Chapter 2

Global Disaster Risk: An Interpretation of Contemporary Trends and Patterns

2.1 Global Disaster Risk Identification

Disaster risk unfolds over time through the concentration of people and economic activities in areas exposed to hazards, e.g. earthquakes, tropical cyclones, floods, drought[23] and landslides; through the frequency and magnitude of hazard events[24] and through the vulnerability of communities and economies, understood in terms of lack of capacity to absorb and recover from hazard impacts. Risk becomes manifest when disasters occur but often is invisible to those taking development decisions at all levels. Risk identification and analysis can therefore be described as a process of making the invisible more visible. Only when risk has been visualized can it be addressed.

In disaster prone countries, identifying, locating, measuring and understanding risk is the first crucial step towards the design of policies, strategies and actions for disaster risk reduction, ranging from development planning through to addressing risk in preparedness for response. Disaster risk identification and assessment at the national and local levels are therefore key priorities for implementing the Hyogo Framework.

Identifying and displaying global patterns and trends in disaster risk does not provide the detailed information required by national planners and decision makers. However, an improved understanding of global risk is vital both to increase political and economic commitment to disaster risk reduction as well as to ensure that the policies and strategies of international organizations are effectively focused and prioritized. Identifying global risk patterns increases understanding of how underlying processes such as climate change, environmental degradation, urbanization and socio-economic development configure disaster risk and vulnerability over time and space. These processes are fundamentally global in character and require a coordinated international commitment.

Risk identification at the global level, will provide key information for the ISDR System. To justify sufficient investment in risk reduction, accurate information on probable disaster losses and costs is required. To be able to predict likely losses, it is necessary to identify the spatial distribution of disaster risk, its likely magnitude and its evolution over time. To be able to reduce disaster impacts effectively, the linkages between development processes, such as urbanization and environmental change, and risk trends and patterns, must be revealed and understood in addition to 'invisible' risk factors such as gender bias, social inequity, socio-political conflict and poor governance. In other words, if the ISDR System is to contribute to reducing disaster risk and not just respond to its manifestations, then it is essential to identify, understand and visualize the nature of risk.

This chapter interprets past reports and studies produced by UNDP, UNEP, the World Bank, IDB and Centre for Research on the Epidemiology of Disasters (CRED)[25] to profile contemporary trends and patterns in global disaster risk. The interpretation provides a baseline of current knowledge on global disaster risk against which progress in reducing risk can be examined. These reports have made crucial progress in identifying patterns of global hazards, the exposure of people and economic activities and initial profiles of vulnerability and risk. In addition, links between development and disaster risk, such as between rapid urbanization and earthquake risk, have been established.

At the same time, it is clear that more progress has been made in identifying and measuring global patterns of natural hazard and exposure than in highlighting those factors that contribute to social, economic, political, cultural and other kinds of vulnerability. For example, global data on disaster loss and on disaster risk is not disaggregated in a way that facilitates an analysis of the different socio-economic implications disaster risk has on women and men, on the young and old, or on other most vulnerable sections of societies across different risk scenarios.

[23] Since drought has a strong food insecurity component, in some analysis it is differentiated from other climatic hazards.
[24] See Annex 1 (Technical Annex): Note 1 – Hazard.
[25] UNDP, UNEP, World Bank, IDB, CRED, op. cit.

© Dulue Mbachu/IRIN

Taking into account the limitations posed by existing global knowledge, this Review examines two kinds of hotspots:

1. Intensive disaster risk, where people and economic activities are heavily concentrated in areas exposed to occasional or frequent hazard events with chronic impacts; and
2. Regions of extensive disaster risk, where people are exposed to highly localized hazard events of low intensity, but with frequent asset loss and livelihood disruption over extensive areas.

In both kinds of hotspots, the review contrasts the risk associated with climatic and geological hazards - with respect to both mortality and economic loss.

The concepts and definitions used, based broadly on standard definitions used by the ISDR[26], are explained to make the analysis accessible to readers non-conversant with the technical use of such terminology. A set of technical notes, contained in Annex 1, provide greater detail on definitions, as well as on the technical and methodological aspects of the evidence presented.

