Chapter 3

Deconstructing disaster: risk patterns and poverty trends at the local level

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Introduction

Viewed at the local level disaster risk reveals a complexity that is essentially invisible when observed from a global perspective, but which is critical to understanding both risk dynamics and disaster risk–poverty interactions.

National disaster databases contain disaster loss reports aggregated at the local government level[1]. Databases from a sample of 12 Asian and Latin American countries document a total of 126,620 such reports between 1970 and 2007[2] and show that, as at the global level, mortality and direct economic loss are highly concentrated. Just 0.7% of the reports cover 84% of the total mortality and 75% of the destroyed housing across the 12 countries. In contrast other risk attributes are more evenly spread. For example, 51% of housing damage is distributed across the other 125,632 loss reports.

These patterns illustrate concentrations of intensive risk and geographically dispersed patterns of extensive risk. The first part of this chapter opens a window on both kinds of risk, viewed at the local level. The second part then examines the empirical evidence on how poverty is translated into disaster risk and how disaster impacts are translated into poverty outcomes at the same scale.

Summary of findings

1. Low-intensity damage and asset loss is extensively spread

Mortality and housing destruction are highly concentrated in infrequently occurring events affecting a small number of geographic areas. However, housing damage is both widely spread and frequently occurring and is indicative of similar impacts in local infrastructure in other sectors. These low-intensity but widespread losses represent a significant and largely unrecognized component of disaster impacts and costs.

2. Weather-related extensive risk is increasing rapidly

Extensive manifestations of risk associated with weather-related hazards are expanding geographically, occurring with more frequency and leading to increased damage levels. These loss patterns reflect ongoing patterns of risk configuration, illustrating a tendency of increasing exposure of people and assets at the local level. Given that almost all the losses are weather-related, they are highly susceptible to magnification by climate change.

3. Urbanization, territorial occupation and environmental degradation have been identified as underlying risk drivers

At least part of the increase in losses associated with extensive risk can be explained by improved disaster reporting. It may also already reflect climate change, which is increasing the frequency and intensity of precipitation events in some areas. However, urbanization, territorial occupation and environmental degradation have also been identified as key risk drivers. There is evidence to show that in some areas risk is becoming more intensive over time.

4. Disaster impacts are associated with both short- and long-term poverty outcomes

There is empirical evidence to show that poor communities are far more vulnerable to, and disproportionately affected by, natural hazards, mirroring the uneven distribution of disaster risk observed at the global level. At the same time, evidence from a range of microstudies indicates that poor households are also less resilient and face greater difficulties in absorbing and recovering from disaster impacts. Both intensive and extensive impacts have both short- and long-term poverty outcomes, including reductions in income and consumption, increases in poverty and inequality, and decreases in human development and welfare. Inadequately targeted and untimely relief and assistance, and a lack of access to insurance and social protection are all underlying drivers of the translation of disaster impacts into poverty outcomes.

3.1 Data and method

The analysis builds on important recent advances in the compilation of national disaster databases in both Asia and Latin America[3] that for the first time enable the exploration of loss patterns at the local level. The data used in this analysis has been extracted from these databases and restricted to those reports with identified losses, associated with weather-related[4] and geological[5] hazards and with verifiable source data. Approximately one third of the reports from the national databases were not used in this analysis because they did not comply with one or more of the above conditions.

The country sample analysed is characterized by a wide range of hazard types, development contexts and geographic conditions. Nevertheless, high-resolution disaster data is still not widely available for Africa, Europe and other regions. As such, while the findings point to many broad patterns and trends across different contexts they may not be globally valid. Case study evidence from Africa has been used to complement the analysis in Asia and Latin America.

Relatively robust and comparable disaster loss data exists for attributes such as mortality, housing destruction and damage. Data on crop and livestock loss is far less robust. As a result, risks associated with droughts and rural agricultural livelihoods have not been covered. In contrast microstudies on the impact of disasters on poverty have tended to focus on rural areas.

While disaster losses are indicative of realized risk, they do not indicate risk levels in a probabilistic sense. Current data does not allow an assessment of local risk levels analogous to the global analysis presented in Chapter 2. Information on local-level hazards, such as urban flooding, does not systematically exist. Global data sets on hazard and population exposure become inaccurate when examined at a high resolution. This chapter, therefore, presents an analysis of patterns and trends in losses and impacts, rather than of probabilistic risk levels.

The spatial units of analysis are local government areas or second or third tier administrative units according to the political–administrative division of each country. These areas are highly heterogeneous both within and between countries, ranging from densely populated urban municipalities, where populations of several hundred thousand may be concentrated in a small area, to sparsely populated rural districts, where a much smaller population is spread over several thousand square kilometres. This heterogeneity again means that absolute losses cannot be used to impute a given level of risk. However, these spatial units are not arbitrarily defined. They reflect the way territory is organized and managed politically and administratively in each country. Demographic, social and economic data, including on poverty attributes, is usually aggregated in the same units. While influenced by global processes such as climate change and economic flows, risk is shaped locally at this level. The losses reported in each local area reflect complex local interactions between hazard, exposure and vulnerability. In many ways they represent the social territory of risk at the local level in the same way as countries do at the global level.

A statistical analysis of the sample of 126,620 disaster loss reports was carried out to identify a threshold where the maximum proportion of the losses was concentrated in the minimum number of reports (see Appendix 2, Note 2.2). For this sample, the threshold was established at 50 deaths or 500 houses. Those loss reports with 50 deaths or 500 destroyed houses or more are characterized in this chapter as manifestations of intensive risk and those with less than 50 deaths and 500 destroyed houses are characterized as manifestations of extensive risk. Taking into account the characteristics of the available data and the spatial units in which this data is aggregated, the application of this threshold to the data does not impute higher or lower levels of risk in specific local areas. However, it does enable a characterization of the extensive spread and intensive concentration of losses. Table 3.1 summarizes the loss reports across the sample by hazard type, by loss attribute and by the type of risk manifestation.

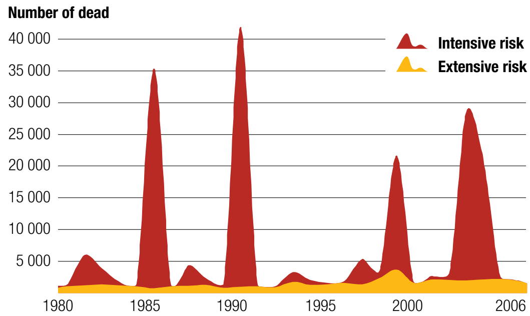
Table 3.1: Extensive and intensive loss reports associated with weather-related and geological hazards

Risk type	Hazard type	Loss reports	%	Deaths	%	Houses destroyed	%	Houses damaged	%
Extensive	Weather-related	121,373	95.9	48,392	15.5	739,002	24.1	3,654,596	48.3
Extensive	Geological	4,259	3.4	2,406	0.8	40,684	1.3	226,545	3.0
Intensive	Weather-related	801	0.6	58,559	18.7	1,618,682	52.7	3,235,176	42.7
Intensive	Geological	187	0.1	203,524	65.0	671,980	21.9	453,094	6.0
Total		**126,620**	**100.0**	**312,881**	**100.0**	**3,070,348**	**100.0**	**7,569,411**	**100.0**

Figure 3.1 shows the distribution of mortality across the sample between 1980 and 2006. The application of the threshold to this mortality distribution clearly illustrates a number of intensive peaks of mortality underpinned by a continuous extensive mortality stream.

The fact that loss attributes such as mortality and destroyed housing are so intensively concentrated in such a small number of reports presents challenges for the identification of patterns and trends. For example, more than two-thirds of the reported mortality in Colombia since 1970 was associated with a single event: the eruption of the Armero Volcano in 1985. The intensive–extensive threshold described above was used as a simple and transparent procedure to filter out these intensive manifestations of risk. Given the large number of remaining extensive manifestations, the trends and patterns identified are then statistically robust.

Figure 3.1: Distribution of mortality associated with intensive and extensive risk across the data set (1980–2006)



Poverty data at a local or household resolution also exists in many of the same countries and has been compared with disaster data in a series of case studies in nine countries[6]. Together with a systematization of the findings of previous studies on disaster and poverty in Africa, this has enabled the identification of the different mechanisms through which disaster risk and poverty interact. The comparison of disaster loss reports and poverty data presents an additional set of data and methodological complications that are examined in Section 3.7.1.

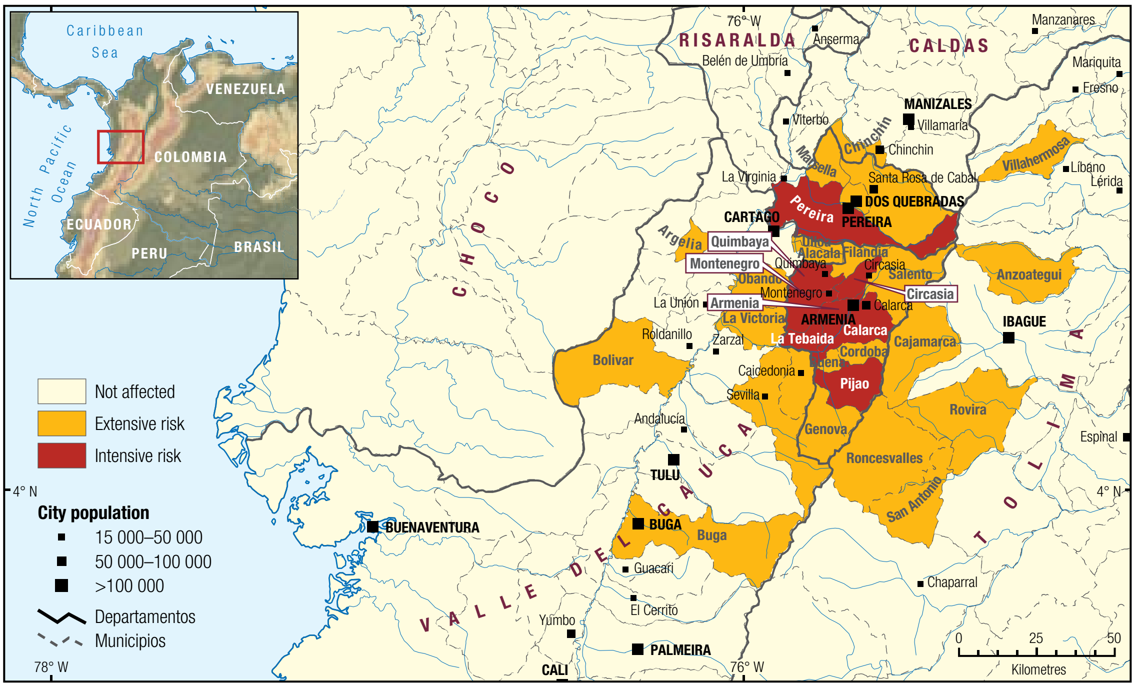
3.2 Reported losses, hazard events and disasters

Loss reports in local government areas are not necessarily synonymous with individual hazard events. Most of the loss reports characterized as extensive in this analysis are associated with highly localized hazard events, such as flooding, landslides, fires and storms. However, a major flood or cyclonic event may also lead to extensive losses in multiple local areas, as well as intensive losses in others. Similarly, some small-scale hazards may have intensive impacts, for example the landslide that killed more than 500 people in a single neighbourhood in Villa Tina, Medellin in Colombia in 1987.

