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Natural Disasters in Latin America and the Caribbean: An Overview of Risk

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TABLE OF CONTENTS

Introduction

In the last five years, the Latin American and Caribbean region suffered from several large natural disasters whose magnitude, in terms of fatalities and damages, has renewed national governments' and international donors' interest in better managing risk.

Natural disasters, though, are hardly a novelty in the region. They have had a considerable importance in its history and its economic development. Historians now believe that an unusually long and severe drought was a primary cause of the disappearance of the Maya civilization.[1] During the past thirty years alone, there have been an average of 32.4 disasters per year, which have caused a total of 226,000 fatalities (or around 7,500 deaths a year) in the region. In addition to causing fatalities, homelessness and injuries, natural disasters have represented an enormous cost for the countries affected and the international community. In this paper, we estimate that the annual average cost between 1970 and 1999 ranges between $700 million and $3.3 billion. Due to the disruption of economic activity and the loss of capital assets they provoke, natural disasters have had negative short-term effects on GDP growth. In many instances, disasters have also resulted in longer-term economic consequences, such as slower growth, higher indebtedness and higher regional and income inequality. Environmental and social costs, though more difficult to assess in monetary terms, have also been substantial.

Natural disasters can be defined as temporary events triggered by natural hazards that overwhelm local response capacity and seriously affect the social and economic development of a region.[2] The sources of risk in the region are both natural and man-made. Because of its geographical conditions, the region is prone to natural events of severe intensity. But the large economic and human cost associated with these natural events is mainly the result of extreme vulnerability. This vulnerability stems from the pattern of socioeconomic development in the region as well as inadequate risk management policies.

Despite renewed preventative efforts at regional and international levels, the risk associated with natural events has not decreased. Economic costs can be expected to increase, as economic assets accumulate and economic interdependence reaches new levels. While the human toll taken by disasters has remained more or less stable, it is unlikely to decrease because of the persistence of widespread poverty, continuing demographic growth and migration towards coasts and mega-cities. Finally, preliminary evidence regarding climate change seems to indicate that the probability of occurrence of severe weather events will rise in the region.

Rather than taking a proactive approach towards risk management focused on risk reduction and preparedness, the region continues to rely upon costly reconstruction processes and post-disaster international assistance. This reactive stance is not only costly in terms of lives and destroyed assets, but also appears largely unsustainable as worldwide international assistance decreases and natural disaster proneness increases everywhere. This is why the improvement of risk management appears essential to guarantee the protection and future progress of economic and social development in the region.

[1] Hodell, Curtis and Brenner (1995).
[2] Adapted from Krimgold, Frederick (1976) as cited in Anderson (1990, p. 2).

After presenting empirical evidence of the substantial impact of natural disasters in the region, this paper examines occurrence trends and the geographical distribution of risk (Section 1). The paper then analyzes the natural as well as man-made sources of natural disasters (Section 2) before exploring risk management options and practices for the region (Section 3).

1 Natural Disaster Risk in Latin America and the Caribbean: Impact, Trend and Distribution

In this first section we analyze the characteristics of the risk of natural disasters by studying their impact on household and aggregate welfare, trends in terms of frequency and impact, and their geographical distribution.

1.1 The Human and Economic Impact of Natural Disasters in Latin America and the Caribbean

1.1.1 The Impact of Disasters on Household Welfare

From a household perspective, natural disasters can represent a multifaceted shock to welfare. There are three categories of impact on an individual or household's welfare: physical integrity, assets and income. Adverse effects are usually combined and occur at a time when individuals are out of their familiar environment, community solidarity is unlikely, and public services unavailable or severely disrupted. These factors contribute to magnifying the overall adverse impact on welfare. Even if the physical event experienced by the community might be the same, there is certainly an idiosyncratic aspect to its impact. Not all households and individuals are affected in the same way, depending on their degree of vulnerability, perception of risk, and capacity to mitigate risk and cope with the consequences of the disaster.

The direct impacts of disasters on an individual's physical integrity include fatalities, injuries, sickness and violence. Fatalities are a direct and immediate effect of the disaster, as buildings collapse and flows of water, mud or debris carry people away. Fatalities, which constitute a permanent shock to a household's welfare, leave individuals orphaned and widowed at a time when community and extended family solidarity might not be available. According to available disaster statistics (see Box 1.1), natural disasters have caused an estimated 464,000 fatalities in the Latin American and Caribbean region, over the century, and an estimated 226,000 fatalities over the last 30 years, or an average of 7,500 fatalities per year in the Latin American and Caribbean region.

Box-1.1. A Word of Caution about Disaster Statistics

Analyzing natural disasters is especially difficult due to the lack of information about occurrence of hazards and detailed analysis of the cost of disasters. The database used in this chapter is the EM-DAT database developed by the Center for the Epidemiological Study of Disasters (CRED) of the Catholic University of Louvain in Belgium. In this database, natural disasters are defined as natural hazards, which have caused of 10 or more fatalities, affected 100 or more people or resulted in a call for international assistance or the declaration of a state of emergency.[3] The database includes the following types of natural hazards: drought, earthquakes, extreme temperature, famine (natural), flood, insect infestation, slides, volcano, wave/surge, wildfire, wind storms and epidemics.[4]

The database covers all natural disasters for the entire world over the 1900-1999 period but suffers from underreporting, especially for the 1900-1970 period. To minimize this bias, we focus our analysis on the last 30 years, where the quality and amount of information available has become significantly better. This period is sufficiently long to provide some indication about the rate of occurrence of natural hazards and probably represents the time basis used by populations and governments to assess risk and make risk management decisions. For 1970-99, EM-DAT covers 972 disaster cases for Latin America and the Caribbean. Sources of information include, by order of importance, the US government, UN agencies, insurance companies, the IFRC, governments of affected countries and the press. The dataset provides fatality information for 90% of recorded disaster cases, information about affected population for 57% of the cases, and damage information for 29% of the cases. For regional comparison, we also used the worldwide dataset, which covers 5,970 disasters and has fatality information in 90% of the cases, affected population information in 62% of the cases and damage information in 34% of the cases.