[26] Different academic communities have developed concepts and definitions that vary widely. In particular, terms and concepts are used very differently in each language. The ISDR secretariat has adopted a set of standard definitions that are now widely accepted and which form the basis for the analysis presented here. These definitions were published in Living in Risk: a Global Review of Disaster Reduction Initiatives (2004).

2.2 Intensive Disaster Risk Hotspots

Intensive risk

Intensive disaster risk describes a scenario where significant concentrations of people and economic activities are exposed to severe, large-scale hazards, with major impacts in terms of mortality and economic loss.

Realized disaster risk[27] is heavily concentrated in a number of intensive risk hotspots, at least in terms of mortality. Between 1975 and 2005, the total number of disaster deaths recorded by the CRED EM-DAT[28] database was more than 2,300,000. However, as Table 1 indicates, 82 per cent of these occurred in only 21 large disasters with over 10,000 deaths each. Of these, 450,000 deaths occurred in the 1983 famine in Africa and 138,866 due to tropical cyclone Gorky in Bangladesh in 1991. More recently, of the 89,916 deaths recorded in EM- DAT in 2005, 73,338 corresponded to the Kashmir earthquake. Of the 241,400 deaths EM-DAT recorded in 2004, 226,408 corresponded to the Indian Ocean tsunami. Most disaster mortality therefore is concentrated in a very small number of major disasters.

Table 1
Largest disasters 1975-2005 (>10,000 killed)

Year	Hazard	Country	Number killed
1975	Earthquake	China	10,000
1976	Earthquake	China	242,000
1976	Earthquake	Guatemala	23,000
1977	Cyclone	India	14,204
1978	Earthquake	Iran	25,000
1981	Drought	Mozambique	100,000
1983	Drought	Ethiopia and Sudan	450,000
1985	Volcano	Colombia	21,800
1985	Cyclone	Bangladesh	10,000
1985	Cyclone	Bangladesh	10,000
1988	Earthquake	Soviet Union	25,000
1990	Earthquake	Iran (Islamic Rep.)	40,000
1991	Cyclone	Bangladesh	138,866
1998	Hurricane	Honduras	14,600
1999	Flood	Venezuela	30,000
1999	Earthquake	Turkey	17,127
2001	Earthquake	India	20,005
2003	Earthquake	Iran (Islamic Rep.)	26,796
2003	Heat wave	France, Italy	34,947
2004	Tsunami	Indian Ocean	226,408
2005	Earthquake	Pakistan	73,338

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

[27] See Annex 1 (Technical Annex): Note 3 – Disaster Risk.

[28] The EM-DAT (Emergency Events Database) is maintained by CRED (Centre for Research on the Epidemiology of Disasters), a non-governmental organization based at the Catholic University of Louvain in Belgium. EM-DAT at present provides the best global assessment of disaster occurrence and loss, available in the public domain, and therefore accessible by the disaster risk management community. For further information on EM-DAT, see Annex 1 (Technical Annex): Note 2 - EM-DAT Disaster Database.

© David Ray - Minks - PAHO/WHO

In terms of economic loss, realized risk is slightly less concentrated. Table 2 indicates that 38.5 per cent of total economic losses between 1975 and 2006 were concentrated in 21 disasters that each caused more than USD 10 billion of damage.

Table 2
Disaster causing more than USD 10 billion economic losses (1975-2006)

Year	Hazard	Country affected	Total damages in million USD
2005	Hurricane	United States	125
1995	Earthquake	Japan	100
1998	Flood	China (People's Rep.)	30
2004	Earthquake	Japan	28
1992	Hurricane	United States	26.5
1980	Earthquake	Italy	20
2004	Hurricane	United States	18
1997	Wild Fires	Indonesia	17
1994	Earthquake	United States	16.5
2004	Hurricane	United States	16
2005	Hurricane	United States	16
1995	Flood	Korea D.P.R.	15
2005	Hurricane	United States	14.3
1999	Earthquake	Taiwan (China)	14.1
1988	Earthquake	Soviet Union	14
1994	Drought	China	13.8
1991	Flood	China	13.6
1996	Flood	China	12.6
1993	Flood	United States	12
2002	Flood	Germany	11.7
2004	Hurricane	United States	11