Disasters are socially constructed. Whether a series of loss reports is characterized as a single large disaster or multiple small disasters, therefore, depends on the perspective of the observer. Extensive loss reports associated with specific localized hazard events are normally classified as small-scale disasters. These disasters are generally not internationally reported and are thus largely invisible at the global level. However, when large numbers of small-scale disasters are associated with a common event, for example the 1997/1998 El Niño episode, their aggregated impact may be viewed from the global perspective as a single disaster, even when the local loss reports occur over a long period in different areas. Events with intensive impacts, whether associated with small- or larger scale hazards are normally characterized as disasters at all scales.

For example, in the case of the earthquake in Armenia, Colombia on 25th January, 1999 (see Figure 3.2), eight municipalities intensively concentrated 98% of the deaths and 95% of the destroyed houses. The remaining 2% of deaths and 5% of destroyed housing were spread extensively over 23 municipalities in very different geographic areas. These losses were associated with a single hazard event. From the global perspective the Armenia earthquake was viewed as a single large-scale disaster. From a local perspective, however, the manifestations of risk were completely different in each municipality.

Figure 3.2: Armenia, Colombia earthquake (1999) – extensive and intensive impacts

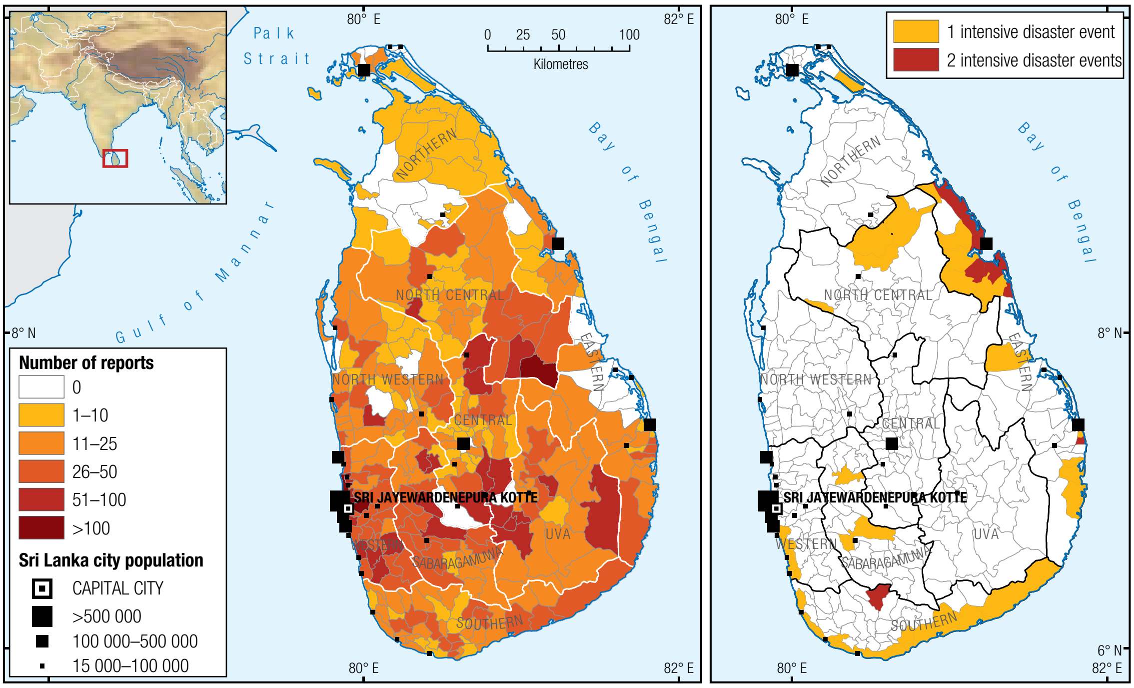


3.3 Extensive and intensive risk patterns

All the countries in the sample experience continuously occurring low-intensity disaster impacts affecting most of their territory.

Across the sample, only 988 loss reports represent manifestations of intensive risk: an annual average of only 27 disasters – approximately one disaster every two weeks. In contrast, there is an annual average of 3,395 loss reports that manifest extensive risk, equivalent to 9 reports per day across the sample. Spatially, Figure 3.3 shows that in Sri Lanka only some districts had manifestations of

Figure 3.3: Sri Lanka extensive (left) and intensive (right) loss reports (1970–2007)



intensive risk whereas nearly all districts reported manifestations of extensive risk over the reporting period.

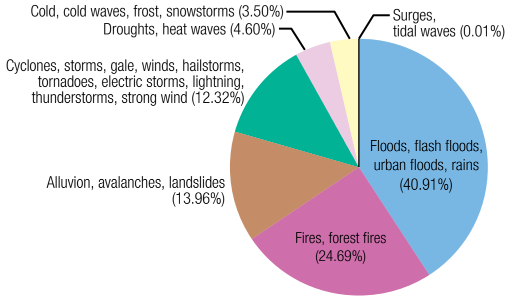
The spatial distribution of the extensive risk loss reports is further highlighted in Table 3.2, which shows that across the 12 countries, 82% of local administrative areas reported losses at least once during the reporting period and 48% were affected six or more times.

More than 96% of these disaster reports were associated with weather-related hazards, including periodic tropical cyclones and major floods but also large numbers of small-scale floods, landslides, storms, mudslides and other localized weather-related events. Of these weather-related events, as Figure 3.4 shows, 40.9% of the reports were associated with floods, flash floods and heavy rains, 24.7% with fires and forest fires, 14% with landslides, mudslides and avalanches, 12.3% with storm events, 4.6% with drought and heat waves and 3.5% with cold waves, frost and snowstorms.

Table 3.2: Spatial distribution of extensive risk loss reports (1970–2007)

Number of loss reports	Number of local administrative areas affected	%	Inverse cumulative %
0	982	17.90	100.00
1	639	11.65	82.10
2 to 5	1218	22.21	70.45
6 to 10	717	13.07	48.24
11 to 20	729	13.29	35.17
21 to 50	647	11.80	21.88
51 to 100	291	5.31	10.08
more than 100	262	4.78	4.78
Total	**5485**	**100.00**	

Figure 3.4: Weather-related extensive loss reports by hazard type across sample



Each country however, has a unique hazard profile. In Orissa, India, for example, fires account for almost 59% of the extensive loss reports due to rural villages of tightly packed thatch houses that are extremely vulnerable to fire. As Figure 3.5 indicates, in Iran 42.9% of extensive loss reports are associated with earthquakes.

While mortality and housing destruction is intensively concentrated, extensive risk disasters account for 51.3% of damaged housing across the sample. In most Latin American countries over 75% of housing damage is extensive. In Asia the percentage is less – given that no less than 58.5% of the housing damage reported in Asia occurred in Orissa where 84.8% of the housing damage was intensive.

This loss pattern is compatible with the fact that most extensive risk loss reports are associated with floods, rains and storms, which are more likely to damage housing than cause mortality or destruction. Research from other countries suggests that mortality and injury only increase significantly in very severe floods, with a large number of affected buildings[7]. And, effectively, flood mortality in the sample is mainly concentrated in the intensive loss reports. Floods were associated with 34.7% of weather-related extensive risk loss reports but with over 60% of corresponding housing damage. Heavy rains were associated with only 6% of the loss reports but 26.7% of the housing damage.

To further illustrate this point, Figure 3.6 shows how housing damage is extensively spread while housing destruction is intensively concentrated in Tamil Nadu, India.

Figure 3.5: Extensive loss reports in Iran associated with earthquakes

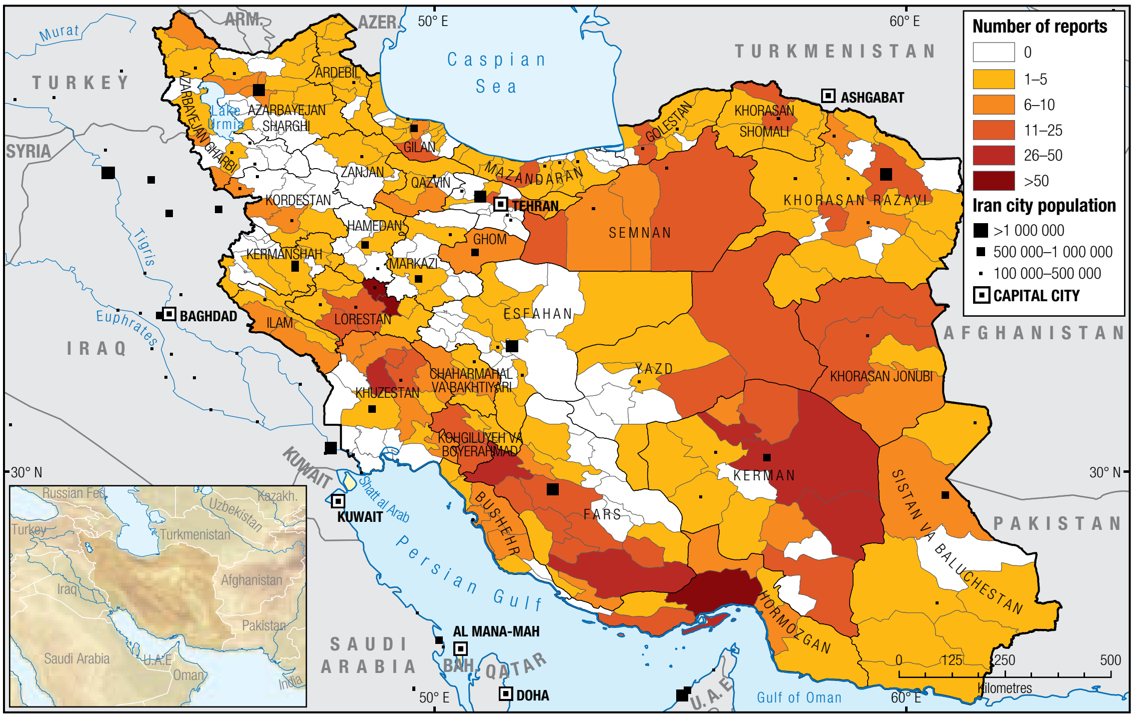
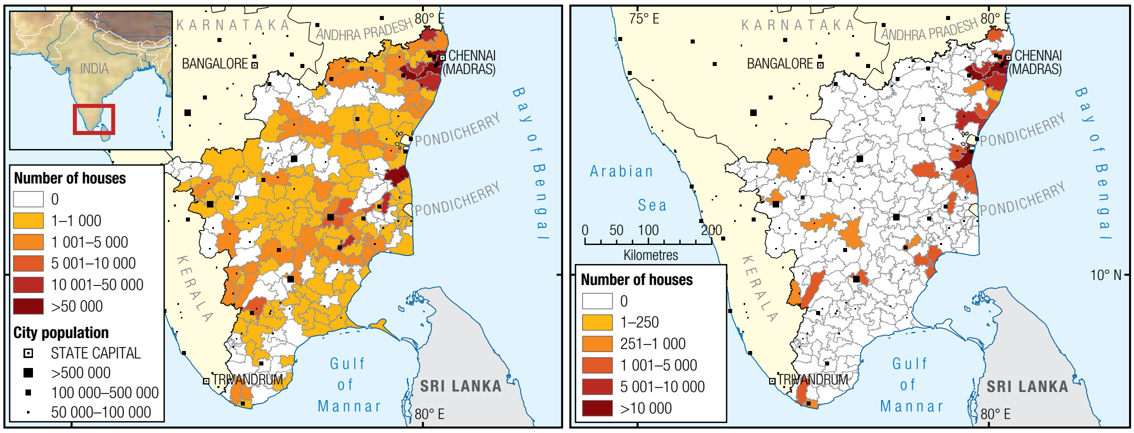


Figure 3.6: A comparison of extensive housing damage (left) and intensive housing destruction (right) in Tamil Nadu, India (1976–2007)



3.4 The costs of extensive risk

The costs associated with extensive risk manifestations are significant. The most robust attribute in the disaster databases is that of destruction and damage in the housing sector. In Mexico, for example, the disaster loss reports documented 316,928 destroyed and 471,708 damaged houses associated with manifestations of intensive risk between 1980 and 2006, and 29,510 houses destroyed and 1,468,509 damaged houses associated with manifestations of extensive risk. The cost of a destroyed house in Mexico has been estimated as US$ 16,800[8] and the cost of a damaged house as 20% of that value.

