per year*	Number of people killed per year	Average number of people killed per million inhabitants	Average physical exposure per year	Physical exposure in percentage of population	Relative Vulnerability	Percentage of Urban growth (as average for 3-year period)
Country Name	Event per year	Killed per Year	Killed per million	People per year	%	Killed per million exposed	%
Armenia	0.05	1 190.48	343.96	155 560	4.49	7 652.82	0.03
Iran (Islamic Republic of)	1.43	2 250.81	38.68	2 094 097	3.60	1 074.84	0.15
Yemen	0.10	72.29	6.90	95 423	0.91	757.53	0.24
Turkey	0.76	949.86	15.58	2 745 757	4.50	345.94	0.15
Afghanistan	0.81	399.95	2480	1 749 097	0.11	228.1	0.13
India	0.67	576.52	0.73	2 730 309	0.35	211.16	0.09
Italy	0.52	225.71	3.98	1 288 265	2.27	175.21	0.00
Russian Federation	0.29	95.29	0.65	658 876	0.45	144.62	0.03
Algeria	0.38	137.19	5.79	1 252 109	5.28	109.57	0.14
Mexico	0.76	427.24	5.05	4 145 529	4.90	103.06	0.08
Nepal	0.10	38.52	2.42	512 716	3.22	75.14	0.19
Georgia	0.14	13.29	2.44	286 210	5.25	46.42	0.04
El Salvador	0.10	53.33	11.23	1 272 919	26.81	41.90	0.07
Pakistan	0.62	30.95	0.30	793 845	0.77	38.99	0.14
Egypt	0.10	27.19	0.45	834 006	1.38	32.60	0.08
Colombia	0.48	85.05	2.34	2 663 322	7.33	31.93	0.09
Bolivia	0.14	5.95	0.86	186 491	2.69	31.92	0.13
Australia	0.14	1.10	0.07	40 727	0.25	26.89	0.04
China	2.10	92.24	0.08	3 493 705	0.30	26.40	0.13
South Africa	0.14	1.62	0.05	82 467	0.25	19.63	0.08
Ecuador	0.43	28.33	2.75	1 542 854	14.97	18.36	0.12
Panama	0.05	1.43	0.58	95 128	3.89	15.02	0.08
Kyrgyzstan	0.10	2.76	0.62	227 769	5.10	12.13	0.04
Indonesia	1.62	193.24	1.04	16 301 764	8.80	11.85	0.15
Venezuela	0.14	4.62	0.25	435 949	2.34	10.60	0.09
Japan	1.14	281.29	2.31	30 855 862	25.39	9.12	0.02
Philippines	0.57	120.57	2.03	16 228 511	27.30	7.43	0.14
Peru	0.62	13.00	0.62	1 844 498	8.81	7.05	0.08
Greece	0.62	11.29	1.11	1 621 341	15.89	6.96	0.03
Nicaragua	0.14	8.86	2.05	1 515 588	35.13	5.84	0.11
Uganda	0.14	0.33	0.02	62 081	0.35	5.37	0.16
Azerbaijan	0.14	1.52	0.19	439 907	5.51	3.46	0.04
Malawi	0.05	0.43	0.05	13 0484	1.44	3.28	0.18
Brazil	0.05	0.05	0.00	14 592	0.01	3.26	0.09
Costa Rica	0.33	2.52	0.85	868 232	29.33	2.91	0.11
Chile	0.24	9.48	0.73	4 465 047	34.34	2.12	0.06
Papua New Guinea	0.33	3.10	0.83	1 645 460	44.19	1.88	0.12
Cyprus	0.05	0.10	0.13	58 652	7.89	1.62	0.07
Bangladesh	0.19	1.38	0.01	925 173	0.73	1.49	0.17
Kazakhstan	0.10	0.05	0.00	39 696	0.24	1.20	0.04
United States of America	0.48	6.52	0.03	6 745 799	2.61	0.97	0.04
Uzbekistan	0.10	0.43	0.02	477 708	2.44	0.90	0.05
Belgium	0.10	0.10	0.01	108 164	1.09	0.88	0.01
United Republic of Tanzania	0.05	0.05	0.00	64 343	0.18	0.74	0.22
Guatemala	0.24	1.71	0.20	2 671 752	30.85	0.64	0.10
Argentina	0.05	0.29	0.01	515 880	1.70	0.55	0.06
Romania	0.14	0.52	0.02	1 007 506	4.37	0.52	0.03
Albania	0.14	0.05	0.02	155 688	5.41	0.31	0.07
New Zealand	0.05	0.05	0.01	239 427	7.28	0.20	0.03
Germany	0.05	0.05	0.00	357 730	0.44	0.13	0.02