Data source: EM-DAT OFDA/CRED International Disaster Database

Hazard exposure

Intensive risk hotspots occur because hazard exposure is concentrated in regions where large numbers of population and economic activities coincide with high levels of single or multiple overlapping hazards, e.g. earthquake, tropical cyclone, flood, drought, volcanic eruption and landslide.

The concept of hazard exposure or physical exposure is used to measure this concentration by combining the level of a hazard's frequency and potential severity in a location, with the number of people and assets including infrastructure and economy exposed. Processes such as urbanization, growing population density and unregulated economic activities can play a key role in concentrating exposure in certain hazard-prone areas. Through other processes such as environmental degradation and land-use change, development can also increase the severity of hazard itself, particularly climatic hazards. Development activities, therefore, are a key driver of patterns of hazard exposure, and unfolding risk.

According to UNEP's Global Resource Information Database (GRID) Europe and UNDP[29], 118 million people are exposed annually to earthquakes (magnitude higher than 5.5 on Richter Scale), 343.6 million people are exposed annually to tropical cyclones, 521 million are exposed annually to floods while 130 million people are exposed to meteorological drought[30]. Additional analysis by UNEP/GRID and the Norwegian Geotechnical Institute has shown that 2.3 million people are exposed to landslides every year mostly in Asia and the Pacific (1.4 million) and Latin America and the Caribbean (351,600)[31].

Vulnerability

Hazard exposure goes a long way in explaining why disaster risk is concentrated in intensive risk hotspots but by itself it is not enough. Disaster risk is also a function of the vulnerability[32] of whatever is exposed. Vulnerability can be broadly defined as a measure of the capacity to absorb the impact and recovery from a hazard event and is conditioned by a range of physical, social, economic and environmental factors or processes. Like hazard exposure, development activities influence patterns of vulnerability in a society and modify those conditions over time, making different social and economic sectors in a society more or less able to resist and recover from hazard events.

Human vulnerability (used here to describe people's vulnerability to hazard as opposed to the vulnerability of physical elements such as buildings/ infrastructure or the vulnerability of an economy) is often characterized by precarious settlements located in fragile ecosystems, structurally unsafe buildings and uncertain livelihood options.

One way of measuring human vulnerability[33] is that, for a given level of hazard exposure, countries experience very different levels of mortality. Mortality for a given level of hazard exposure over a given period of time can be described, from one perspective, as a measure of relative mortality risk. However, it can also be viewed as a proxy value for all the physical, social, environmental, economic, political and cultural vulnerability factors that increase or decrease the probability of mortality. For example, improved disaster preparedness systems and emergency health facilities or improved building standards may reduce mortality. Other factors, such as the occupation of extremely hazard-prone locations by socially and economically excluded populations, environmental degradation that alters the strength, frequency, extent and predictability of hazard events and chronic poverty trends, are factors that may increase mortality.

Clearly, mortality is one possible outcome of vulnerability. Other outcomes include injury, loss of livelihood, long-term health problems and psycho-social ailments, the partial or total displacement of communities, and the deterioration of living conditions, social services and the environment, which, for some hazard scenarios, may be far more significant

[29] See Annex 1 (Technical Annex): Note 4 - Hazard Exposure.

[30] 'Meteorological drought' refers to a significant deficit in rainfall over an extended period, e.g. three months with less than 50 per cent of the usual precipitations. Meteorological drought may lead to agricultural drought, where crops and harvests are negatively affected. However, lack of precipitation may be offset by irrigation, use of ground water and by water storage in many cases. Similarly, agricultural drought does not necessarily lead to mortality and other human impacts, given that it can be offset by food imports, stockpiles and other measures.