Based on these values, the cost of destroyed and damaged housing associated with intensive risk between 1980 and 2007 was US$ 6,909 million compared with US$ 5,429 million associated with extensive risk. In other words the losses associated with extensive risk represented approximately 44% of total economic losses in the housing sector. Applying the same methodology across the whole sample, the damage and destruction associated with extensive risk would represent approximately 34% of the value of economic losses in the housing sector.

Table 3.3 illustrates that, across the sample, a significant proportion of losses in other sectors such as education, health and transport, as well as of the people affected, are also associated with extensive risk: 57% of schools, 65% of hospitals,

Table 3.3: Loss attributes by risk category across the sample (1970–2007)

		Risk category			
Loss attribute	**Total**	**Extensive risk**	**%**	**Intensive risk**	**%**
Schools	32,157	18,488	57	13,669	43
Hospitals	1,037	677	65	360	35
Kilometres of roads	64,917	57,695	89	7,221	11
People affected	182,989,857	144,627,235	79	38,362,622	21

89% of damaged and destroyed roads, and 79% of the people affected. Disaster loss data in these sectors is less robust than in housing, meaning that the absolute figures are not meaningful. The proportional distribution between extensive and intensive risk manifestations, however, is valid given the size of the sample.

While the costs associated with extensive risk are clearly additional to those associated with intensive risk, it is not possible to directly compare these estimates with internationally reported economic losses. Around two thirds of internationally reported disasters do not have economic loss data and most of those that do include impacts associated with both intensive and extensive risk.

What can be demonstrated is that international attention to disasters – as measured by the release of UN situation reports; international appeals for assistance launched by the UN or by the IFRC; and post-disaster damage and loss assessments by the World Bank, regional development banks or the UN[9] – is usually triggered by intensive losses. For example, of 2,281 disasters registered by the IFRC between 2004 and 2009 only 142 led to emergency appeals and only 398 lead to the involvement of IFRC delegations. The remainder were managed nationally by the Red Cross and Red Crescent Societies[10]. The implication is that part of the costs associated with extensive risk are not accounted for by the international community.

3.5 Underlying risk trends

3.5.1 Extensive weather-related risk

Only 3% of the extensive risk loss reports in the sample correspond to geological hazard, mainly the extensive impacts of large-scale earthquakes and tsunami. As such, excepting Iran, which has a higher proportion of extensive risk associated with geological hazards, extensive risk is largely associated with weather-related hazard.

The average annual occurrence of extensive weather-related disasters has doubled over the last 27 years across the sample. As Figure 3.7 shows, the average number of deaths per loss report is actually going down while the number of houses damaged per loss report is increasing. This finding is coherent with the trends identified in Chapter 2 at the global level, which indicate that economic loss is growing faster than mortality. As countries develop, improvements in risk-reducing capacities lead to reductions in mortality but do not compensate for the increasing exposure of assets.

A comparison of these trends in mortality and housing damage with the average annual population growth in each country confirms this hypothesis (Table 3.4). In most of Latin America, with the exception of Ecuador and Mexico, mortality is falling relative to population size, whereas in Asia, except in Iran, it is increasing, probably reflecting differences in income and

Figure 3.7: Extensive weather-related mortality (left) and housing damage (right) – all countries (1980–2006)

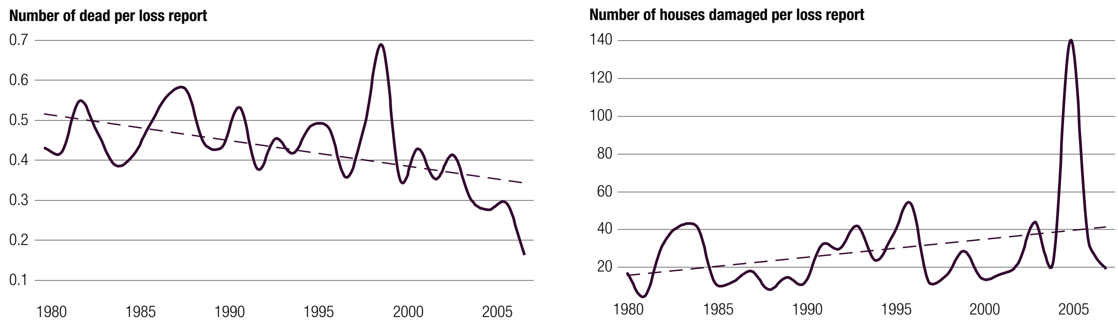


Table 3.4: Annual increase in mortality and housing damage compared with annual population growth (1980–2006)

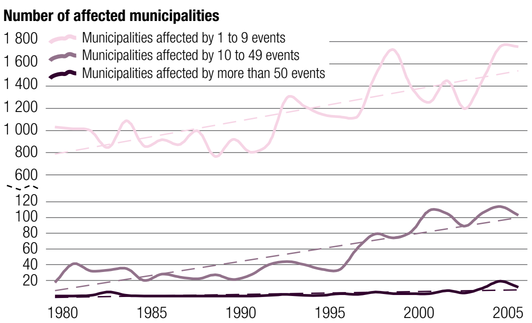
Country name	Average annual % change in mortality (1970–2007 unless otherwise indicated) from extensive weather-related events	Average annual % change in houses damaged 1970–2007 from extensive weather-related events	Average annual % increase in population 1970–2007[11]
Argentina	0.90	2.92	1.33
Bolivia	1.48	0.03	2.17
Colombia	–0.95	9.48	1.89
Costa Rica	0.93	8.18	2.35
Ecuador	3.93	26.12	2.09
Iran (1980–2007)	–1.23	–9.05	2.37
Mexico (1980–2007)	6.48	17.94	1.88
Nepal (1971–2007)	4.47	8.28	2.25
Orissa	5.75	7.80	1.66[12]
Peru (1970–2006)	1.31	3.03	1.96
Sri Lanka (1974–2007)	1.70	5.68	1.15
Tamil Nadu (1976–2007)	11.67	12.23	1.25[13]
Venezuela	0.51	5.96	2.49

human development between countries in both regions. In contrast, with the exception of Bolivia and Iran, housing damage is increasing far faster than population growth.

The identified trend of increasing exposure is associated with a centrifugal geographical expansion of extensive weather-related risk. Figure 3.8 illustrates the consistent increase in the annual number of affected local administrative areas. The number of local areas with 1–9 loss reports between 1980 and 2007 has doubled and those with 10–49 loss reports has almost quintupled. This confirms that many new local areas are now characterized by weather-related extensive risk, while the frequency of losses has also increased.

For example, Figure 3.9 highlights that the number of states with manifestations of extensive risk in Mexico has consistently grown over recent decades.

Figure 3.8: Number of municipalities across the sample affected by extensive weather-related risk (1980–2006)



Extensive risk configuring intensive risk

Extensive risk can become intensive over time in areas that are subject to severe levels of similar kinds of hazard. For example, areas with very frequent manifestations of extensive flood risks are likely to experience intensive impacts during major cyclonic events. Figure 3.10 indicates that in Orissa manifestations of intensive risk tend to occur in areas with the most frequent manifestations of extensive risk. Similar patterns can be seen in other countries[14]. In other words, intensive risk is often superimposed on patterns of extensive risk.

Figure 3.9: Number of extensive risk reports, Mexico (1980–1989, 1990–1999, 2000–2006)

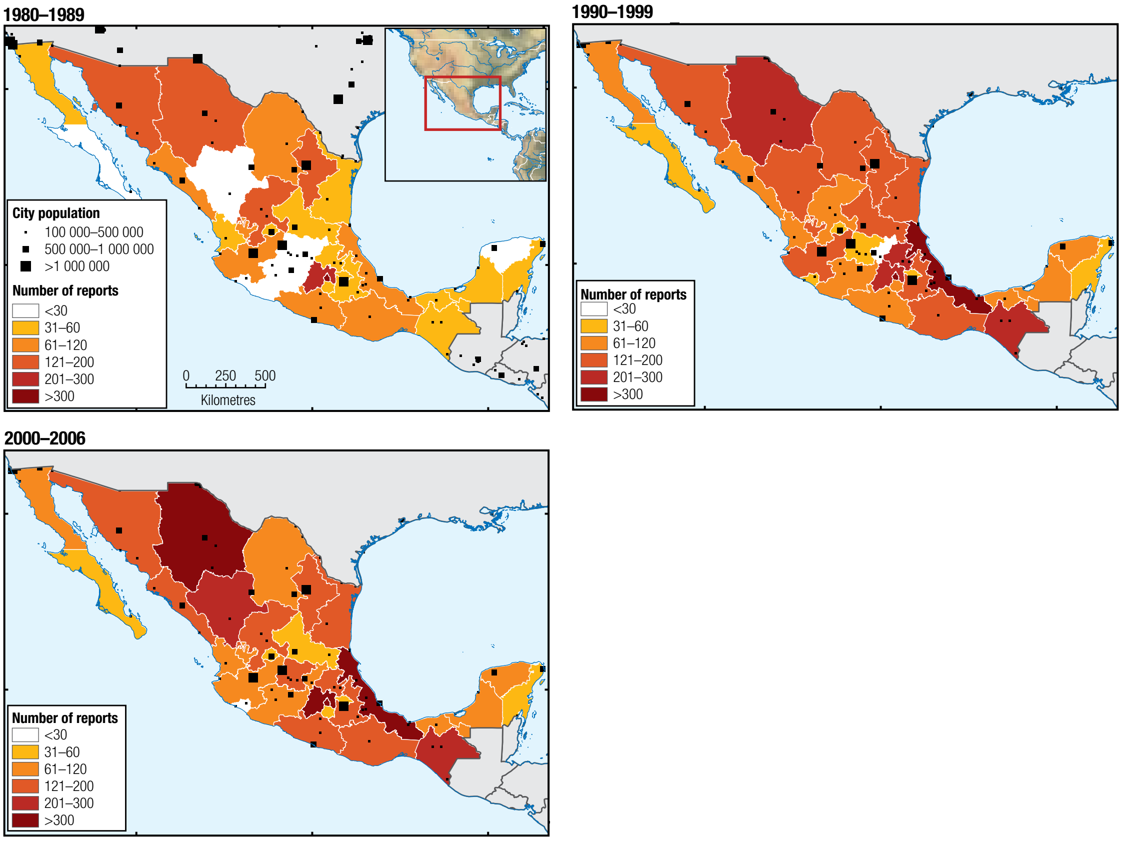
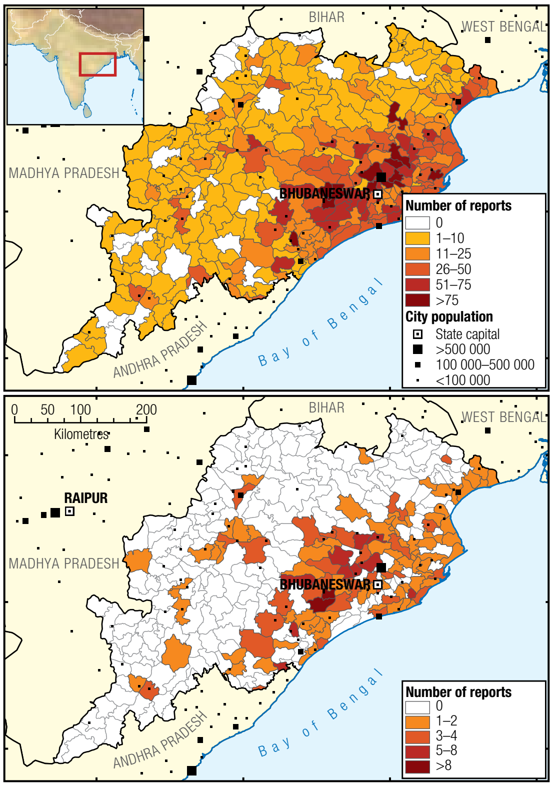


Figure 3.10: Comparison of extensive (above) and intensive (below) risk loss reports, Orissa, India (1970–2007)



Floods and heavy rains

As Figure 3.11 illustrates, the number of loss reports associated with floods and heavy rains is increasing at a far faster rate than all other categories of weather-related hazards, particularly since 1990.