Source: Columns 1, 2 and 3: EM-DAT: The OFDA/CRED International Disaster Database; Columns 4, 5, and 6: calculated by UNDP/BCPR and UNEP/GRID-Geneva for this report. For details, see technical annex; Column 7: UNEP/GRID-Geneva, calculated from UNDESA: UN Dep. Of Economic and Social Affairs/Population Division.
*Note: These include events equal or greater than a magnitude of 5.5 on the Richter scale.

Table 4. Disaster Risk for Floods, 1980 - 2000

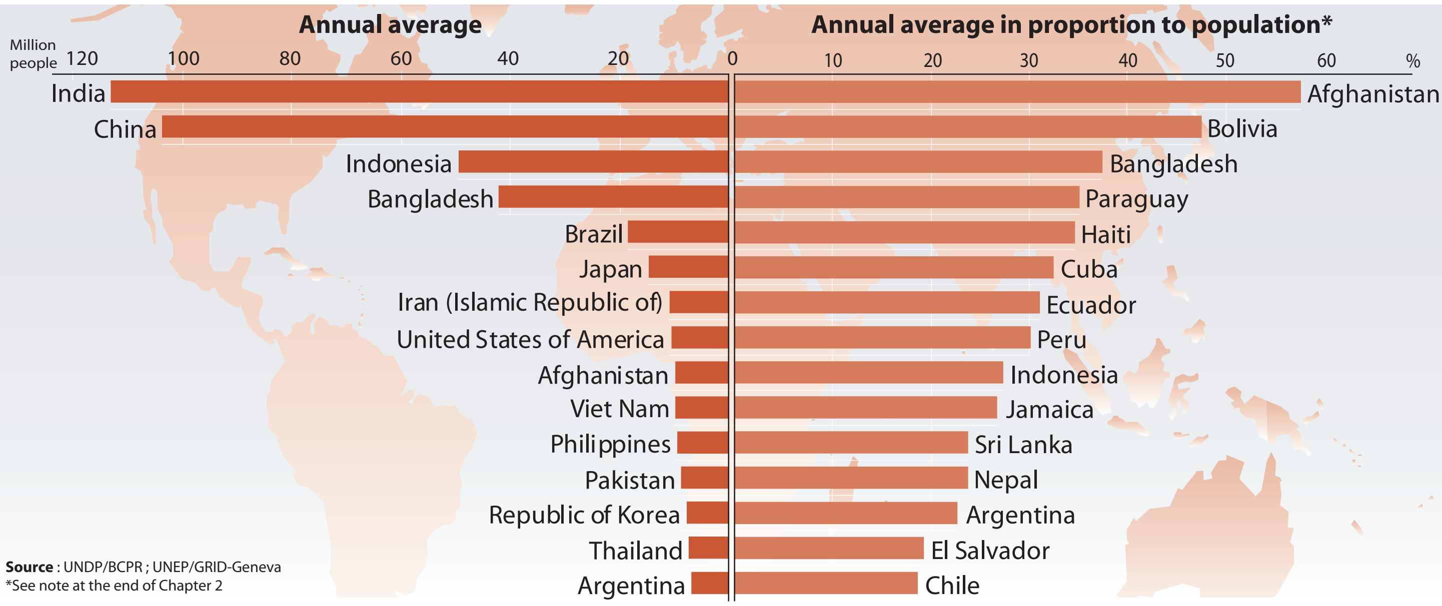
Country Name	Average number of events per year Event per year	Number of people killed per year Killed per Year	Average number of people killed per million inhabitants Killed per million	Average physical exposure per year People per year	Physical exposure in percentage of population %	Relative Vulnerability Killed per million exposed	Density of population (living in the watershed exposed to flood) Inhab. per km^2	Gross Domestic Product, per capita, ppp)
Venezuela	0.67	1 439.62	68.30	2 927 023	13.89	491.84	41.61	5 082
Somalia	0.52	117.62	15.38	579 679	7.58	202.90	17.64	--
Djibouti	0.19	8.57	18.26	81 203	17.30	105.56	107.14	--
Morocco	0.33	39.62	1.40	384 498	1.36	103.04	102.79	2 650
Bhutan	0.10	10.57	5.44	127 900	6.59	82.65	54.24	336
Papua New Guinea	0.24	2.76	0.72	34 440	0.90	80.19	4.49	1 898
Gambia	0.10	2.52	2.09	31 785	2.63	79.40	51.99	1 340
Egypt	0.14	28.95	0.48	389 815	0.65	74.27	215.39	2 287
Botswana	0.14	1.48	1.07	21 187	1.54	69.67	4.24	4 734
Mozambique	0.33	41.33	2.66	614 559	3.95	67.26	30.38	556
Georgia	0.14	4.81	0.90	82 976	1.55	57.96	91.40	2 353
Uganda	0.14	7.05	0.36	136 561	0.69	51.61	107.41	794
Yemen	0.52	46.71	3.65	936 992	7.33	49.86	43.35	746
Zimbabwe	0.10	5.05	0.41	105 595	0.85	47.80	34.09	2 158
Nepal	0.90	199.38	10.92	4 334 045	23.74	46.00	150.11	927
Puerto Rico	0.10	24.67	7.07	552 327	15.83	44.66	475.90	--
Afghanistan	0.76	420.57	24.63	9 841 123	57.63	42.74	31.17	--
Ghana	0.19	9.95	0.60	258 802	1.56	38.46	43.96	1 391
Guatemala	0.43	38.24	4.02	1 018 818	10.70	37.53	100.15	2 885