[31] Nadim, F. O. Kjekstad, P. Peduzzi, C. Herold and C. Jaedicke, (2006), Global Landslides and Avalanches Hotspots, Landslides.

[32] See Annex 1 (Technical Annex): Note 5 – Vulnerability.

[33] See Annex 1 (Technical Annex): Note 6 – Disaster Risk Index.

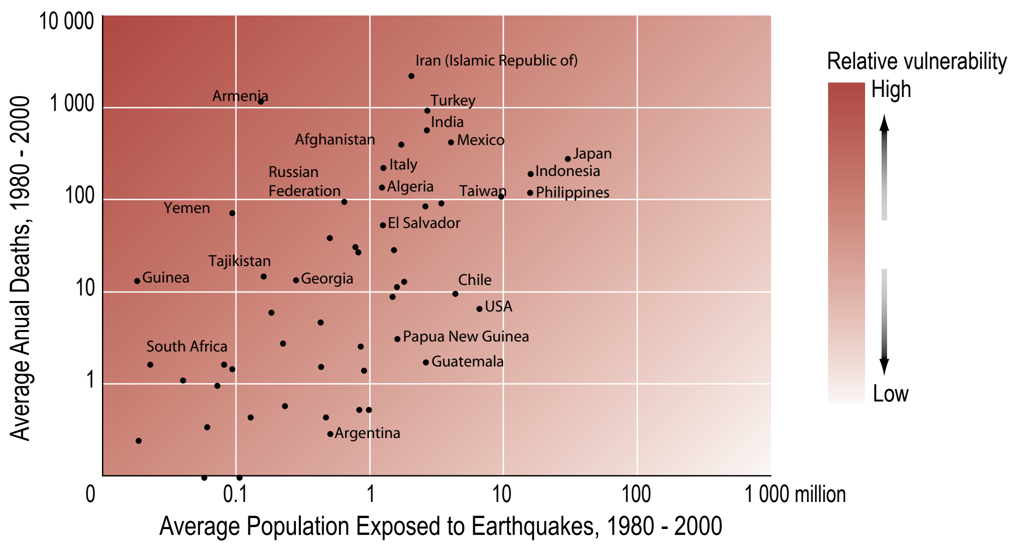
than mortality. For example, frequent floods may cause low mortality but a very extensive disruption of livelihoods and infrastructure. Unfortunately, data availability constraints do not currently allow the analysis of human vulnerability using disaster-related outcomes other than mortality.

Figure 1 shows a distribution of relative human vulnerability for earthquakes, expressed in terms of realized mortality from 1980-2000 for populations exposed to earthquakes. Countries on the top left of the figure are more vulnerable relative to those on the bottom right. It is important to highlight this difference when interpreting the figure. Below the trend line, countries like Japan and the United States of America may have high levels of hazard exposure but low levels of vulnerability relative to that exposure. In contrast, a country like Yemen has a high level of vulnerability relative to its level of hazard exposure. From this perspective, there are very wide variations in relative vulnerability between countries. In the case of earthquakes[34], the number of people killed per million exposed each year in the Islamic Republic of Iran (1,074) is over 1,000 times greater than that of the United States of America (0.97) and 100 times greater than that of Japan (9), even though exposure is greater in the latter two countries. That implies very wide variations in mortality for similar levels of hazard exposure that can only be explained in terms of differential contexts of vulnerability. The level of mortality that occurred in Bam, Iran, in December 2003, where 26,796 were killed would never have occurred if a similar earthquake had affected a similar sized city in the United States of America or Japan. At the same time, risk increases along the trend line from bottom left to top right illustrated by countries such as the Islamic Republic of Iran, which combine high relative vulnerability with large numbers of people exposed.

Figure 1

Relative Vulnerability to Earthquakes

This graph shows the vulnerability of national population for earthquakes. On the x-axis, the number of population yearly exposed (in average) to earthquakes while the y-axis, shows the average number of deaths as recorded in EM-DAT. The ratio killed / exposed provides a proxy for vulnerability, e.g. Iran is 1000 times more vulnerable than the USA.