In Mexico, for example, the annual average number of extensive loss reports associated with floods, rains and flash floods has increased eight-fold since 1980. These hazards accounted for 31% of all extensive weather-related loss reports in the 1980s but over 40% in the last decade. Similarly, in Colombia (Figure 3.12), floods, flash floods and heavy rains accounted for 43% of extensive weather-related disasters in the 1970s but 53% in the last decade.

Figure 3.11: Number of flood and rain extensive risk loss reports (1980–2006)

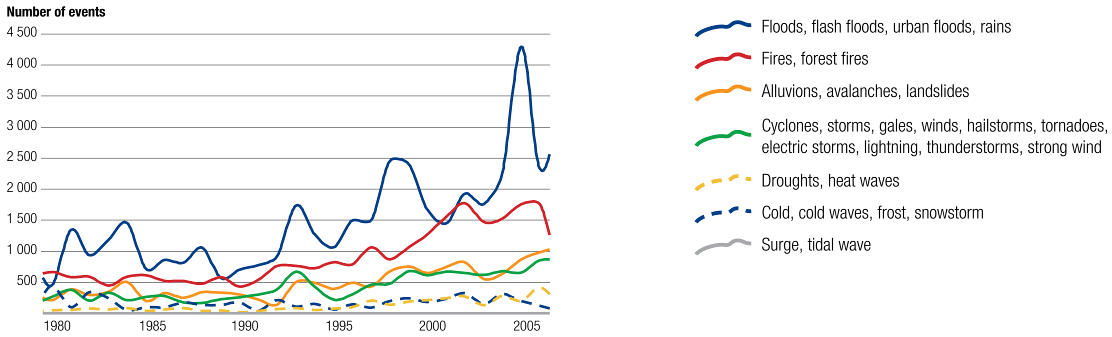
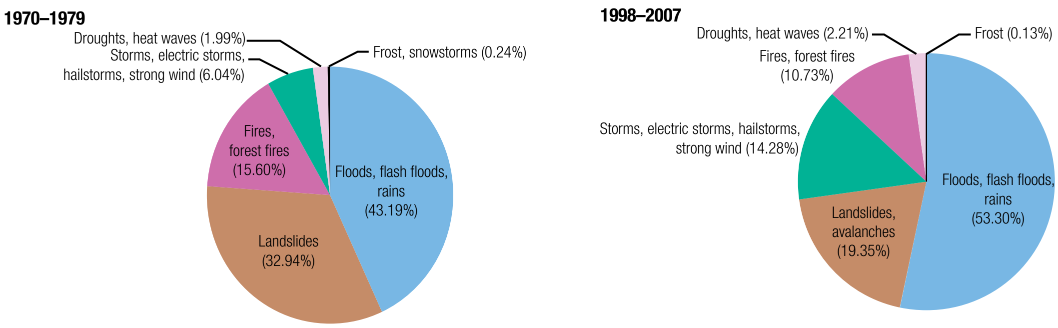


Figure 3.12: Floods and rains in Colombia as a proportion of all extensive weather-related loss reports, 1970–1979 and 1998–2007



3.6 Interpreting the trend

3.6.1 Improved disaster reporting and a bias in the data?

As in the case of the global trends identified in Chapter 2, it is very likely that improved reporting of disaster events due to enhanced communications, the introduction of the Internet and more systematic government reporting [15] is responsible for an increase in the number of loss reports. However, improved reporting alone is not sufficient to explain the trends identified. Improved reporting should lead to an even increase in loss reports across all hazard categories and not just floods and rains. Similarly the number of loss reports is increasing not only in remote rural areas, where disasters may previously have gone unreported, but also in major metropolitan areas, such as Buenos Aires or Mexico City.

Evidence from Colombia and Peru indicate that many more loss reports originate in major cities and from provincial capitals than from isolated rural areas [16]. This may reflect a bias in the reporting, given that losses occurring in centres of political administration are more likely to be reported than in remote rural areas. All the losses reported from urban areas are documented and therefore did occur. While it is likely that many small-scale losses in remote rural areas go unrecorded, it is unlikely that this includes nationally significant losses. In parts of Asia, in contrast, it is likely that losses in rural areas may be more consistently reported than in some cities.

3.6.2 Climate variability and change

The IPCC has confirmed that the geographic distribution, frequency and intensity of precipitation events is already being altered significantly by climate change[17], although these effects will have different manifestations in different regions. It is likely therefore, at least in some regions, that climate change, as well as cyclical patterns of climate variability, is influencing the doubling of the number of loss reports associated with weather-related extensive risk over the last 27 years and the even more rapid increase in those reports associated with floods and rains.

Without a detailed analysis at the watershed level, however, it is impossible to determine the influence of climate variability and change. In some countries, such as Colombia, Costa Rica, Ecuador and Venezuela, the increase in flood- and rain-related reports since the mid-1990s has coincided with a period of increased annual average precipitation, as Figures 3.13 and 3.14 highlight in the case of Costa Rica[18]. However, in Mexico and Nepal, the number of loss reports is increasing while average precipitation is decreasing. In Peru, average precipitation is increasing while the number of loss reports is decreasing. In other words, there is no consistent relationship between both variables across the sample.

Figure 3.13: Extensive flood and rain loss reports in Costa Rica (1990–2007)

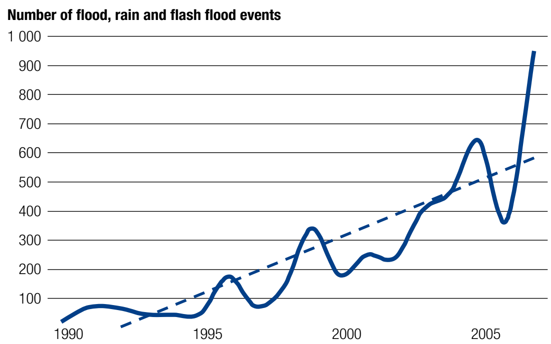
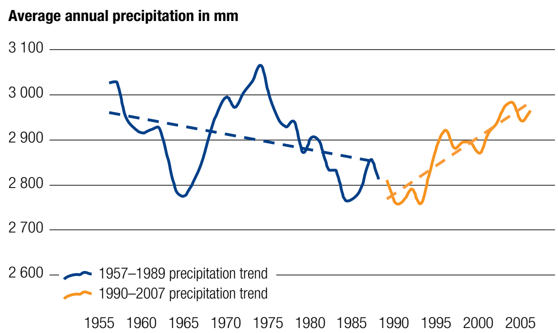


Figure 3.14: Precipitation in Costa Rica: 10-year averages (1957–2007)



3.6.3 Urbanization, environmental change and territorial occupation

Aggregate national statistics on variables such as deforestation and urban growth similarly provide little insight into the trend of increasing weather-related risk. Continuing with the example of Costa Rica, forest cover has increased, due to environmental protection policies and the application of a system of payment for ecosystem services, over the same period that a dramatic increase in flood and rain loss reports has occurred.

In contrast, case study evidence from Latin America, Asia and Africa demonstrates how drivers such as urbanization, environmental change and territorial occupation are fundamentally shaping the geography and evolution of extensive risk. A detailed description of evidence from national case studies is presented in Appendix 2, Note 2.4.

Urban expansion

Case studies from Argentina, Colombia, Costa Rica and Mexico indicate how extensive risk is generated through processes of urban expansion. Extensive flood risk is closely linked to the increased run-off caused by new urban development, a chronic underinvestment in city-wide pluvial drainage, the location of informal settlements and social housing projects in low-lying flood prone areas and inadequate water management in the surrounding watersheds. In other words, the urbanization process not only leads to increasing exposure of vulnerable people and assets in hazard prone areas but is also responsible for magnifying the hazards themselves, particularly floods.

In the metropolitan area of San Salvador, for example, the municipalities with recurrent extensive loss reports were those with the most rapid urban growth[19], in some cases up to 16% per year. And, according to the Municipality of San Jose, Costa Rica, more than 80% of the floods occurring in the country's capital are caused by either inadequate drainage to cope with the increased run-off caused by urban growth or by the accumulation of garbage and waste in drainage channels. Most housing damage is concentrated in *precarios* occupying marginal land adjacent to the streams and torrents that drain the city.

Many cities in Asia are also increasingly experiencing losses due to urban flooding. For example, there were 240 reports of flood loss in Colombo since 1974. Almost half these reports and about 80% of the associated housing damage have occurred since 2005. Chennai similarly experienced major flooding in 1990, 1994 and 1996 and Kathmandu in 2000 and 2002. Flooding in these, as in other cities across South Asia, would tend to suggest that rapid urban growth, the expansion of informal settlements, inadequate water management and an underinvestment in drainage are driving risk in a way that is analogous to Latin America, although with very different characteristics.

Some cases also indicate how extensive risk in cities can be reduced over time through investment in public infrastructure as urban areas are consolidated. In some cities, this means that extensive risk patterns expand concentrically from the centre towards the periphery of the city following the logic of informal settlement, while at the same time progressively reducing in the centre. In other cases extensive risk is concentrated in pockets of land ignored by formal urbanization, for example in ravines or riverbanks.

Figure 3.15 shows local loss reports from floods in Cali, Colombia since the 1950s. The number of flood loss reports mirrors the expansion of the city, mainly through the occupation of land for informal settlement without a corresponding investment in drainage infrastructure.

Flooding reported in early November 2006 in the Colombo District, Sri Lanka, destroyed 221 houses, damaged 1,674 houses and affected 80,128 people. Figure 3.16 shows the distribution of flooded areas overlaid with population density. The flooding illustrated the typical problems of settlements in low-lying areas and inadequate drainage.

Four types of flood have been identified in African cities[21]: (1) localized flooding due to inadequate drainage; (2) flooding from streams whose catchment is entirely within the urban areas; (3) flooding from major rivers on whose banks cities and towns are located; and (4) coastal flooding from the sea or by a combination of high tides and river flows. According to Action Aid, the first two kinds of flood are most prevalent.