South Africa	0.67	54.71	1.38	1 468 803	3.70	37.25	26.89	7 699
Honduras	0.62	30.62	6.09	865 397	17.22	35.38	44.70	2 043
Malawi	0.43	23.33	2.36	721 338	7.31	32.35	95.63	459
Fiji	0.14	1.57	2.10	49 944	6.66	31.46	41.38	3 721
Mexico	1.10	121.19	1.41	4 469 462	5.21	27.12	79.57	6 453
Chad	0.29	4.00	0.63	148 952	2.33	26.85	10.05	705
United Republic of Tanzania	0.71	22.00	0.77	823 825	2.87	26.70	28.51	453
El Salvador	0.33	26.76	4.92	1 050 226	19.31	25.48	271.13	3 159
Cambodia	0.29	48.52	4.08	1 986 049	16.69	24.43	77.04	1 096
Democratic People's Republic of Korea	0.29	28.14	1.35	1 211 567	5.81	23.23	287.89	--
Pakistan	0.95	200.38	1.77	8 773 423	7.73	22.84	185.81	1
Burkina Faso	0.24	2.10	0.23	93 658	1.03	22.37	28.08	713
Czech Republic	0.05	1.38	0.13	62 435	0.61	22.12	130.64	12 296
Slovakia	0.10	2.67	0.49	129 203	2.40	20.64	100.79	7 905
Ethiopia	1.00	27.14	0.50	1 321 588	2.44	20.54	41.75	525
Liberia	0.05	0.48	0.19	23 283	0.93	20.45	24.99	--
Mali	0.29	1.81	0.18	96 590	0.95	18.73	17.19	576
Sudan	0.57	15.52	0.57	829 480	3.02	18.72	14.73	--
Niger	0.29	4.57	0.47	244 500	2.54	18.70	25.00	719
Algeria	0.71	13.33	0.50	741 412	2.80	17.98	67.27	4 394
Cameroon	0.24	1.76	0.13	98 214	0.75	17.94	46.55	1 521
Lesotho	0.14	1.90	1.19	110 141	6.90	17.29	49.90	1 167
Angola	0.24	1.38	0.11	82 348	0.67	16.77	23.36	1 811
Tunisia	0.14	8.43	1.13	512 643	6.85	16.44	90.36	4 090
Peru	1.10	97.62	4.56	6 456 876	30.17	15.12	16.73	3 843
China	5.57	1 490.57	1.32	103 804 314	9.16	14.36	126.61	1 741
Colombia	1.14	47.90	1.34	3 346 973	9.36	14.31	34.46	4 625
Viet Nam	1.00	137.90	1.98	9 720 110	13.95	14.19	223.72	1 427
Moldova, Republic of	0.14	2.67	0.62	193 262	4.47	13.80	136.00	2 876
Saint Vincent and the Grenadines	0.14	0.14	1.37	10 764	10.31	13.27	230.63	3 469
Sierra Leone	0.05	0.57	0.14	44 589	1.09	12.82	158.07	665
Yugoslavia	0.38	3.90	0.38	321 934	3.13	12.13	100.32	--
Iran (Islamic Republic of)	1.90	131.19	2.20	10 903 040	18.26	12.03	45.40	3 932
India	3.86	1 313.24	1.55	113 041 300	13.33	11.62	303.38	1 424
Turkey	0.67	20.90	0.36	1 883 782	3.26	11.10	97.01	4 681