Finally, it is important to underline that the disaster statistics used in this paper do not account for smaller disasters, which occur at a household or community level. These events might have serious effects on the welfare of the affected household or community but are not considered as natural disasters because their impact is not significant at the aggregate level. These smaller disasters are considered as idiosyncratic events, similar to accidents or illness. Nevertheless, the accumulation over time of smaller disasters might have a sizable effect on welfare at regional or even aggregate levels. High-frequency small-scale natural hazards might also induce changes in behavior of economic agents because of perceived risks. For instance, medium level climatic variability might have greater effects on agricultural production and development over the long run than a flood happening once every thirty years. By nature, these smaller disasters are extremely difficult to track and their effects even more difficult to capture. According to statistics produced by La Red de Estudios Sociales en Prevención de Desastres (La Red) for 11 countries of Central and Latin America, more than 20,000 small-scale natural disasters occurred in Latin America over the last 30 years.[5]

In addition to fatalities, disasters can have various adverse effects on an individual's physical integrity. First of all, disasters can cause grave or permanent injuries that can provoke a fall in income and an increase in health-related expenditures. Sickness and violence can also accompany disasters, depending on the quality of the management of a disaster situation. Earthquakes, storm surges and floods tend to destroy water distribution or contaminate water supply, leading to increased risks of water-borne diseases in the aftermath of a disaster. The

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[3] CRED (2000).

[4] We excluded epidemics from our analysis in this paper due to the nature and complexity of their origins.

[5] La Red (1999).

stagnation of waters following a flood is also a factor in the increase of certain endemic diseases such as malaria. Unsanitary and crowded shelters can also promote the easy spread of diseases. For instance, Vos, Velasco and Labastida (1999) estimate that the health conditions of 2.5 million Ecuadorians in the coastal regions worsened as a result of the 1997-98 El Niño.[6] In terms of mental health, sudden disasters such as earthquakes or hurricanes are found to have a profound psychological impact on victims, resulting in higher rate of incidence of stress, alcoholism, violence and depression.[7] Individuals are also more likely to become victims of violence because of looting, the gathering of population in shelters, and the breakdown of family units. Case studies report an increase in violence, rape, child abuse and prostitution in temporary shelters, which usually regroup the poorest and most marginalized members of a community.[8]

Natural disasters can also affect household welfare through homelessness, as well as the loss of productive assets and income. Over the past 30 years, an estimated 148 million people have required immediate assistance during a period of emergency for basic survival needs such as food, water, shelter, sanitation and immediate medical assistance.[9]

Household assets such as housing and income-generating assets can be damaged or destroyed by disasters. Housing is likely to be destroyed by earthquakes, high winds, volcanic eruptions and landslides, while damages in times of flood might be more limited and null in the case of droughts. Disasters are estimated to have made 2.5 million people homeless between 1990 and 1999. The partial or total loss of income-generating assets (shops, factories, crop, cattle, arable land, forests, etc.) is also a consequence of disasters. In the case of agricultural income-generating assets, the loss might be temporary or permanent. Floods make land unsuitable for agricultural production until waters recede, while hurricanes might wash out arable land or permanently increase its salinity through storm surges and flash floods. Loss of perennial crops such as forests or banana trees also has long-term consequences on the ability to generate income. In the case of Hurricane Mitch, banana production is expected to return to its historical level in 2002, i.e., four years after the disaster. The effect of disasters on employment, though, is still largely unknown, since no study has looked into their impact on open unemployment and underemployment. The impact on unemployment depends primarily on the degree of destruction of income-generating assets and the period of disruption of flows of goods and services. The frictional unemployment generated by a disaster results in a long-term reduction of income if alternative sources of employment are not available inside or outside of the affected area and the reconstruction efforts are limited in scale and slow in their execution. During the last El Niño in Ecuador, Vos estimated that around 12,000 workers on banana and sugar cane plantations in the lowlands temporarily lost their jobs. In Honduras, the press reported that the rate of unemployment in the immediate aftermath of Mitch had reached an estimated 32%, according to the firm Asesorias Económicos. But these figures differ significantly from official estimates of unemployment by November 1999 that registered 89,000 unemployed people, or 3.7%, compared with 3% before the hurricane. A reason for the discrepancy of these

[6] Vos, Velasco and Labastida (1999).
[7] Fogerthill (1998, p. 19).
[8] Anderson and Woodrow (1989, p. 165).
[9] IDNDR (1992)

figures might be explained by the fact that much of the frictional unemployment was absorbed between March and November of 1999.[10]

1.1.2 The Impact of Disasters at the Aggregate Level

Natural hazards can have effects on a country's economy when the sum of individual asset and income losses is significant at the aggregate level. Effects at the aggregate level can represent more than the sum of individual, household or community losses because of negative synergies and because of losses of common assets or resources (e.g., public infrastructure and environmental damage). In the short term, major natural disasters might have an impact on a country's GDP due to the loss of assets and the associated disruption of economic activity. But GDP growth and other flow indicators do not fully capture the effect of disasters, whose principal impact is on the stock of human and physical capital. In the longer term, the destruction of capital can have effects on factor endowments, income distribution, regional inequalities, growth trajectory and public indebtedness.

1.1.2.1 The Direct and Indirect Cost of Disasters: Theory and Empirical Evidence

Within hours of their occurrence, hazards produce *direct damages* to fixed assets and capital. As defined by ECLAC, direct damages comprise total or partial destruction of housing, buildings, installations, machinery, equipment, means of transport, storage, and furniture, as well as damages to cropland, irrigation works and dams and the destruction of crops ready for harvesting. Calculating direct damages is a difficult enterprise, especially in countries where the coverage of land titles, property taxes and insurance is low, resulting in problems for the valuation of assets. Under these circumstances economic agents and governments might be encouraged to overvalue lost assets to obtain insurance compensation, international assistance and debt relief. Inversely, assets lost by poor individuals, typically uncovered by insurance, might not be included in the valuation of losses. Moreover, direct damage assessments tend to underestimate damages to the environment (for instance, erosion or total sedimentation that makes the land unsuitable for cultivation) as well as negative effects on human capital because of fatalities and injuries.