The underlying cause has been the gap between the very rapid growth in the population of many urban centres and the capacity of urban governments to cope (see Box 3.1). Although growth rates in many urban centres have declined, far too little attention has been given to needed measures to improve urban governance. Very poor conditions in many rural areas, including the combined impacts of conflict, floods and drought, have underpinned much rural to urban migration. Due to poor urban governance, most cities absorb growth through the expansion of informal settlements,

Figure 3.15: Extensive flood reports in Cali, Colombia (1950–2000)

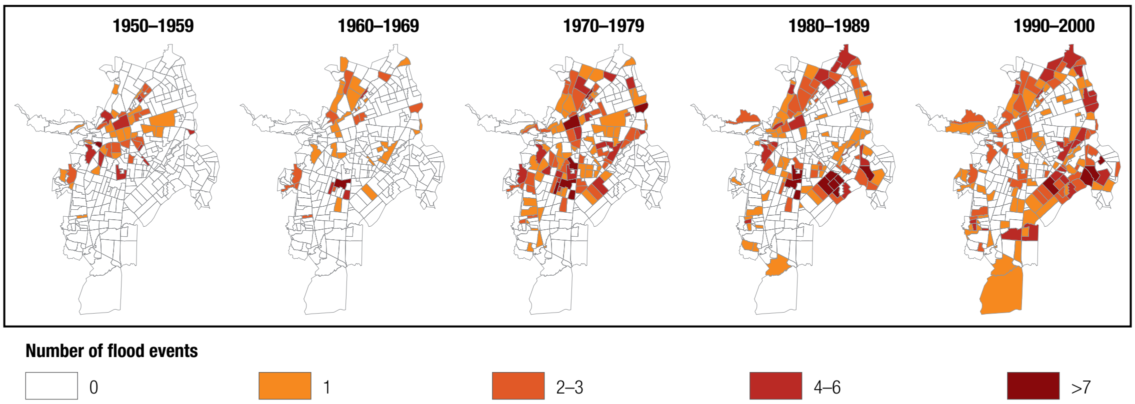
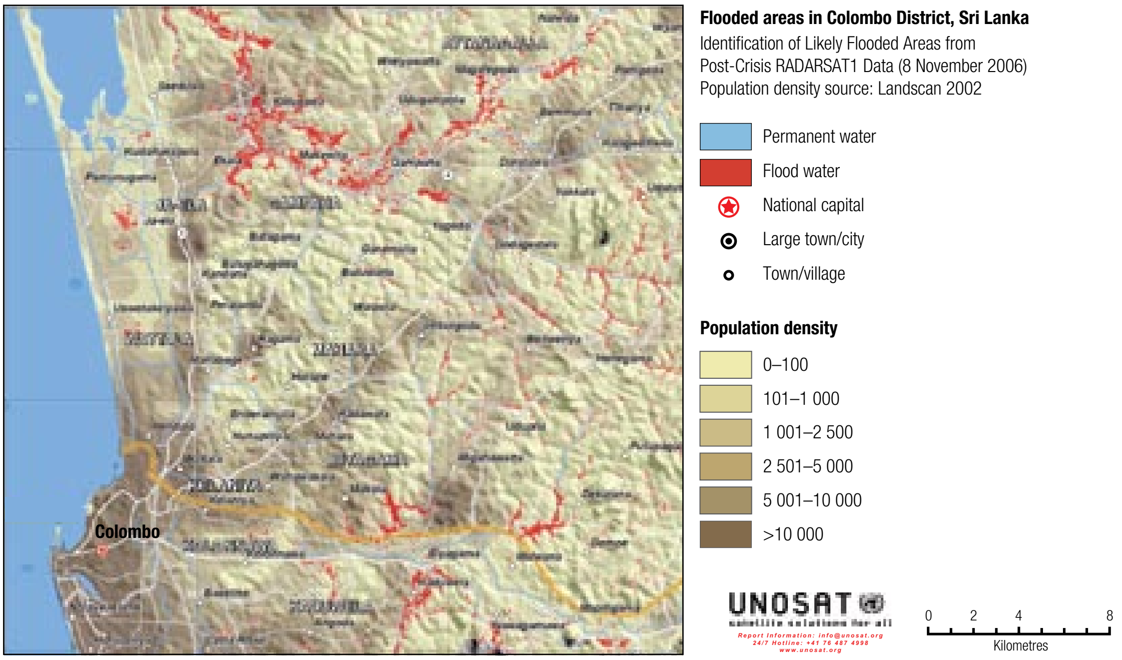


Figure 3.16: Flooded areas overlaid with population density in the Colombo District, Sri Lanka[20]



which often occupy low-lying flood prone areas. 72% of Africa's urban population lives in informal settlements. Investment in drainage infrastructure is often non-existent and there is little or no maintenance of existing infrastructure.

Territorial occupation

Case studies from Ecuador, Mexico and Peru show how in parallel to mirroring the growth of large cities, extensive risk also expands concentrically in a country's territory, following the construction or improvement of roads, the opening of the agricultural frontier and the growth of small and medium urban centres. Increasing extensive risk associated with floods, for example, is often related to a combination of factors including a decline in the regulatory services provided by ecosystems, inadequate water management, land-use changes, rural–urban migration, unplanned urban growth, the expansion of informal settlements in low-lying areas and an under-investment in drainage infrastructure.

Figure 3.17 shows how over the last four decades the distribution of extensive weather-related loss reports in Ecuador has followed the process of territorial occupation, from the country's Andean backbone westwards into the Pacific lowlands and eastwards into the Amazon.

Figure 3.18 shows a similar process in Peru, where the distribution of loss reports associated with landslides has moved eastwards, following the opening of new roads into the Amazon.

Figure 3.19 shows the devastating flooding in Tabasco, Mexico in 2007 due to a combination of inadequate water management in an 80,000 km^2 watershed and the urbanization of low-lying areas without adequate investment in drainage.

Densely populated rural areas

In contrast to Latin America, all the Asian countries, except for Iran, are still markedly rural. In Iran, 66.9% of the population was classified as living in urban areas in 2005 compared with 28.7% in India, 15.8% in Nepal and 15.1% in Sri Lanka. In these predominantly rural countries extensive risk flood losses are associated not only with urban growth and territorial occupation but also with major concentrations of the rural population living on floodplains, near major river deltas and along coastal plains.

Environmental degradation – in particular declines in the regulatory services provided

Box 3.1: Flooding in African cities[22]

Kampala, Uganda
Construction of unregulated settlements has reduced infiltration of rainfall and changed land cover leading to runoff six times higher than occurs in natural terrain. After the 1960 floods a channel from Nsooba to Lubigi was dug and workers were employed to clean it regularly. There were no further flood problems until the 1980s but since then residents have had to re-build their houses after flooding up to six times. Some of this is because the main drainage channel, originally two metres deep, is now only 30 cm deep because of an accumulation of sediment and rubbish.

Nairobi, Kenya
Flooding is a major problem in all of Nairobi's informal settlements. Houses are built of weak, inadequate building materials. Migration has led to more houses being built close to streams, with consequent greater disruption when floods occur. Many local residents link increased flooding to both local activities and climate change. Slum inhabitants agree that floods now occur in places where they did not two decades ago.

Accra, Ghana
Women in Alajo, Accra, observed that patterns of rain and flooding have become unpredictable since the 1980s. They noted that it used to rain heavily in June and July but since 2000 the heavy rains sometimes start earlier and in other years start only after July. Consequently, it is difficult for them to prepare for flooding in Alajo. Since slum dwellers' livelihoods depend on activities such as small-scale commerce, petty trading and artisanal trades conducted in wooden kiosks that do not withstand the force of the floods, people lose working time, economic opportunities and income. The immediate impact is loss of income for food and bills, including children's education and medical costs.

Bamenda, Cameroon
Bamenda's population expanded more than 10-fold between 1965 and 1993, to reach around 270,000 in 1993. Human settlements have expanded up hill-slopes and onto wetlands because land is much cheaper (land can be 300–400 times more expensive within the urban district compared to the very steep slopes and wetlands) but it is difficult (and expensive) to build stable, safe homes there. Around 20% of Bamenda's population lives on floodplains and around 7% lives in informal settlements on steep slopes. There is a serious lack of provision of water, sanitation, schools, health posts, roads and drainage. Land clearance for settlement and for quarrying and sand-mining, along with other land-use changes caused by urban expansion, have created serious problems of soil erosion – with the soil that is washed down the hills blocking drainage channels and changing peak water flows. These have exacerbated the long-standing problems with floods in the area. It is difficult to address these problems, especially given the economic crisis and the absence of capacity and skills within the local authority[23].

Saint Louis, Senegal[24]
The population of Saint Louis almost doubled between 1998 and 2002, from 115,000 to 200,000. Floods affect low-lying areas with no drainage that have been settled by very poor rural migrants fleeing the effects of rural drought. In order to protect against the floodwaters, residents make barriers using household waste, but this increases the incidence of health hazards. Flood risk in Saint Louis is basically a problem of poor urban governance. Basic information on flood risk is not available and urban development and risk reduction policies or projects are both uncoordinated and non-inclusive.

by forest ecosystems – may be contributing to increased flooding in some watersheds. In Nepal, increased flooding in the Terai region may be related to increased glacier melt in the Himalayas as well as to environmental changes in upland watersheds. In India, as well as in Nepal and Sri Lanka, housing damage in rural areas would seem to be closely associated with the high density of rural settlement in flood prone areas and the vulnerability of rural housing.

For example, in Tamil Nadu, India there is a concentration of extensive risk housing damage around urban centres in the north-east of the state (Figure 3.20). While poorly studied, flooding would seem to be associated with the high level of urbanization and associated problems of settlement of low-lying areas, increased run-off and inadequate drainage. In Chennai, for example, 18.9% of the urban population was living in slums in 2001[26]. However, the other

Figure 3.17: Spatial evolution of extensive weather-related loss reports in Ecuador from 1970–2007