Country Name	Average number of events per year Event per year	Number of people killed per year Killed per Year	Average number of people killed per million inhabitants Killed per million	Average physical exposure per year People per year	Physical exposure in percentage of population %	Relative Vulnerability Killed per million exposed	Density of population (living in the watershed exposed to flood) Inhab. per km^2	Gross Domestic Product, per capita, ppp)
Kenya	0.24	12.86	0.50	1 169 475	4.54	10.99	120.00	878
Bangladesh	2.00	461.95	4.11	42 168 039	37.51	10.96	912.59	1 014
Thailand	1.33	78.52	1.37	7 436 253	12.99	10.56	131.73	3 952
Lao People's Democratic Republic	0.43	3.29	0.75	337 368	7.70	9.74	20.61	918
Portugal	0.19	3.33	0.34	348 453	3.51	9.57	233.80	10 920
Spain	0.52	8.38	0.21	888 261	2.28	9.44	74.51	12 301
Ecuador	0.38	30.62	2.92	3 261 635	31.10	9.39	43.19	2 695
Philippines	1.76	75.71	1.22	9 301 763	14.96	8.14	256.98	3 191
Romania	0.43	9.24	0.41	1 174 894	5.20	7.86	90.57	5 955
Rwanda	0.05	2.29	0.34	291 406	4.35	7.84	365.88	952
Nicaragua	0.24	2.52	0.60	328 459	7.75	7.68	40.90	2 146
Democratic Republic of the Congo	0.19	3.05	0.07	415 189	0.94	7.34	132.32	--
Republic of Korea	0.71	51.95	1.19	7 579 290	17.31	6.85	503.77	9 243
Sri Lanka	1.29	27.62	1.62	4 064 648	23.85	6.79	290.30	2 142
Benin	0.48	4.67	0.91	714 078	13.95	6.54	58.17	736
Chile	0.57	16.48	1.21	2 540 958	18.72	6.48	43.39	5 512
Kuwait	0.05	0.10	0.06	14 986	0.88	6.36	124.09	9 010
Burundi	0.10	0.57	0.10	95 306	1.61	6.00	300.73	610
Armenia	0.05	0.19	0.05	34 337	0.91	5.55	80.25	1 822
Jordan	0.10	0.81	0.26	146 508	4.63	5.53	94.76	3 498
Brazil	2.19	99.33	0.67	18 304 697	12.33	5.43	24.29	5 623
Jamaica	0.24	3.43	1.45	632 000	26.76	5.42	215.15	3 124
Albania	0.19	0.71	0.22	131 704	4.12	5.42	109.64	2 755
Congo	0.14	0.10	0.03	17 607	0.64	5.41	2.89	699
Ukraine	0.29	3.00	0.06	589 853	1.15	5.09	90.68	5 178
Haiti	0.81	11.90	1.72	2 399 474	34.71	4.96	275.89	1 449
Panama	0.29	0.81	0.32	167 199	6.57	4.84	42.48	4 352
Bolivia	0.48	14.48	2.27	3 035 231	47.57	4.77	6.63	1 868
Italy	0.57	14.00	0.24	2 994 349	5.23	4.68	208.73	16 619
Cote d'Ivoire	0.10	1.33	0.10	285 823	2.12	4.66	178.14	1 413
Malaysia	0.43	4.43	0.24	958 222	5.09	4.62	69.69	5 380
Costa Rica	0.38	1.67	0.51	371 493	11.32	4.49	65.02	5 415
Myanmar	0.29	9.05	0.20	2 166 338	4.88	4.18	100.06	--
Australia	1.10	4.43	0.26	1 087 860	6.33	4.07	8.44	17 293
Central African Republic	0.24	0.33	0.09	86 217	2.44	3.87	6.90	1 009
Russian Federation	1.33	9.24	0.06	2 393 629	1.63	3.86	43.65	8 179
Nigeria	0.62	12.67	0.12	3 555 094	3.28	3.56	133.19	783
Dominican Republic	0.29	3.00	0.42	1 023 241	14.43	2.93	149.03	3 700
France	1.10	5.29	0.09	1 821 024	3.17	2.90	138.87	17 072
Japan	0.62	30.71	0.25	10 925 468	8.86	2.81	478.94	18 629
Austria	0.29	0.90	0.12	336 735	4.39	2.69	108.83	18 289
Greece	0.19	1.19	0.11	482 663	4.58	2.47	102.71	11 148
Indonesia	2.48	120.29	0.67	49 323 896	27.34	2.44	178.57	1 964
Paraguay	0.38	3.62	0.85	1 494 319	35.06	2.42	10.00	3 841
Canada	0.52	1.52	0.05	659 274	2.36	2.31	50.54	19 456
Poland	0.24	2.95	0.08	1 287 600	3.45	2.29	151.05	6 939
United States of America	3.48	24.19	0.09	10 591 826	4.06	2.28	49.48	22 494
Azerbaijan	0.19	0.76	0.10	351 330	4.55	2.17	84.95	3 670
Ireland	0.10	0.14	0.04	77 876	2.20	1.83	111.07	13 641
Hungary	0.24	0.43	0.04	237 148	2.36	1.81	93.35	8 717
Argentina	1.19	11.14	0.34	7 434 608	22.71	1.50	26.78	9 310
Cuba	0.71	5.00	0.47	3 482 880	32.53	1.44	116.93	--
Trinidad and Tobago	0.10	0.24	0.19	173 512	13.80	1.37	269.47	6 247