Disasters also cause *indirect damages,* which refer to the loss of potential production due to the disturbed flow of goods and services, lost production capacities and increased costs of production. As shown in Table 1.1, indirect damages, which are the consequence of direct damages to production capacity and social or economic infrastructure, can be substantial. They include loss of future harvests as a result of flooding of farmland or loss of perennial crops, loss of industrial output as a result of damages to factories or lack of inputs and increased transport costs due to destruction of road infrastructure. Indirect damages continue to occur until reconstruction is completed and the entire production capacity is restored, which can take several years. Other indirect damages are less tangible but might have serious economic consequences. For instance, the destruction of school infrastructure and the decrease in enrollment due to impoverishment in affected areas can have a negative impact on school achievement and human capital building.

[10] Boletin del Comisionado, November 16, 1999; *La Prensa*, March 11, 1999.

Table 1.1. Direct and Indirect Damages of Selected Natural Disasters

Year	Country	Type of Hazard	Magnitude	Damages (millions of $, 1998)		
				Direct damages	*Indirect damages*	*Total*
1972	Nicaragua	Earthquake	8.5 Rs	2,383	584	2,968
1974	Honduras	Hurricane Fifi	165 km/h winds	512	818	1,331
1976	Guatemala	Earthquake	7.5 Rs	586	1,561	2,147
1979	Dominican Republic	Hurricanes David and Frederick	200-260 km/h winds	1,301	568	1,869
1985	Mexico	Earthquake	7.8-8.1 Rs	5,436	780	6,216
1987	Ecuador	Earthquake	6.1 and 6.8 Rs	1,170	267	1, 352
1988	Nicaragua	Hurricane Joan	n/a	1,030	131	1,160
1995	Saint Maarten, Netherland Antilles	Hurricanes Luis and Marilyn	250 and 170 km/h	611	502	1,112
1997-98	Andean countries	El Niño	n/a	2,784	4,910	7,694
1998	Dominican Republic	Hurricane Georges	170 km/h	1,337	856	2,193
1998	Central America	Hurricane Mitch	285 km/h	3,078	2,930	6,008
1999	Colombia	Earthquake	5.8 Rs	1,391	188	1,580
1999	Venezuela	Floods/debris flows	n/a	1,961	1,264	3,237

Source: ECLAC/IDB 2000.

Given the complexity of damage assessment, estimating the total impact of disasters in monetary value is quite difficult. It is also complicated by the fact that governments and international agencies use different methodologies and there is an obvious incentive for governments to overestimate losses to receive more assistance. Given these obstacles, it is not surprising that estimates of cumulative losses differ widely.

ECLAC, given its specific mandate to evaluate damages after disasters, is the primary source of information for the assessment of economic costs. According to their estimates, the cumulative damages from disasters for the period 1972-1999 amount to $50 billion in 1998, with $29 billion in direct damages and $21 billion in indirect damages, or $1.78 billion a year.[11] This figure probably underestimates the actual economic burden associated with disasters, as ECLAC bases its estimates on studies of about 40 disasters during that period whereas, according to CRED, 972 natural disasters occurred during that period. On the other hand, ECLAC figures include indirect damages,[12] whose assessment is particularly controversial. According to the CRED database, the cumulative damage figure amounted to $100 billion in 1998 dollars for 1970-1999, or $3.3 billion a year. The reliability of these figures is limited, however, as only one third of the recorded disasters include damage information and data comes from a variety of sources. Between 1990 and 1999 (when information reliability is much higher), losses reached $30.5 billion, or $3 billion a year. A third source, Munich Re—a major reinsurance company—estimated that, between 1985 and 1999, the total cumulative amount of damages caused by the 570 disasters in Latin America and the Caribbean (versus a total of 648 disasters according to CRED) was $10.9 billion, $420 million of which was covered by insurance.[13] Considering all sources together, the estimated annual average cost of recorded disasters over the last 30 years is between $700 million and $3.3 billion.

1.1.2.2 The Effect of Disasters on Short-Term Macroeconomic Performance

Theoretical Elements

Natural hazards of a sufficient magnitude can have an impact on overall economic performance, as measured by changes in the GDP, balance of payments, level of indebtedness, state of public finances, and investment rate (Table 1.2). These effects are expected to take place in the year of the disaster, as well as during the two to three years following the disaster. The timing of the impact varies depending on the month of occurrence of the disaster.

The impact of disasters on GDP growth can be expected to be transitory when the overall public and private investment effort for reconstruction (which boosts the growth rate of gross fixed capital formation) outweighs the adverse growth effects of the disaster. According to Albala-Bertrand (1993b), the amount of investment effort needed to counterbalance the negative impact of the disaster does not necessarily have to be massive because of the large multiplier effect associated with the increase in investment for the reconstruction. In addition, the process

[11] ECLAC/IDB (2000).
[12] Indirect damages refer to impact of hazards on the flows of goods and services that cease to be produced, distributed or provided. For a more detailed definition, see Section 2.
[13] Munich Re (2000, pp. 64-65).

of replacement of lost fixed capital can be expected to raise its quality, and therefore capital productivity.[14]

Table 1.2. Effects of Disasters on Macroeconomic Indicators

Macroeconomic Indicator	***Expected change after disaster***
Growth rate of GDP	Decrease or negative rate in year of disaster and subsequent increase during 1 to 2 years.
Agricultural Sector	Significant fall in production (if hurricane, flood or drought).
Manufacture Sector	Decrease in activity due to disruption of transportation, reduced production capacities.
Export sector	Poor performance due to the effects described above
Gross Formation of Fixed Capital	Sharp increase in the year following the disaster.
Inflation rate	Increase caused by the disruption of production and distribution and increasing transportation costs.
Public finances	Worsening of deficit due to a shortfall in tax revenues and increase in public expenditures.
Trade balance	Deficit due to decrease in exports and increase in imports, associated with the decline in production capacities and strong public and private investment for reconstruction.
Current Account	Increase in deficit due to trade imbalance, partially offset by capital inflows generated by official and private donations.

Adapted from Albala-Betrand (1993a) and Downing, Holstoorn and Tol (1999).

Empirical Evidence

To provide empirical evidence on the impact of disasters on GDP growth, we analyze 35 disaster cases between 1980 and 1996 in 20 Latin American and Caribbean countries to assess their effects on real GDP growth. All 35 cases have loss-to-output ratios superior to 1%. The distribution by type of disasters is fairly similar to the regional distribution between 1970 and 1999 (see Table 1.3).