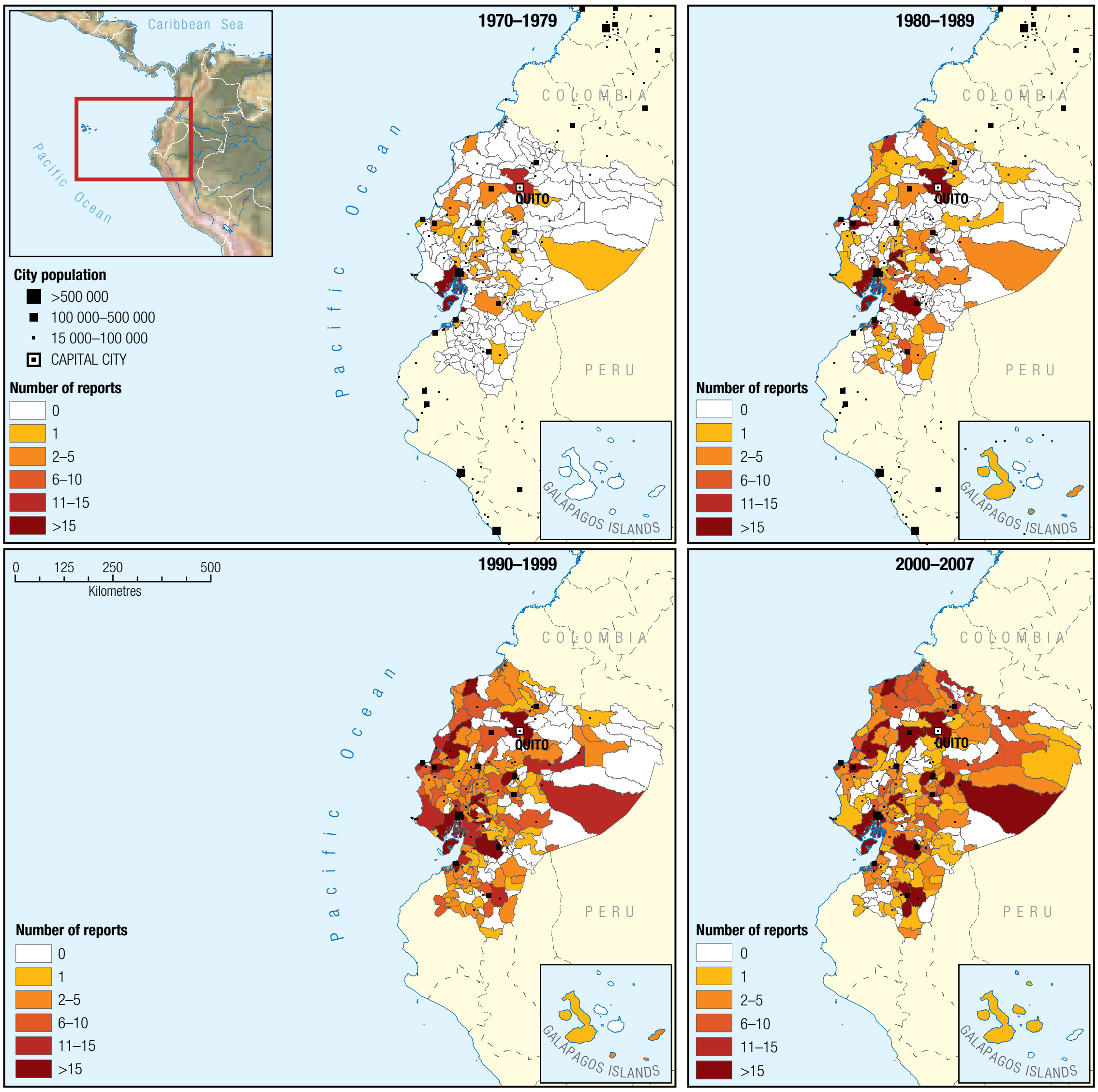


Figure 3.18: Redistribution of extensive landslide risk in central Peru between 1970–1985 and 1986–2006

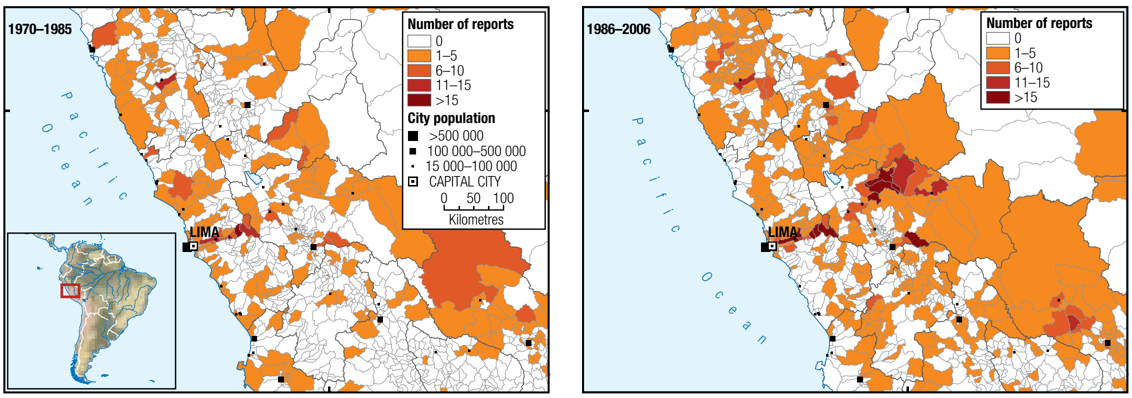


Figure 3.19: Population density and flooded areas in Tabasco, Mexico, 2007 [25]

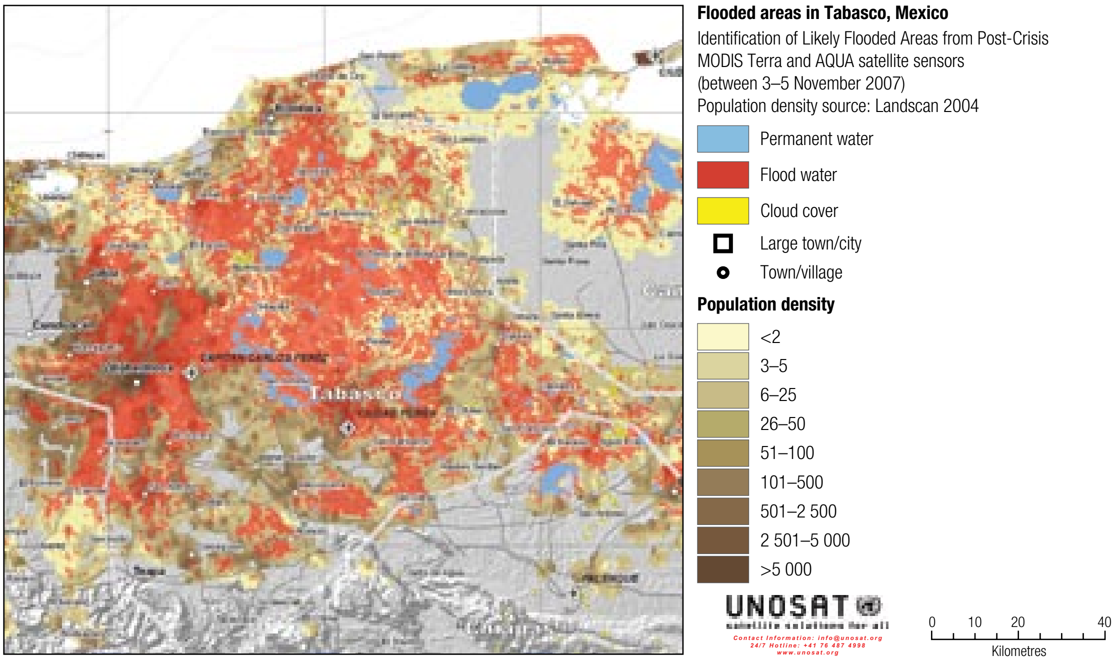


Figure 3.20: Distribution of housing damage in extensive flood and heavy rain loss reports in Tamil Nadu, India (1970–2007)

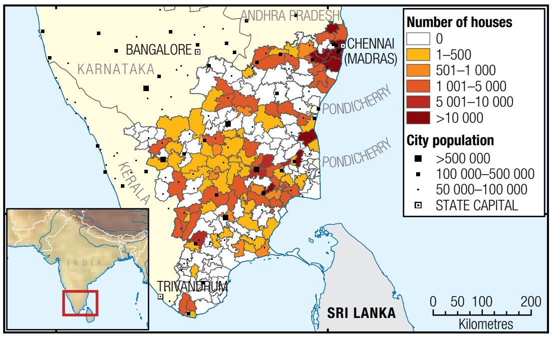
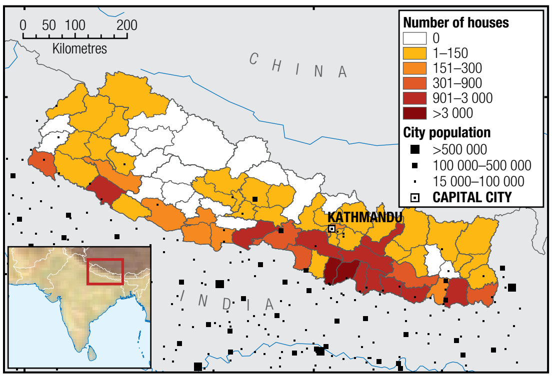


Figure 3.21: Housing damage by extensive flood events, Nepal



concentration of housing damage is along the floodplain of the Kaveri River, in the watershed of the Ponnaiyar River and in the Kambam Valley. Tamil Nadu has a long history of chain-tank irrigation – a system that has fallen into disuse. Much flood damage in rural areas is associated with chain-tank failure and the silting of irrigation channels. In upland areas, increasing extensive flood risk may be associated with issues of environmental degradation.

In Nepal, extensive flood risk and associated housing damage is concentrated in the densely populated alluvial plains of south-eastern Nepal in the Terai region (Figure 3.21). Floods in this case are not a consequence of urbanization or population density, but a cause. The richness of the soils is due to the frequent replenishment of nutrients through flooding and the reason why the region can support such a large dense population.

3.7 Disaster and poverty interactions at the local level

3.7.1 Data and methodological challenges

The analysis presented in Chapter 2 indicated that global disaster risk is disproportionately concentrated in low-income countries with weak governance. Similarly, countries with small and vulnerable economies, such as many SIDS, were shown to be far less resilient to disaster loss than those with larger and more diversified economies.

While the analysis of disaster risk at the local level presented in the preceding sections implies that losses would appear to be concentrated in poorer areas, such as urban informal settlements, it is far from easy to establish empirically a causal relationship between disaster risk and poverty, for a number of reasons:

- Empirical studies tend to be opportunistic rather than systematic, given the limited availability of both disaster and poverty data at a suitable scale.
- Spatially aggregated data may smooth important local differences in both disaster risk and poverty, making it difficult or impossible to identify statistically valid relationships.
- Disaster losses are often measured only in terms of mortality or direct economic impact. There is little systematic data collection on longer-term human development impacts in dimensions such as health, education and nutrition. Documenting impacts in these dimensions is not simple given the sparse survey data covering the same units of analysis over long periods of time. Few national statistical systems collect time series household panel data that incorporates information on hazard impacts.
- Hazard levels explain a large part of the variance in disaster incidence and loss between different local areas. However, information on the distribution and intensity of localized hazards is often not available, making it difficult to control for what may be a key variable.
- In Latin America, national disaster data may have an urban bias and over-estimate impacts in cities and under-estimate disaster risk in poor and dispersed rural areas. In Asia disaster data may be less reliable in urban areas due to the spatial resolution with which it is captured.
- When disaster impacts are compared nationally with data on the poverty headcount, poverty gap or unsatisfied basic needs, counter-intuitive results may be produced in countries with predominantly urban populations given relative differences between urban and rural poverty.

A number of case studies from Latin America and Asia were commissioned specially for this Report in countries where both poverty and disaster data were available. Despite the challenges mentioned above they do provide empirical insight into how poverty shapes disaster risk and vice versa. These case studies were complemented by a systematization of the results of other studies in Africa. Many of these empirical studies address drought and rural livelihoods, complementing the analysis on floods and the housing sector that characterized the previous section. Appendix 2 summarizes the empirical results of the country case studies commissioned for this report, other studies within both regions, as well as results from analysis of Africa poverty studies.

3.7.2 Assets, poverty and disaster risk

Households and communities exposed to natural hazards take decisions to manage the risks they face. Ex ante decisions in areas such as housing and livelihood have important short- and long-term implications for both welfare and human development as people seek to manage not only the risks associated with natural hazards, but also other everyday risks. Poor households may accept high levels of disaster risk and thus a higher risk of incurring losses in order to maximize income opportunities. Others may organize their livelihoods in such a way that overall risks are lowered, even if that means a reduction in income and increased poverty.

When disaster losses are incurred, ex post responses or the inability to respond also have implications for short- and long-term welfare and human development outcomes[27].Both ex ante and ex post responses to disaster impacts are influenced by the range of tangible (natural, physical and financial capitals) and intangible assets (human capital, social ties and networks, intrahousehold relations) at people's disposal, which in turn are shaped by broader economic, social and political considerations in each context.

Asset holdings have a positive impact on welfare in at least two distinct ways. First, higher net asset holdings can increase the income-generating potential of poor households leading to higher welfare and less poverty during normal times. For example it may enable a household to choose a less hazardous location or to live in less vulnerable housing. Second, asset holdings offer a crucial means to buffer disaster losses[28]. The ability of a household to access and mobilize assets therefore has a dramatic influence on both the ex ante and ex post capacity of households and communities to manage disaster risk.