Source: Reducing Disaster Risk, UNDP 2004
Data on exposure: UNEP/GRID-Europe,
Data on mortality, EM-DAT OFDA/CRED International Disaster Database

[34] Taking into account the methodological limitations of the DRI explained in Annex 1 (Technical Annex): Note 6.

In the case of tropical cyclones (Figure 2), the relative vulnerability of the United States of America (2.49) is more than 15 times greater than that of Cuba (0.16). This result was also illustrated recently by the very low level of mortality produced by hurricanes affecting Cuba in 2004 and 2005, compared to the 1,833 lives lost when Hurricane Katrina affected New Orleans and Mississippi in 2005. Similarly, Figure 3 shows that the relative vulnerability of Haiti is far greater than that of the Dominican Republic, even though both countries share the same island and have similar numbers of exposed population.

Risk

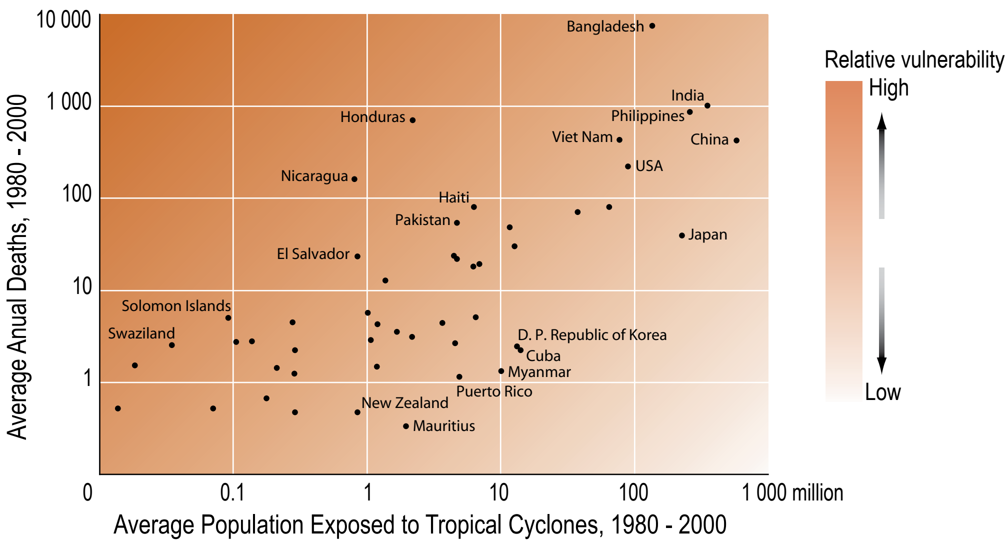
Unless existing risk levels are drastically reduced, it is likely that in the future, large-scale catastrophes involving significant mortality, economic loss and other outcomes will occur in intensive risk hotspots, where high relative vulnerability is combined with major concentrations of hazard exposure. The level of disaster risk in these intensive risk hotspots has been calculated for earthquake, flood, tropical cyclone, drought and landslide and for multiple hazards, by multiplying hazard exposure with a vulnerability indicator[35]. Disaster risk has been calculated in terms of mortality, total economic loss and economic loss as a proportion of Gross Domestic Product (GDP) density.

Mortality and economic loss hotspots for earthquakes (Figures 4) include the trans-Himalayan and trans-Caucasian regions as well as parts of Japan, Indonesia, the Andean countries and Central America. In terms of economic loss, Japan, Turkey and Iran are at particular risk, as well as parts of South and South-East Europe and Central Asia. Mega cities such as Tehran represent both mortality and economic loss hotspots where enormous concentrations of vulnerable people and economic activities interface with a high

Figure 2

Relative Vulnerability to Tropical Cyclones

Same representation as in Figure 2, this plate shows vulnerability to tropical cyclones. Yearly average exposed population is on the x-axis, average recorded killed on the y-axis. Once comparing the killed per exposed, Cuba is 12.5 times less vulnerable than the USA.