[14] Albala-Bertrand (1993b, pp. 1421-1422).

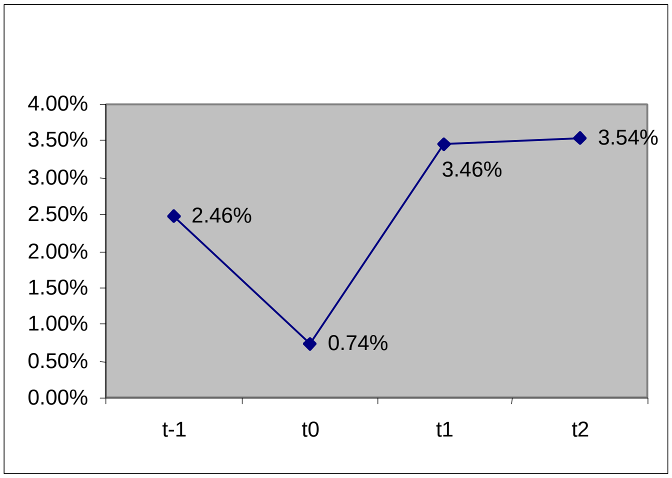
Table 1.3

Selected Disaster Cases

Country	Year	Type of hazard	Loss as share of GDP (%)
Argentina	1985	Flood	1.48%
Bahamas	1992	Hurricane	8.75%
Barbados	1987	Hurricane	6.86%
Bolivia	1982	Flood	19.80%
Bolivia	1986	Flood	1.26%
Bolivia	1988	Drought	1.09%
Bolivia	1992	Flood	1.63%
Brazil	1984	Flood	1.00%
Chile	1985	Earthquake	9.10%
Colombia	1983	Earthquake	1.06%
Colombia	1985	Volcano	2.87%
Costa Rica	1988	Hurricane	1.50%
Costa Rica	1991	Earthquake	8.87%
Costa Rica	1996	Flood	2.73%
Ecuador	1982	Flood	1.68%
Ecuador	1987	Earthquake	6.65%
Ecuador	1993	Landslide	3.50%
Guatemala	1982	Flood	1.20%
Haiti	1988	Hurricane	4.09%
Honduras	1982	Tropical storm	3.44%
Honduras	1990	Flood	1.57%
Honduras	1993	Hurricane/Flood	3.39%
Jamaica	1980	Hurricane	2.39%
Jamaica	1986	Flood	3.00%
Jamaica	1988	Hurricane	28.21%
Jamaica	1991	Flood	6.62%
Mexico	1985	Earthquake	2.18%
Nicaragua	1982	Tropical storm	18.74%
Nicaragua	1988	Hurricane	32.57%
Nicaragua	1992	Earthquake	1.36%
Nicaragua	1994	Drought	8.74%
Panama	1988	Hurricane	1.23%
Paraguay	1983	Flood	1.36%
Peru	1983	Flood/drought	5.96%
St. Kitts & Nevis	1995	Hurricane	85.42%

We find that real GDP growth tends to decrease in the year of the disaster and increase sharply in the two successive years. The median real GDP growth decreases by almost 2% and subsequently increases by almost 3% during the next two years (see Chart 1.1). These observations corroborate the theory according to which the depressionary effect of the disaster is outweighed by the sharp increase in GFCF in the years following the disaster.

Chart 1.1. Median Real GDP Growth



As shown in Table 1.4, growth decelerates in the year of disaster in 28 cases out of 35. In 5 of the 7 cases in which growth accelerates, the loss to GDP ratio is inferior to 5%, which might explain the absence of aggregate negative effect. Growth accelerates during the two years following the disaster in 30 cases and 21 cases, respectively.

Table 1.4. Real GDP Growth Rate in Cases Analyzed

	y+0	y+1	y+2
Change			
Down	*28*	*5*	*14*
Negative	13	5	13
Positive	15	0	1
Up	*7*	*30*	*21*
Negative	1	5	1
Positive	6	25	20

For the 28 cases with decreasing GDP growth, GDP changes still vary widely among cases, and these variations do not always coincide with the level of loss-to-output ratio, suggesting that other contemporary events might enhance or counteract the effects of the disaster. This variation could also show different levels of economic vulnerability to natural hazards (see Chart 1.2).