Households with limited ability to mobilize assets are less resilient when assets are lost in a disaster – for example, when houses are damaged or livestock killed. In the absence (or delayed activation) of formal and informal credit and insurance markets and state-funded mechanisms, such as safety nets and social security, these impacts can reduce consumption in the short term and also lead to an observable deterioration in health, nutritional and educational status and other long-term human development problems.

When assets are available, asset sales can buffer income and consumption fluctuations. However, particularly in the case of large disasters, such strategies are often ineffective when many households simultaneously decide to dispose of the same kind of asset in the context of limited demand. Moreover, in contexts of deprivation, where assets are already scarce, asset disposal makes recovery harder by affecting the ability to generate income in the future. Reduced future income further entrenches poverty and associated poor nutritional, educational or health status.

The role that assets play in managing disaster risk is also influenced by whether the risk is extensive or intensive in character. The impacts associated with both intensively concentrated and extensively spread risk have very different but equally important implications for the translation of disaster impacts into poverty outcomes.

As discussed earlier in the chapter, manifestations of intensive risk are characterized by major mortality and asset destruction, which can seriously compromise the capacity of a household to buffer losses and recover: for example when household income earners are killed or injured or where an asset such as a house, which may represent a reserve of inter-generational savings, is lost. In contrast, it is more likely that the low-intensity damages associated with extensive risk can be more easily buffered.

Similarly, manifestations of intensive risk are more likely to be associated with large-scale hazards that simultaneously affect large numbers of households, stretching and often overwhelming not only local but even national coping mechanisms. In contrast, in the case of extensive risk impacts affecting smaller numbers of households and communities, local and national coping mechanisms are more likely to be effective. This effectiveness will also be challenged, however, when a large number of extensive impacts occur, for example during an ENSO episode.

At the same time, intensive losses occur infrequently and only affect very specific areas and are more likely to be buffered by national and international assistance. In contrast, recurrent extensive losses affect wide areas on a regular basis and can lead to asset depletion and erosion, which significantly affects capacity to absorb future losses and recover.

3.7.3 Poverty, exposure and vulnerability: the uneven distribution of disaster occurrence and loss

Evidence that demonstrates that the poor are more exposed and vulnerable to natural hazards sometimes appears counter-intuitive. In some countries, the areas that experience most disasters are actually those with the most dynamic economic and urban growth or with prosperous rural economies. However, there is evidence to show that communities in poor areas lose a far higher proportion of their assets, confirming that they have far higher levels of vulnerability (Table 3.5).

Table 3.5: Summary of case study findings on the social distribution of disaster loss

Country	Findings
Burkino Faso	The 1984–1985 drought affected the poorest third of a sample of rural household's 10% more than the wealthier third: the former experienced crop-income losses of 69% versus 58% drop for the latter.
Madagascar	Tropical cyclone impacts led to a reduction of 11% in the volume of agricultural production of the poorest 20% households compared to a reduction of only 6% in the case of the richest 20%[29].
Mexico	Municipalities with the highest number of loss reports also had large percentages of their population with high or very high levels of marginality, according to an Index of Municipal Marginality developed by the National Population Council. For example, Acapulco (54.4%), Coatzocoalcos (54.1%), Juarez (45%), Tapachula (54.1%), Tijuana (31.3%) or Veracruz (31%)[30]. Municipalities with high or very high levels of marginality had high proportions of damaged and destroyed housing. In a third of these municipalities, between 10 and 25% of the housing stock was damaged or destroyed, while in another third this proportion was more than 25%. Over 20% had more than 50% of their housing stock affected. In contrast, only 8% of the housing stock was affected in municipalities with low or very low levels of marginality.
Nepal	Areas affected by floods tended to have lower poverty rates and higher per capita expenditures. Flooding incidence and impacts are concentrated in the highly productive lowland agricultural plains of the Terai belt in south-eastern Nepal. As flooding contributes to the fertility of the soil of the region, it contributes to the wealth of the area. Areas affected by landslides tend to have higher poverty and mortality rates. Landslide impacts are heavily concentrated in districts in mountainous western Nepal with marginal rain-fed agriculture and which concentrate the country's rural poverty.
Orissa, India	A statistically significant relationship was found between families living in houses with earth walls and thatch roofs (typically the housing of the poor) and those most affected by tropical cyclone, flood, fire and lightening. The incidence of extensive risk loss reports was higher in the central eastern coastal region where there are higher levels of urbanization and relatively affluent agricultural areas on floodplains and deltas. Mortality in extensive risk disasters was concentrated in the districts of Bolangir, Kalahandi and Koraput in southern Orissa, which are characterized by repeated droughts, floods, food insecurity and chronic income poverty and localized near-famine conditions.
Peru	Rural households that reported a disaster impact in 2002 on average had less access to public services, were less well integrated into the market and had a higher proportion of agricultural income.
Sri Lanka	A very strong correlation was found between the proportion of population living below the poverty line and the number of houses damaged due to floods, and a less strong but significant correlation between this population group and houses damaged due to landslides. This highlights that exposed human settlements and unsafe, vulnerable housing are poverty factors that increase the likelihood of suffering greater loss due to natural hazard.
Tamil Nadu, India	Mortality in areas with manifestations of extensive flood risk was higher in areas with vulnerable housing. Similarly, tropical cyclone housing damage was inversely related to the literacy rate. If literacy is taken to be a proxy for poverty again this indicates that the poor were more likely to suffer housing damage typically because their houses are more vulnerable or situated in more exposed locations. Mortality amongst the socially and economically excluded scheduled castes was also higher in blocks with a high proportion of vulnerable housing.

3.7.4 Disaster impacts and poverty outcomes

Disaster impacts include death, injury, acute and chronic illness, disruption of socio-economic activities and damage or destruction to property and natural resources and other physical assets. In rural areas, hazard impacts may include the loss of crops and livestock due to flood or drought with a consequent reduction in income from loss of cash crops and dairy output, or food intake from loss of staple foods. Similarly, loss of assets can affect income-producing activities, including transport, infrastructure, housing and livestock-raising; but can also lead to income or welfare reductions, for example reduced expenditure on education to fund house repair.

The effectiveness of assets to buffer household losses

If households have not lost assets these can be sold to buffer losses. However, asset prices tend to be depressed after a disaster, as many people sell possessions at the same time, therefore compromising the effectiveness of the coping response. This is particularly the case for livestock or other possessions in remote rural areas or in conflict zones with limited access to markets. The limited success of asset-coping strategies translates into consumption or income shortfalls. The loss of a house can be particularly catastrophic, given that for many poor households it may represent the capitalized savings of multiple generations. It is often also the site of livelihood activities. House sales, however, are rare after disasters and in most cases this is a last resort strategy. Table 3.6 summarizes key findings from national cases.

Local and regional outcomes: poverty, income and consumption

The empirical evidence also confirms that disaster impacts have a direct and negative effect on welfare at the local and regional levels. Impacts may include reductions in income and consumption, an immediate increase in monetary poverty, both in terms of its depth and breadth, as well as deterioration in other welfare indicators. Table 3.7 gives examples of national case studies.

Human development outcomes: education, health and gender inequality

Disaster impacts, however, not only lead to reductions in income or consumption but can also negatively affect other aspects of human development. For example, in countries where the socio-economic status of women is low, disasters have a significant effect on the gender gap in life-expectancy given that disasters exacerbate previously existing patterns of discrimination that make women more vulnerable. Table 3.8 gives examples of national case studies.

Inequality outcomes

Disaster impacts translate into more severe poverty outcomes in poorer households, thus increasing inequality. Table 3.9 gives examples of national case studies.

Table 3.6: The effectiveness of assets to buffer household losses

Country	Findings
Burkina Faso	In a sample of rural farmers, livestock sales during the 1984–1985 drought only covered 20–30% of crop income short-falls due to rainfall deficiencies [31]. Increases in poverty occurred in the two main agro-ecological zones of the country: from 2 to 19% in the Sahelian region and from 12 to 15% in the Sudan region. Other studies, however, show livestock sales counterbalancing disaster losses: inequalities between household incomes actually fell in the Sahel, the most affected zone.
El Salvador	In the aftermath of the 2001 earthquakes, affected rural households had to sell productive assets such as animals or land, use savings or borrow, and stop or cancel planned investments in physical capital. Between 2000 and 2002 average household income per capita actually increased in El Salvador (from 5449 to 6957 colones per annum) and extreme poverty rates fell from 33.8 to 26.6%. In poor rural households affected by the earthquakes, average household income per capita was reduced by approximately one third of the pre-shock average (a reduction of 1,760 colones). Those most affected suffered higher loss of housing, productive assets (such as livestock, farm machinery) and other physical and human capital, which reduced their future earning capacity.
Ethiopia	During the 1999 drought in Ethiopia livestock herds declined by almost 40% and it was estimated that 25% of livestock reductions were distress sales where the seller received less than 50% of the normal price. In a 2004 study of Ethiopian rural households it was found that those affected by a serious drought in the last two years had consumption levels 16% lower per adult than other households, 80% of consumption being basic food [32].
Iran	Larger families suffered smaller decreases in expenditure following disaster losses in a number of provinces, notably Ardebil, Fars, Gilan, Khorasa, Kordestan, Lorestan and Tehran.
Peru	Rural families with more livestock holdings had less probability of being ‘always poor’.
Zimbabwe	During the 1994–1995 drought in Zimbabwe, livestock holdings appeared to buffer drought impacts on children living in poor households [33].

Table 3.7: Summary of findings of case studies on local and regional outcomes

Country	Findings
Bolivia	A major flood in the city of Trinidad in 2006 increased poverty levels by 12% compared with pre-disaster levels. This increase was 5 times more than the national increment over the same period. A similar situation was observed with the poverty gap, which widened by more than 6% [34].
Iran	With an urban population of 69%, earthquakes affecting entire provinces are associated with most mortality (95%) and housing destruction (73%) [35]. The impact of disaster losses on the expenditure of urban households varied from province to province, according to hazard type, family size and kind of loss, including loss of life and housing damage and destruction. There were significant negative effects in Ardebil, Fars, Gilan, Golestan, Khorasa, Khuzestan and Kordestan, most of which are highly disaster prone provinces [36].
Mexico	Municipalities that reported disaster losses between 2000 and 2005 experienced a 3.6% increase in food poverty, a 3% increase in capacity poverty and a 1.5% increase in asset poverty [37]. Municipalities that reported losses associated with floods experienced an increase in food poverty of 3.5%, and with drought by 4.2%. Municipalities that reported disaster losses experienced an average reduction of 0.006 in their Human Development Index, equivalent to losing on average 2 years of human development gains over the same period: a very substantial reversal [38].

Table 3.8 Summary of findings of case studies on human development outcomes

Country	Findings
Bolivia	Following the 2006 floods in Trinidad, Bolivia, women's income fell more that that of men.
Côte d'Ivoire	In Côte d'Ivoire enrolment rates declined by about 20% between 1985 and 1988 for boys and girls in regions where rainfall deviated more than one absolute standard deviation from the historical mean, compared to regions without drought [39].
El Salvador	Following earthquakes in 2001 the probability of school enrolment for children in the most affected households decreased by 5.3% [40]. This decline was analogous to the worsening in school retention and progression in some areas of Nicaragua affected by Hurricane Mitch in 1998 [41].
Ethiopia	Drought disasters (expressed through crop damage) in Ethiopia over the period 1995–1996 had a large detrimental effect on child health. Children in communities with 50% of their crop affected and aged 6–24 months at the time gained 0.9 cm less in height over a six-month period when compared to communities whose percentage of damaged crop area was 25% [42]. Evidence of short-term impacts on adults has also been found. For instance, a study on a group of 1,447 households in Ethiopia during the 1994–1995 drought found that the Body Mass Index in communities with poor rainfall and low landholdings had dropped by 0.9% [43].
Nepal	People living in areas that had been affected by floods in the past were more likely to suffer from wasting and low weight. Similarly the population in areas affected by landslides was associated with higher percentages of stunting.
Zimbabwe	Women along with young children were the most affected by the 1994–1995 drought [44]. Women's body mass fell by about 3% while no impact was found on men's health. With good rains the following year, women regained much of the lost body mass but the effects of drought on health might not always be temporary.