Country Name	Average number of events per year Event per year	Number of people killed per year Killed per Year	Average number of people killed per million inhabitants Killed per million	Average physical exposure per year People per year	Physical exposure in percentage of population %	Relative Vulnerability Killed per million exposed	Density of population (living in the watershed exposed to flood) Inhab. per km²	Gross Domestic Product, per capita, ppp)
Israel	0.10	0.52	0.09	542 419	9.50	0.97	326.08	14 084
Norway	0.10	0.05	0.01	50 683	1.15	0.94	144.07	20 045
Belgium	0.29	0.33	0.03	386 689	3.85	0.86	425.19	18 814
Togo	0.19	0.14	0.04	187 082	4.61	0.76	57.98	1 344
Switzerland	0.14	0.10	0.01	157 413	2.33	0.61	176.30	21 816
New Zealand	1.10	0.29	0.09	554 050	16.49	0.52	13.76	16 332
Germany	0.38	1.00	0.01	3 976 284	4.94	0.25	280.34	21 848
United Kingdom of Great Britain and Northern Ireland	0.43	0.48	0.01	2 082 205	3.53	0.23	198.75	18 738
Kazakhstan	0.10	0.48	0.03	2 344 290	14.24	0.20	6.74	5 165
Belarus	0.10	0.10	0.01	620 500	6.04	0.15	60.23	6 059
Kyrgyzstan	0.10	0.10	0.02	874 669	18.34	0.11	16.57	2 812