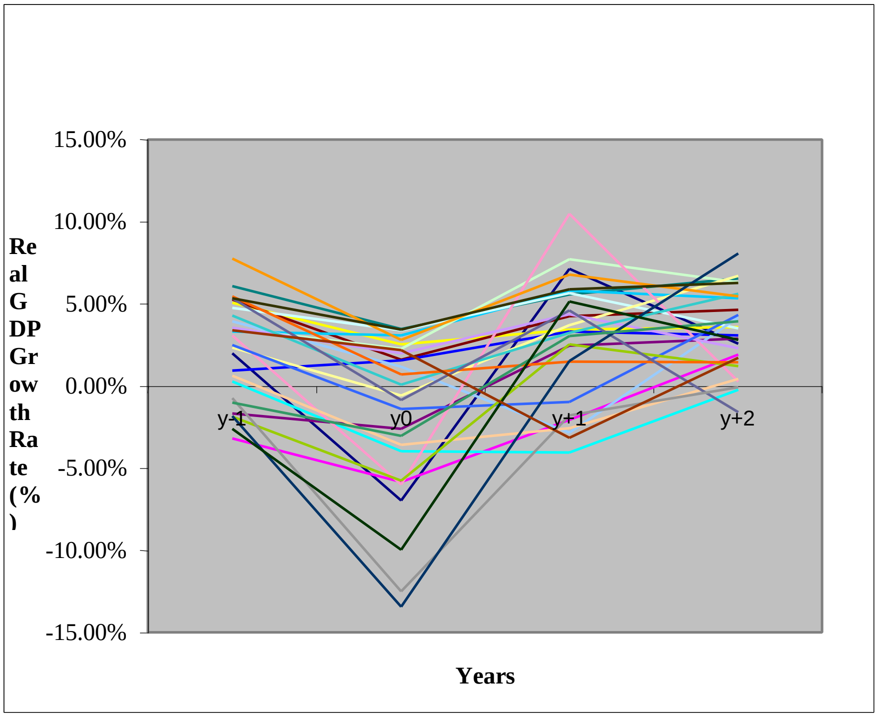


Chart 1.2. Cases with Decreasing GDP Growth in Year of Disaster

Studying twenty-one cases of hurricanes occurring between 1970 and 1997 in the Carribbean Development Bank's borrowing member countries, Crowards (1999) finds similar results: GDP growth slows down by 3% on average the year of the disaster and rebounds by 3% in the subsequent year. But there are wide deviations from this average pattern, with certain countries even experiencing an acceleration of GDP growth in the year during the disaster, as in the case of St. Lucia in 1988. During the subsequent two years, once the activity boom subsides, average growth slows down again. Exports are reduced by 9% in the year of the disaster while imports increase by 8.2%, causing a substantial increase in the trade deficit. Sugar-exporting countries such as Barbados and St. Kitts tend to suffer a greater loss in exports in the year following the disaster, since hurricanes hit after the sugar harvest. There is no discernible pattern in the variation of government expenditures, but external debt tends to rise during the disaster year, presumably due to emergency borrowing. Similarly, Crowards finds no observable pattern in the response of consumer prices.[15]

A study by Albala-Bertrand of twenty-eight case studies[16] between 1960 and 1979 finds that disasters result in an increase or constancy of GDP growth rate in 75% of the cases studied. This result might be explained by the fact that 13 of the 26 cases studied are earthquakes, which usually have less of an aggregate effect than other disasters. In addition, there is no analysis of the real GDP growth rate, while inflation accelerates in a third of the cases studied. Finally, since the aggregate effect of the disaster seems to be proportional to the degree of development of the

[15] Crowards (1999, pp. 12-18).
[16] Albala-Bertrand (1993a, pp. 57-89).

economy affected,[17] these results, based on 1960s and 1970s data, might not be indicative of the effect that disasters have today on LAC economies. Other macroeconomic effects during the year of the disaster in this study include an increase in the growth of Gross Rate of Formation of Fixed Capital, a worsening of the public and trade deficits and an increase of capital flows. No discernible change in the inflation rate is observed.

Explaining Variations in Macroeconomic Impact: Key Variables

The wide variation in the macroeconomic effects of disasters observed in these empirical studies can be explained by analyzing three factors: the size of direct and indirect damages caused by a disaster as a share of the economy, the nature of the hazard and the vulnerability of the economy.

A natural disaster will have a strong impact on a country's economic performance if the size of damages compared with the size of the economy (loss-to-output ratio) is high, as in the case of Hurricane Mitch (see Box 1.2). Not surprisingly, smaller countries are more likely to experience a sharp decrease in GDP in the short term as their loss-to-output ratios are substantially higher on average (see cases in Table 1.3). On the contrary, medium and large-size countries do not usually suffer from significant aggregate secondary effects of disasters. The regional or asymmetric shock that the disaster represents for a larger country is absorbed by activity in other regions.

[17] Benson and Clay find that the aggregate impact of droughts was less substantial in the least developed economies, mainly due to the lack of intersectoral linkages (1998, p. 26).

Box 1.2. The Case of Hurricane Mitch in Honduras

This case is particularly interesting due to the very high loss-to-output ratio (38% for direct damages, 70% for all damages) and the fact that economic prospects for Honduras before the hurricane, which occurred at the end of October 1999, were estimated as very promising. The IMF projected that real GDP growth, which was 4.7% in 1997, would reach 5% annually for 1998 and 1999. According to ECLAC, the total amount of damages incurred by Honduras amounted to $3.8 billion, with $2 billion in direct damages and $1.8 billion in indirect damages. Losses in the productive sector represented 68% of total losses, the rest consisting of the loss of housing, health and education facilities (11.6%), infrastructure (17.5%), and the environment (1.2%). Losses in the productive sectors were distributed as follows: 77.6% in agriculture, livestock and fisheries; 14.4% in industry, and 8% in commerce.

Table 1.5

Macroeconomic indicators	1997	1998	1999 (est.)	2000 (forecast)
Real GDP growth (%)	4.5	3.0	-2.0	3.0
Inflation (%)	20.2	13.7	11.6	12.2
Central government finances (balance, La m)	--	2,080.7	1,089.5	N/a
Exports $ m	1,857	2,017	1,773	2,077
Imports $ m	-2,150	-2,340	-2,580	-2,904
Current account deficit (%GDP)	5.7	6.4	6.5	N/a
Total external debt $ million	4,698	5,017	5,652	N/a

As shown in Table 1.5, real GDP growth was 3% in 1998 (i.e., 2% points less than forecast) and –2% in 1999 as a result of the indirect damages brought about by Hurricane Mitch, as well as the decreasing price of bananas and coffee. Activity in the agricultural sector, which contributes to 20% of the GDP, contracted by 8.7%. By contrast, the construction sector grew by 10.4%, fueled by reconstruction effort. As expected, exports decreased while imports increased (fueled by demand for materials for reconstruction). Remittances and capital inflows compensated for the increase in the deficit of the current account. Central government finances worsened due to a 40% increase in capital expenditures. The only surprising result was the decrease in inflation despite rising oil prices. It appears that low consumer demand and the quick recovery of basic foodstuff production (grains and beans) contributed to stabilizing prices.
Source: EIU (2000) and ECLAC (2000).

The duration and geographical size of the disaster is another important factor. Localized disasters tend to produce limited aggregate impacts, unlike countrywide natural events such as Hurricane Mitch. Sudden hazards (such as storms) usually have fewer long-lasting effects than slowly developing ones (such as droughts). Hurricanes, floods and droughts tend to have stronger aggregate effects than earthquakes and volcanic eruptions, mainly because of their stronger adverse effects on the agricultural sector, especially in countries dependent on agriculture.[18] Recurrent disasters in the same geographical area (such as El Niño) might induce long-term effects such as a reduction in investment due to the perceived risk of asset loss, or emigration from stricken areas.