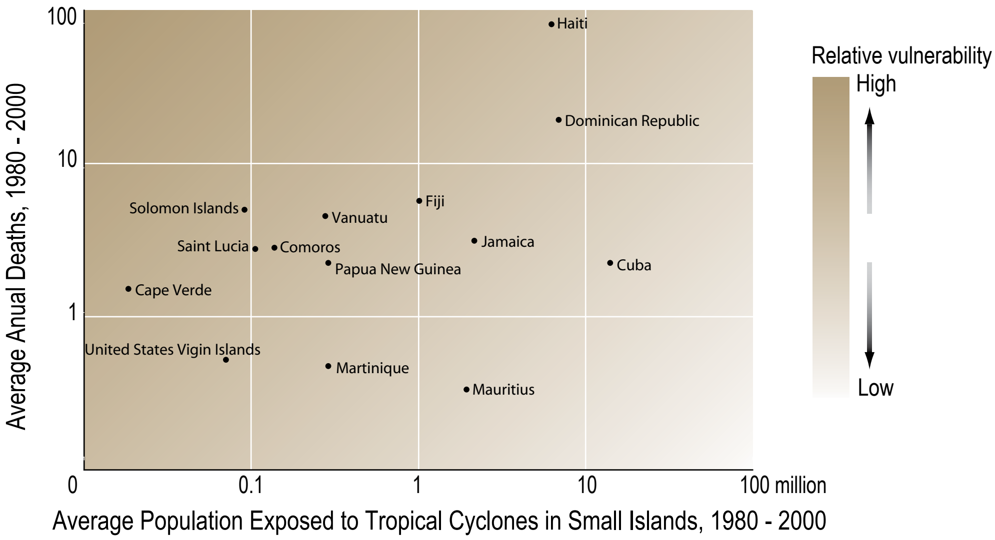
Source: Reducing Disaster Risk, UNDP 2004
Data on exposure: UNEP/GRID-Europe,
Data on mortality, EM-DAT OFDA/CRED International Disaster Database

[35] See Annex 1 (Technical Annex): Note 7 – Disaster Risk Hotspots.

Figure 3

Relative Vulnerability to Tropical Cyclones in Small Islands

This is a zoom in from Figure 2 with a special focus on small island developing states (SIDS). Haiti and the Dominican Republic are located on the same island and quite logically have a similar exposure to tropical cyclones. However, Haiti suffers on average 4.6 more deaths per person exposed than the Dominican Republic.



Source: Reducing Disaster Risk, UNDP 2004
Data on exposure: UNEP/GRID-Europe,
Data on mortality, EM-DAT OFDA/CRED International Disaster Database

level of hazard. Cities concentrate a substantial proportion of a country's gross domestic product (GDP), implying that the indirect economic loss would be national in character. In the case of some mega-cities, for example Tokyo, the impact in economic terms would be global. In the case of earthquakes, both economic loss and mortality hotspots are heavily concentrated in rapidly urbanizing developing countries.

In the case of cyclones, mortality hotspots include coastal areas in South and East Asia, Central America and the Caribbean and parts of Madagascar and Mozambique. Economic loss hotspots however include the eastern seaboard of the United States of America, a region with relatively low mortality risk.