Long-term poverty outcomes

Short-term impacts can last a few weeks or months. Effective responses, through mechanisms such as food relief, cash transfers, microcredits, insurance and public health interventions, can all contribute to avoiding the translation of disaster impacts into poverty outcomes. The recovery of basic services such as water, sanitation and power is likewise critical. In contrast, if households and communities have few assets to buffer asset losses and if outside assistance is non-existent, late or poorly targeted, disaster impacts may lead to longer-term outcomes, particularly in the case of highly vulnerable groups such as children.

Table 3.9: Summary of findings of case studies on inequality outcomes

Country	Findings
Honduras	In 1998, Hurricane Mitch destroyed over a quarter of the household implements, tools or animals of the wealthiest 20% of households but only a tenth in the case of the poorest 20% of households. But because these latter had so few assets to start with, they experienced more severe outcomes due to hurricane losses. The poorest group lost nearly 18% of their pre-Mitch asset value and 40% of their total crop value, compared to just 3% and 25% respectively for the wealthiest group[45]. A different study showed that poorer households lost a greater percentage of their productive wealth (31%) than did wealthier households (8%)[46].
Indonesia	Following the 2005 tsunami in Aceh, a World Bank study identified two overlapping but distinct vulnerable groups: those who were structurally poor before the tsunami and those who lost assets due to the tsunami. After the tsunami, the recovery of this second group was facilitated because they retained capacities, such as their education, that facilitated recovery, which the structurally poor never had[47].
Mexico	The reduction in the HDI in those municipalities that had suffered disaster impacts was significantly greater in those that already had the lowest levels of human development.
Peru	Disasters between 2002 and 2006 had a drastic effect on the monthly per capita consumption of rural households in 2006. This impact was significantly greater in the poorest quarter of families, whose consumption was reduced by 3.85%, compared to the wealthiest quarter, whose consumption was reduced by only 1.2%.

Nutritional shortfalls in children can affect their human development later in life. Although there is evidence that children can catch up over time if they recover the lost nutrition[48], stunting is a serious problem with far-reaching consequences. Children with slow height growth are found to perform less well in school, score poorly on tests of cognitive functions and generally develop more slowly.

The permanent effects from disasters are not restricted to nutrition or health. Given the very low penetration of catastrophe insurance in rural areas in Africa, Asia and Latin America, many households have major difficulties in recovering productive assets lost in, or sold to cope with, a disaster. This means that many years after disaster rural households are still facing difficulties in recovery. When households start with very few physical assets, for example, livestock in a rural context, recovery is challenged.

Finally, it is clear that successive disaster impacts seriously undermine coping strategies[49]. This is particularly critical in areas exposed to multiple hazards or to recurring drought or flood. Table 3.10 presents key findings in the above contexts.

Table 3.10: Summary of findings from long-term effects of disasters

Country	Findings
Bangladesh	Improved targeting of assistance to the poor and the positive impact of food assistance after the 1998 floods meant that per capita consumption actually increased in the case of households whose head had less than four years of schooling and with less than median assets[50]. The 1998 floods had a lower impact on the affected population than the 1988 floods, even though the 1998 floods were of a considerably longer duration in most places. One of the reasons for this was that previous to 1988 there had been two major floods, in 1984 and 1987, which undoubtedly left many poorer households in a precarious situation and unable to recover their pre-disaster situation before the next disaster occurred[51].
Ethiopia	Children between the womb and 36 months of age at the time of the 1984 drought-induced famine in Ethiopia and living in drought shock villages were almost 3 cm shorter ten years after the disaster than their non-affected counterparts[52]. Ten years after the famines in Ethiopia in the mid-1980s, cattle holdings in asset-poor households were still only two-thirds what they were just before the famine[53]. Households that had most difficulty in coping with the droughts of the mid-1980s had about 4–16% lower growth between 1994 and 1997 – on average a period of substantial recovery of food consumption and nutrition levels[54].

Table 3.10 (continued): Summary of findings from long-term effects of disasters

Country	Findings
Honduras	Households without asset losses in the aftermath of Hurricane Mitch showed substantially higher growth 30 months later than those that suffered losses. Amongst the poorest quarter of households, those who had suffered losses had experienced growth of –5% by 2001 while those that hadn't experienced growth of 8.8%: a gap of 13.8%. This gap was much smaller (5.1%) in the case of wealthier quartile of households [55].
Indonesia	Poverty increased only slightly after the tsunami, probably reflecting the influx of humanitarian assistance compensating for losses. Since 2006, poverty has declined below pre-tsunami levels facilitated by reconstruction activities and the end of the conflict. At the household level, the receipt of government and non-government organization (NGO) aid increased the likelihood of escaping from poverty by 43% and 23%, respectively.
India (Maharashtra and Andhra Pradesh)	The proportion of households experiencing longer (3–5 year) spells of poverty increased from 5.5% to 14.8% in the case of households that had experienced crop losses due to deficient or delayed rainfall [56]. When crop shocks occur in three consecutive years there is an increase in the proportion of 'always poor' (6–7 years). Even relatively affluent households (i.e. owning large amounts of land, possessing a few years of education and affiliated to upper castes) are highly vulnerable to persistent poverty under consecutive droughts.
Iran	Housing damage and destruction had a positive impact on consumption in a number of provinces including Khuzestan (climatic disasters), Kerman and Lorestan due to assistance in recovery and reconstruction by the government.
Nicaragua	Households that experienced a drought between 1998 and 2001 had 10–15% more probability of a downward welfare trajectory, with a 10% higher probability of remaining at the bottom of the welfare distribution in 2005 [57].
Peru	Between 2004 and 2005 households that experienced a disaster in those years were up to 4.6 times more likely to be 'always poor' than 'never poor'.
Zimbabwe	Coping actions in the 1991–1992 drought, the worst in living memory, both by households themselves as well as by the public sector were limited by the demands placed on such mechanisms by previous droughts in 1982–1984 and 1986–1987. Food consumption fell in spite of the variety of smoothing mechanisms employed by households and government. Quite dramatic negative impacts were found in a group of 400 households if nutritional deficiencies occur in children between the womb and about 2 years of age. In this case, temporary poor health and malnutrition during the drought lead to stunting, lower school achievement and levels of attainment later in life, as well as lower health and lower wages and productivity as adults. Sixteen years after the 1982–1984 droughts the affected children had 7% lower adult earnings than those not affected by the drought [58].

Endnotes

1 According to the political–administrative division of each country these are second or third tier administrative levels: for example the District in Peru; the Block in India and the Municipality in Colombia.

2 The Peru database covers the time period 1970–2006; the Mexico database covers the time period 1980–2006; and the Tamil Nadu database 1976–2007.

3 DesInventar: http://gar-isdr.desinventar.net/DesInventar/main.jsp

4 Floods, flash floods, urban floods, rains, fires, forest fires, mudslides, avalanches, landslides, tropical cyclones, storms, gales, strong winds, hailstorms, tornados, electric storms, lightning, thunderstorms, droughts, heat waves, cold waves, frost, snowstorms.

5 Earthquakes, tsunamis and volcanic eruptions are considered as geological hazards in the analysis that follows. Landslides may be either geological or weather-related and are often both. For the purposes of this report they have been classified as weather-related, although recognizing that many are related to earthquake occurrence.

6 Case studies on Bolivia, Ecuador, El Salvador, India, Iran, Mexico, Nepal, Peru and Sri Lanka were commissioned specially for this report by UNDP. Additional case study material was contributed by the World Bank on Indonesia and by SOPAC (Pacific Islands Applied Geoscience Commission) on Fiji.

7 In Japan, the threshold above which flood mortality increases has been calculated at 1,000 inundated buildings by Zhai, et al., 2006. Clearly this threshold will be different in other countries but suggests that in general extensive flood disasters are unlikely to cause major mortality.

8 Costs normalized using as a baseline the Indice de Precios de la Construccion, 2003 (Mansilla, 2008a) on the basis of an average sized social house of 42 m^2 and an average construction cost per m^2 of US$ 400.

9 In general post-disaster damage and loss assessments use a methodology developed by the Economic Commission for Latin America and the Caribbean (ECLAC), 2003.
10 Red Cross/Red Crescent Emergency Responses in 2004–2009, personal communication from IFRC, Disaster Information Senior Officer, Geneva, 12/02/2009.
11 UNEP GEO Data, 1970–2010 5-year average: http://geodata.grid.unep.ch
12 Office of the Registrar General and Census Commissioner, 2001
13 Office of the Registrar General and Census Commissioner, 2001
14 For example, see Figures 3.3 for Sri Lanka and 3.6 for Tamil Nadu
15 In some disaster databases, such as that of Colombia, systematic government reporting has contributed additional reports since the 1990s. The Peruvian Government has implemented, since January 2003, a new decentralized system for monthly reports of natural hazards at the local level.
16 Glave et al., 2008
17 IPCC, 2007b – see Chapter 2.1.4.
18 GPCC, 2008
19 Mansilla, 2008b
20 Contribution from the UN Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT).
21 Action Aid International, 2006
22 Action Aid International, 2006
23 Acho-Chi, 1998
24 Diagne, 2007
25 Contribution from UNOSAT/UNITAR.
26 Office of the Registrar General and Census Commissioner, 2005
27 Fuente and Dercon, 2008; Dercon and Christiaensen, 2007
28 Fuente and Dercon, 2008
29 Randrianarisoa and Minten, 2003, as quoted in Fuente and Dercon, 2008
30 Mansilla, 2008a; Mansilla, 2008c
31 Fafchamps et al., 1998
32 Fafchamps et al., 1998
33 Hoddinott and Kinsey, 2001
34 Rada and Fernández, 2008
35 Given this pattern of major earthquakes affecting entire provinces and their urban centres, it was possible to identify correlations between disaster impacts and decreased household expenditure at a high provincial level of spatial aggregation.
36 Government of the Islamic Republic of Iran and UNDP Iran, 2009.
37 The Government of Mexico defined these three official poverty lines (food, capacity and asset poverty). Food poverty takes into account the population without enough income to buy a basic food basket. Capacity poverty considers the population without enough income to simultaneously satisfy their needs for food, health and education. Asset poverty considers the population without enough income to satisfy food, health, education, shelter, public transport, clothing and footwear needs.
38 Rodriguez-Oreggia et al., 2008
39 Jensen, 2000
40 Baez and Santos, 2008
41 Ureta, 2005
42 Yamano, et al., 2005
43 Dercon and Krishnan, 2000
44 Hoddinott, 2006
45 Morris and Wodon, 2003
46 Carter, et al., 2006
47 World Bank, 2008b
48 Dercon, et al., 2005
49 Deaton, 1992; Dercon, 2002
50 Quisumbing, 2005; 2007
51 Beck, 2005
52 Porter, 2008
53 Dercon, 2002
54 Dercon, 2004
55 Carter, et al., 2006
56 Gaiha and Imai, 2003
57 Premand and Vakis, 2009
58 Porter, 2008