The third key element, the vulnerability of the impacted economy, depends mainly on the degree of diversification of the economy and its macroeconomic performance before the disaster hits. Smaller countries such as the Caribbean islands (see Box 1.3) are particularly vulnerable

[18] Anderson (1990, p.14).

because island economies are often dependent on tourism and agricultural exports of cash crops.[19] Nevertheless, when the main economic activity is severely hit, even larger countries can be affected. For example, the 1987 earthquake in Ecuador represented a loss-to-output ratio of only 1.8% but destroyed the most important oil pipe in the country, cutting down oil exports for months.[20] A country's type of economic structure and the linkages between different sectors also play an important role. Countries with large informal sectors are likely to suffer more,[21] since these sectors are poorly covered by insurance and reconstruction assistance. They are also less likely to have access to private financing in the post-disaster credit crunch, increasing risks of bankruptcy. The size of the agricultural sector is also an important factor. The agricultural sector (including agroindustries) represents around 25% of GDP in the region but is much higher for some countries, magnifying their vulnerability to weather-related hazards.[22] Finally, in countries dependent on hydroelectricity for their electricity supply, drought conditions might have important ripple effects on the entire economy, by interrupting production in various sectors, as shown by the effects of El Niño on electricity supply in Nicaragua or Brazil.[23]

Box 1.3. Economic Impact of Disasters on Small Island Economies: The Case of Montserrat, UK

The Caribbean island of Montserrat, whose territory is 0.6 times the size of Washington DC and has 12,853 inhabitants, constitutes an extreme example of the kind of impact disasters can have on a small and undiversified economy. In 1996, 81% of the island's activity was linked with tourism. In 1989, Hurricane Hugo caused an estimated $240 million in damages, i.e., a loss-to-output ratio of more than 600%.[24] 98% of the housing stock was damaged or destroyed by the hurricane. In 1995, while the island was still recovering from Hugo (with growth rates between 0 and 2% in 1992, 1993 and 1994), the Soufriere Hills Volcano became active again for the first time in 350 years, causing 32 fatalities and the evacuation of 70% of the population. Volcanic activity, which peaked in 1996-97 with several violent eruptions, subsided by March 1998, leaving much of the island unsuitable for agricultural production or inhabitable. The UK government has committed about $100 million for reconstruction (i.e., 300% of the island's GDP). Despite this massive assistance and the boom generated by reconstruction in the construction sector, GDP declined by 18.5% in 1997 in real terms and declined again in 1998 *(CIA World Factbook 1999*; DFID, 1999, pp. 60-61; Crowards, 1999, p.18).

1.1.2.3 The Longer-Term Economic and Social Impact of Disasters

Due to the loss of fixed capital they cause, disasters can have long-term effects on growth and distribution of income.

Growth Effects

Factor endowments, such as natural resources and physical and human capital, play an essential role in long-term growth. Disasters can impact these variables in several ways. The sudden destruction of individual assets, as well as common assets such as public infrastructure, reduces the amount of physical capital in an economy, at least until reconstruction is completed. The

[19] Anderson (1990, p. 14).
[20] Albala-Bertrand (1993b, p. 1419).
[21] Anderson (1990, p.17).
[22] Such as Bolivia, Ecuador, Paraguay, Haiti and Nicaragua (Pichon and Uquillas, 1997, p. 483).
[23] Benson and Clay (1998, p. 6); IDB (1998b); *Wall Street Journal*, July 20, 1999, p. A1.
[24] Calculation using 1996 GDP, *CIA World Factbook.*

losses incurred can reduce the rate of accumulation of fixed capital as risk and solvency problems limit investment willingness and capacities. Disasters can also have an adverse impact on the human capital available in a given region or country because of fatalities, emigration, or decrease in school enrollment due to the destruction of schools and hazard-related impoverishment. Finally, the impact of hazards on water reserves, forests, arable soil, and coral reefs, as well as land subsidence and coastal erosion, can modify a country's endowment in natural resources.

The level, mode and timing of financing of reconstruction efforts are essential in determining the long-term growth effect of the disaster (see Box 1.4). If lost capital is not replaced, because of an insufficient public policy or private sector response to the disaster, there might be longer-term negative effects on the supply side, whose magnitude depends primarily on the capital per output ratio of the affected economy. When reconstruction is financed by reallocating public resources (of national or donor origin) away from other investments, an opportunity cost arises. The growth potential of the economy might be reduced if the expected rates of return of the investments planned before the event exceed the marginal growth in productivity of the physical capital replaced by reconstruction funds. The accomplishment of other development goals can be delayed or abandoned altogether because of reallocation needs.

If reconstruction is fully financed by insurance payments, the cost for the economy amounts to disaster insurance premiums paid by economic agents. The aggregate negative impact on aggregate welfare is therefore minimized, unless the premiums paid were high enough to discourage investments or insurance payments are delayed because of solvency problems or lengthy appraisal of damages. When massive international assistance finances the replacement of lost capital, the cost for the economy as a whole is limited or null depending on the share of grants and concessional funds in the assistance package. If international assistance is only composed of concessional resources, the overall impact might be positive because of the multiplier effect of the reconstruction process and the increase in capital stock productivity.

Box 1.4. Simulation of Macroeconomic Effects of a Major Storm in Honduras

This study uses risk assessments provided by Swiss Re and the World Bank's Revised Minimum Standard Model for simulating macroeconomic effects. Total annualized hazard exposure is estimated at $82 million per year of 0.63% of the capital stock.

The model analyzes macroeconomic effects of a 1-in-100-year storm under three scenarios:

- 100% of the foreign financing needed to resume growth trajectory is available immediately following the event;
- only half of the necessary funding is available;
- all funding necessary is available, but with disbursement spanning over two years following the event.

Results show that under the first scenario macroeconomic effects are temporary: After a decrease of GDP in the year of the disaster, the economy gets back to its long-term growth pattern. The only lasting effect is the increase of the stock of the country's debt as a share of GDP by around 60%. Under scenarios 2 and 3, the GDP further deviates from its baseline growth trajectory for 7 years after the disaster (after the decrease observed in year of the disaster also observed under scenario 1). Other macroeconomic indicators behave as follows (changes observed are greater under scenario 2 than under scenario 3):

- total investment decreases as immediate consumption needs diverts resources;
- total exports decrease;
- an increased deficit in the balance of payments becomes more likely;
- private savings are lower than before the disaster due to decreased, subsistence-level income;
- government consumption increases to provide relief to the very poor;
- stock of government debt increases as the public deficit increases.
- ability to service debt decreases due to additional need for external financing and decreased export earnings.