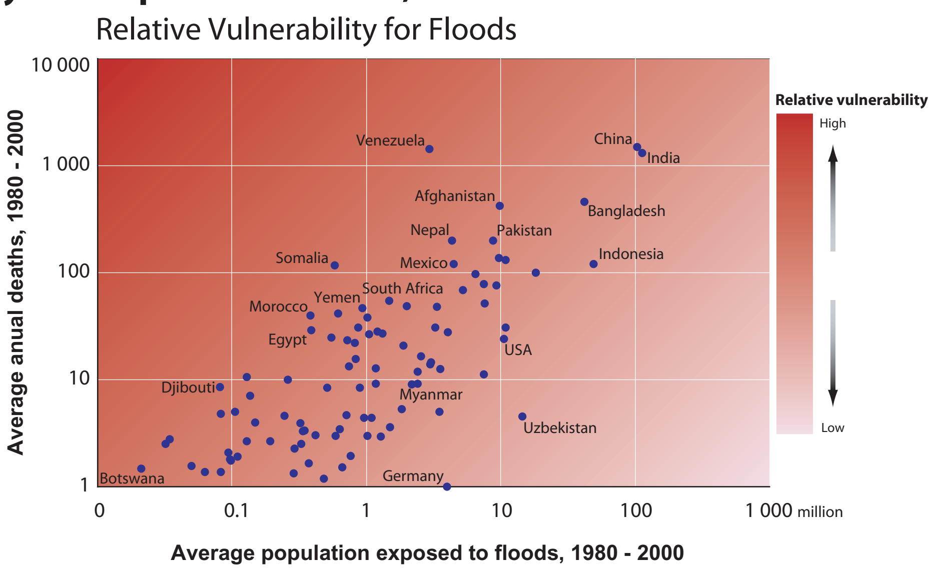
Source : Columns 1, 2 and 3 : EM-DAT : The OFDA/CRED International Disaster Database ; Columns 4, 5, and 6 : calculated by UNDP/BCPR and UNEP/GRID-Geneva for this report. For details, see technical annex ; Column 7 : UNEP/GRID-Geneva, calculated from UNEP/GRID-Geneva spatial modelling based on CIESIN population data. For more details see http://geodata.grid.unep.ch; Column 8 : UNEP/GRID-Geneva from World Development Indicators (World Bank), "ppp", purchasing power parity.

Figure 2.12 Physical exposure to floods, 1980 - 2000



Source : UNDP/BCPR ; UNEP/GRID-Geneva
*See note at the end of Chapter 2

Figure 2.13 Physical exposure to floods, 1980 - 2000



Source : The EM-DAT OFDA/CRED International Disaster Databasse and UNEP/GRID-Geneva