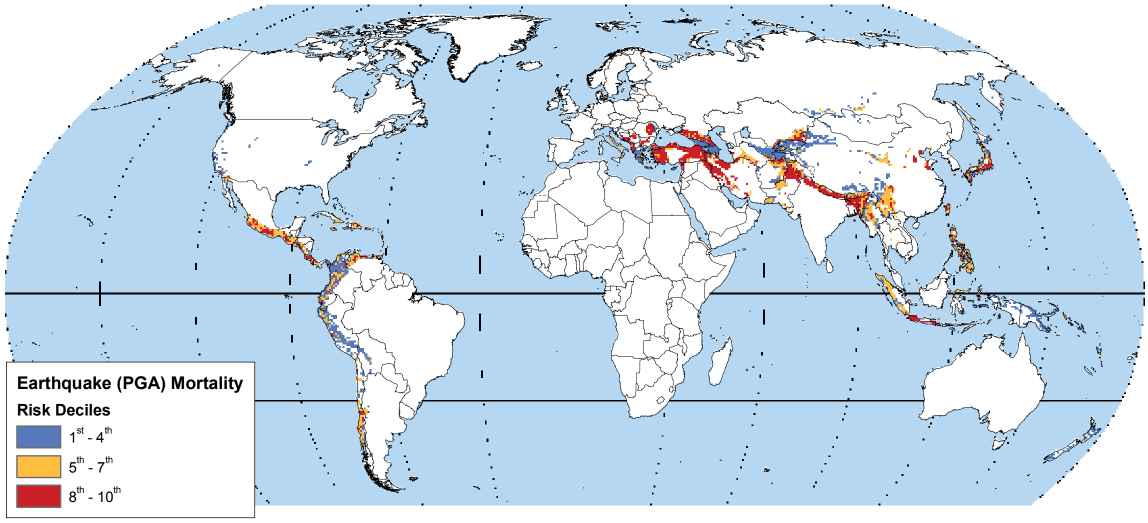
Flood mortality hotspots are concentrated in major river basins in South and East Asia as well as in Latin America. As in the case of cyclones, economic loss hotspots include areas of Europe and the eastern United States of America, with relatively low mortality risk.

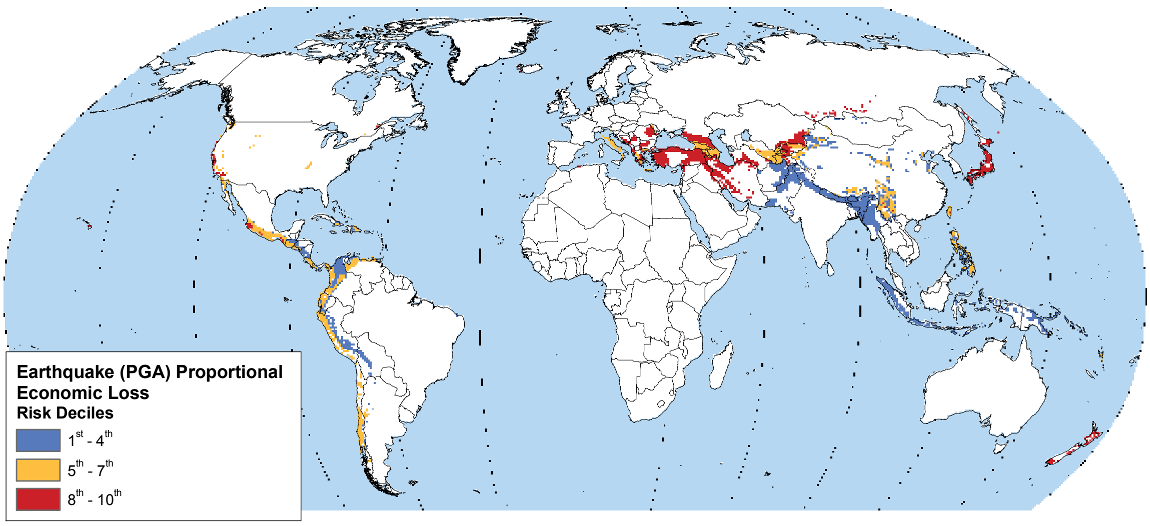
Drought mortality hotspots (Figures 5) are concentrated exclusively in sub-Saharan Africa. Economic loss hotspots for drought, in contrast, are located in more developed regions, for example in southern Europe and the Middle East, Mexico, north-east Brazil and north-east China.

Figure 4

Mortality, economic and proportional economic loss from earthquakes

These maps show distribution of mortality and economic risk for earthquakes. This visualization shows a broadly similar distribution of mortality and economic loss risk for earthquakes.





Source: Natural Disaster Hotspots: a Global Risk Analysis Synthesis Report, World Bank