Source: Freeman, McKellar, Martin, Mechler and Warner (2000).

Given the low rate of insurance coverage in developing countries, the negative effect of disasters on fiscal balances and the limited amount of available international assistance, governments in the region usually have to resort to borrowing to finance reconstruction. The degree of additional indebtedness involved directly depends on the amount of capital inflows obtained via international assistance or insurance. Cochrane (1997) claims that increased indebtedness would have long-term negative effects on a country's growth because of the increase in its interest rates associated with an increased debt stock and higher risk premiums required by lenders.[25]

Distributional Effects

Natural disasters can affect the distribution of income among regions, income groups or genders. As demonstrated by the Inter-American Development's *Economic and Social Progress Report* (abbreviated in Spanish as *IPES*) for 2000, geographical factors can have a sizeable impact on levels of wealth at regional, national and local levels.[26] In the case of repeated disasters, affected

[25] Cochrane (1997, p. 14).
[26] Inter-American Development Bank (2000a).

regions might be stalled in their economic development. This is due to the fact that affected households might not be able to fully recuperate between disasters when those disasters occur frequently. Repeated disasters might cause a gradual depletion of households' asset base. Adverse conditions might also cause the emigration of the most skilled individuals to other regions and result in a decline of the quality of human capital available. Investment in high-risk regions also becomes less attractive because high risks of asset loss are detrimental to the competitiveness of a given region, especially if adjacent areas are much less risk-prone. In fact, regions repeatedly hit by natural disasters, such as Northeast Brazil (see Box 1.5), or the coasts of Peru and Ecuador, are usually poorer on average than less hazard-prone areas in a given country.[27]

[27] This said, the above-average disaster proneness of these regions might be the result of higher poverty rather than the reverse. More research would be needed to clear establish the direction of the relationship.

Box 1.5: The Impact of Droughts on Northeast Brazil

A study of several droughts in Sub-Saharan economies, as well as India and Australia, found that the aggregate impact of droughts could be quite significant in terms of growth. A 50% fall in agricultural GDP would translate into a 10% decrease in GDP for an economy in which agriculture accounted for 20% of total activity in the pre-drought year.[28]

A study of the supply-side shock (and associated demand effects) triggered by 10 drought episodes in Northeast Brazil between 1970 to 1993 produced similar results (see Table 1.6).[29]

Table 1.6 Estimates of Drought Impact on the GDP of North-East Brazil

Drought years (Y)	Growth of regional agricultural GDP, year Y (%)	Growth of regional GDP, year Y (%)	Estimated supply and demand effect of drought on regional GDP (%) (**D**)	Difference between actual growth of regional GDP and growth trend of GDP (**G**) (% points)	Difference between drought effect and deviation from growth pattern (**D**-**G**) (% points)
1970	-17.5	-4.2	-9.2	-9.2	0
1976	-8.3	7.0	-4.8	2.0	6.8
1979	-0.5	7.2	-1.0	2.2	3.2
1980	-6.5	2.9	-3.4	-2.1	1.3
1981	0.8	-0.7	-0.4	-5.7	-5.3
1983	-29.7	-3.8	-9.0	-8.8	0.2
1987	-1.7	-1.0	-5.0	-5.1	-0.1
1990	-10.5	-5.9	-3.6	-10.9	-7.3
1992	-10.5	-2.3	-4.0	-7.3	-3.3
1993	-24.4	-1.7	-6.0	-6.7	-0.7

Source: Gomes and Vergolino (1995).

Despite the decrease of the weight of agriculture in the regional GDP (from 23.5% in 1970 to 11.3% in 1993), droughts resulted in the decrease of the region's GDP by 4 to 9 percentage points. Over the whole period, the main determinant of the fluctuations of GDP of the Northeast region was still the national GDP. For instance, in years of rapid growth in Brazil, such as 1976, the region's GDP grew even if there was a drought because of a growth rate of fixed capital of almost 30%. Nevertheless, it appears that, during years of severe drought (such as 1970, 1983 and 1993), when the agricultural GDP decreased between 17.5 and 29.7%, the behavior of the region's GDP can be almost entirely explained by the occurrence of drought (as shown by column D-G).

The aggregate impact of droughts on Brazil's GDP is limited, as the GDP of the Northeast only represents 14.4% of the country's GDP. Nevertheless, the repeated occurrence of droughts, with their recessionary effects, might contribute to worsened, regional inequalities. In fact, the estimated GDP per capita in the Northeast was $1,494 in 1993, compared with $3,010 in the rest of the country.

The poor and near poor can be expected to suffer greatly from the impact of a disaster because of their high degree of vulnerability and limited coping abilities (see box in previous section). This is not to say that higher-income groups are immune to disasters. Past examples of

[28] Benson and Clay (1998, p. 15).
[29] This entire section draws on Gomes and Vergolino (1995).

disasters do not necessarily show that higher-income groups with access to information are less vulnerable and therefore less likely to suffer. In the 1985 Mexico City earthquake, the lower-middle class was the most affected group as their high-rise housing was more vulnerable to the earthquake's ground motion than the low adobe and brick-built houses in low-income neighborhoods.[30]

A study by Vos *et al*. (1999) on the impact of El Niño in Ecuador estimates that the poverty incidence in affected municipalities in the coastal province, which already reached 73% before El Niño, rose by 10 percentage points in 1998 due to loss of harvests of poor farmers and rising unemployment among agricultural workers. Using panel data, Scott and Litchfield (1994) provide empirical evidence that the occurrence of localized floods and droughts had regressive distributional effects both across communities and across households within communities in the rural region of Coquimbo in Chile between 1968 and 1986. The main agricultural activities of the region consist of extensive grazing of ruminants and rain-fed agriculture. Because of recurrent droughts, non-irrigated land could not be cultivated and livestock mortality rose because of a shortage of fodder and drought-induced diseases. Poor households were the most affected because they could not afford to buy fodder or relocate animals to summer pastures. As a result, inequality and poverty at the community level increased significantly in Las Tazas due to the cumulative effects of very low rainfall over the years.[31]

In the aftermath of Hurricane Mitch, the Social Investment Fund of Honduras conducted research to update the poverty map according to the effects on the hurricane by using data on destroyed social infrastructure according to geographical area. The result indicated that the poverty rate increased by an estimated 4% on average, with the exception of the 10 municipalities that did not suffer damage from Mitch.[32] On the contrary, results from surveys done in June 1999 in Nicaragua show that the national poverty rate slightly decreased between 1998 and 1999 in spite of Hurricane Mitch. Nevertheless, rural poverty increased by 2.6% in the Central Region due to the impact of the hurricane on agriculture and the region's difficult access, while the Pacific Region benefited from international assistance and the reconstruction process.[33] These ambiguous results show that more research needs to be done to analyze the short-term effects of the hurricane on income as well as longer-term consequences due to the loss of assets.