TABLE 5 DISASTER RISK FOR TROPICAL CYCLONES, 1980 - 2000

	Average number of events per year	Number of people killed per year	Number of people killed per million inhabitants	Average physical exposure per year	Physical exposure in percentage of population	Relative Vulnerability	Percentage of Arable Land	Average HDI 1980-2000
Country Name	Event per year	Killed per Year	Killed per million	People per year	%	Killed per million exposed	%	HDI_{av}*
Honduras	0.19	702.29	139.65	2 185 215	43.45	321.38	16.44	0.61
Nicaragua	0.33	162.57	37.39	804 228	18.50	202.15	17.92	0.60
Cape Verde	0.10	1.52	5.07	18 402	6.12	82.80	10.21	0.65
Swaziland	0.05	2.52	4.04	34 728	5.56	72.67	10.26	0.59
Bangladesh	3.43	7 467.62	64.02	135 835 143	116.45	54.98	67.77	0.41
El Salvador	0.19	23.43	3.90	847 932	14.12	27.63	38.56	0.64
Comoros	0.19	2.81	5.97	137 528	29.25	20.43	49.81	0.50
Haiti	0.29	81.24	11.63	6 269 306	89.77	12.96	32.82	0.45
Pakistan	0.62	53.90	0.46	4 697 462	4.04	11.48	27.40	0.44
Malaysia	0.10	12.86	0.60	1 368 871	6.41	9.39	19.91	0.72
Papua New Guinea	0.10	2.24	0.52	289 367	6.76	7.73	1.32	0.49
Fiji	0.67	5.71	7.99	1 012 072	141.57	5.65	12.87	0.72
Viet Nam	2.24	435.24	6.40	77 521 410	114.01	5.61	20.60	0.63
Mozambique	0.33	22.10	1.41	4 698 084	29.88	4.70	4.17	0.31
Madagascar	0.71	48.81	3.87	11 638 792	92.36	4.19	5.27	0.44
Belize	0.10	0.67	3.01	176 043	79.48	3.79	3.05	0.75
Costa Rica	0.19	4.29	1.22	1 196 901	34.15	3.58	10.04	0.79
Philippines	5.57	863.19	14.35	259 304 805	430.94	3.33	32.99	0.71
Guatemala	0.05	18.29	1.69	6 226 716	57.65	2.94	16.87	0.58
India	2.76	1 022.52	1.24	352 431 552	42.75	2.90	56.94	0.51
Dominican Republic	0.38	19.19	2.68	6 889 529	96.30	2.79	30.72	0.68
United States of America	12.14	222.86	0.86	89 407 185	34.41	2.49	20.23	0.91
Thailand	0.71	30.24	0.54	12 739 238	22.84	2.37	38.38	0.71
Republic of Korea	1.00	71.52	1.67	37 649 377	87.85	1.90	20.98	0.81
Jamaica	0.24	3.14	1.34	2 169 085	92.57	1.45	22.52	0.72
Colombia	0.14	1.48	0.05	1 180 056	3.68	1.25	4.66	0.72
Mexico	1.57	80.76	0.93	65 081 375	74.78	1.24	13.64	0.76
Australia	2.38	4.43	0.26	3 666 088	21.72	1.21	6.26	0.90
Venezuela	0.10	5.14	0.26	6 534 046	33.13	0.79	4.20	0.75
China	6.90	428.38	0.37	579 217 240	49.51	0.74	13.50	0.63
Lao People's Democratic Republic	0.19	2.67	0.60	4 554 774	102.72	0.59	3.75	0.42
New Zealand	0.29	0.48	0.13	848 108	23.87	0.56	13.03	0.88
Japan	1.95	39.29	0.32	226 166 900	184.04	0.17	14.26	0.90

Source: Columns 1, 2 and 3: EM-DAT: The OFDA/CRED International Disaster Database; Columns 4, 5, and 6: calculated by UNDP/BCPR and UNEP/GRID-Geneva for this report. For details, see technical annex; Column 7: UNEP/GRID-Geneva, calculated from FAOSTAT; Column 8: Calculated by UNEP/GRID-Geneva, for details see note below

*Note: Human Development Index has been adjusted as follows: HDI_{av}= (Sum $K_i HDI_i$)/(Sum K_i)
Where "K" is the number of people killed by this disaster, "i" is the year and HDI_i is the HDI linearly extrapolated from the standard 5-year interval HDI.