Many studies[34] emphasize that the role of women in society as caregivers for other family members and their lack of mobility increase their vulnerability to disasters.[35] Research on disaster-related fatalities provides mixed results, as more women than men tend to die in earthquakes, whereas the contrary holds for weather-related events. A potential explanation is that women tend to stay at home (a riskier location in times of earthquakes), whereas men work outside (a riskier location in the event of hurricanes and tornadoes). An empirical study after Hurricane Mitch provides similar conclusions about women's physical vulnerability to disasters. Gomariz (1999) finds that more men than women died in Nicaragua (46/54% as share of total

[30] Main and Williams (1994, p. 38).
[31] Scott and Litchfield (1994).
[32] According to internal documents of the Government of Honduras.
[33] Government of Nicaragua (2000, p.11)
[34] This section draws extensively on Fothergill (1998, pp. 11-21) in Enarson and Morrow (1998).
[35] Unfortunately, most of these studies are on Asia, Africa or developed countries. Given the importance of cultural factors in gender issues, conclusions might not be applicable to Latin America and the Caribbean.

fatalities) and El Salvador (43/57%) because of Mitch (there is no data available for Honduras and Guatemala).[36] The explanation for this disparity seems to be that men were more likely to underestimate risks. Research about risk perception by gender shows that women are more concerned with danger, human suffering and loss of life than men. In the case of natural hazards, studies concluded that women were more fearful of earthquakes than men, while less knowledgeable about the hazard itself.[37] In addition to these behavioral differences, several disaster cases, such as the 1985 Armero mudslide in Colombia, show that relief tasks are usually divided along gender lines, with men in charge of rescue operations or property protection against looting while women shelter children and prepare communal food.[38]

In the recovery and reconstruction phases, women (especially when head of household) are more likely to suffer long-term consequences on their welfare than men, according to several studies in developing and developed countries. In India, when households have to reduce consumption after an adverse shock, girls are more likely to suffer from malnutrition than boys because of biases in the allocation of food among household members.[39] Moreover, women have less access than men to reconstruction jobs and credit. Two years after the occurrence of Hurricane Andrew in the United States, families still needing permanent housing were the very poor—primarily minority women-headed households.[40] In the case of Hurricane Mitch in Central America, the percentage of women living in shelters in the immediate aftermath of the disaster was equal to their proportion in the total population. But this percentage significantly increased as the weeks passed, especially in the case of female-headed households, possibly showing their difficulties in finding permanent housing solutions. According to 1999 estimates from Gomariz, open unemployment for women in Honduras was expected to double in 1999 (to above 9%) while underemployment would reach 60%.[41] Part of this increase in unemployment is due to the fact that many women were employed in activities particularly vulnerable to disasters, such as packaging fruits for exports. They also had less access to food-for-work programs and were relegated to volunteer work despite the fact that many of the affected households are single female-headed. All these facts seem to corroborate the belief that women encounter more difficulties in recovering financially from disasters. At the same time, disasters can also constitute opportunities for female leadership and empowerment, as shown by the fact that more than 30% of the shelters in Honduras were managed by women.[42]

1.2 Risk Trends: Disaster Occurrence and Impact over Time

The previous section has established that the cumulative impact of disaster has been substantial in the region. This section analyzes trends in disaster occurrence and impact, which provides some clues about future risk in the region.

Over the last hundred years, the Latin American and Caribbean region has been affected by an estimated total of 1,309 natural disasters. During the last 30 years alone, the region was

[36] Gomariz (1999, pp. 97 and 161).
[37] Fothergill (1998, p. 14).
[38] Clarke (1992, p. 97) in Kreimer and Munasinghe (1992).
[39] Rose (1999, pp. 41-49).
[40] Fothergill (1998, p. 21).
[41] Inter-American Development Bank (1999a, p. 5).
[42] Gomariz (1999, p. 140).

affected by 972 disasters, i.e., 32.4 disasters annually on average. The distribution along this average frequency is quite wide. Peak years (1988 and 1999) witnessed 60 or more disasters, while low years (1972 and 1975) included only 10. The rate of occurrence of *major* natural disasters—defined here as 1,000 fatalities or 10 million people affected or $1 billion in damages—is much lower than for all disasters. In the last 30 years, 44 major disasters occurred, i.e., an average of 1.5 per year (see Table 1.7 for a list).

Over the century, there has been a noticeable trend of increase in the frequency of disasters, but much of this increase can probably be attributed to the poor quality of data in the first half of the century (see Chart 1.3).

Chart 1.3. Occurrence of Natural Disaster Events in Latin America and the Caribbean by Decade (1900-99)

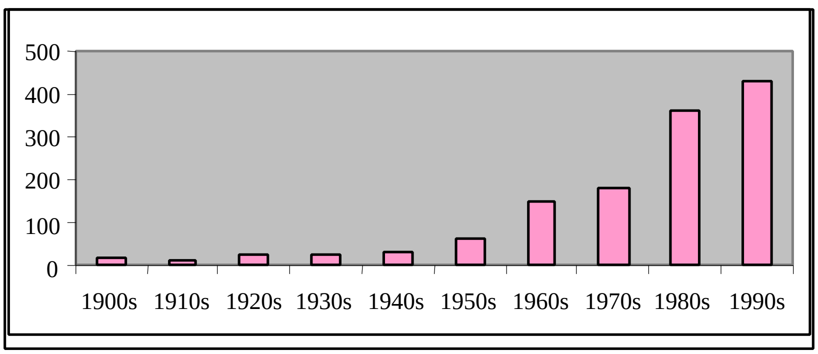


Table 1.7

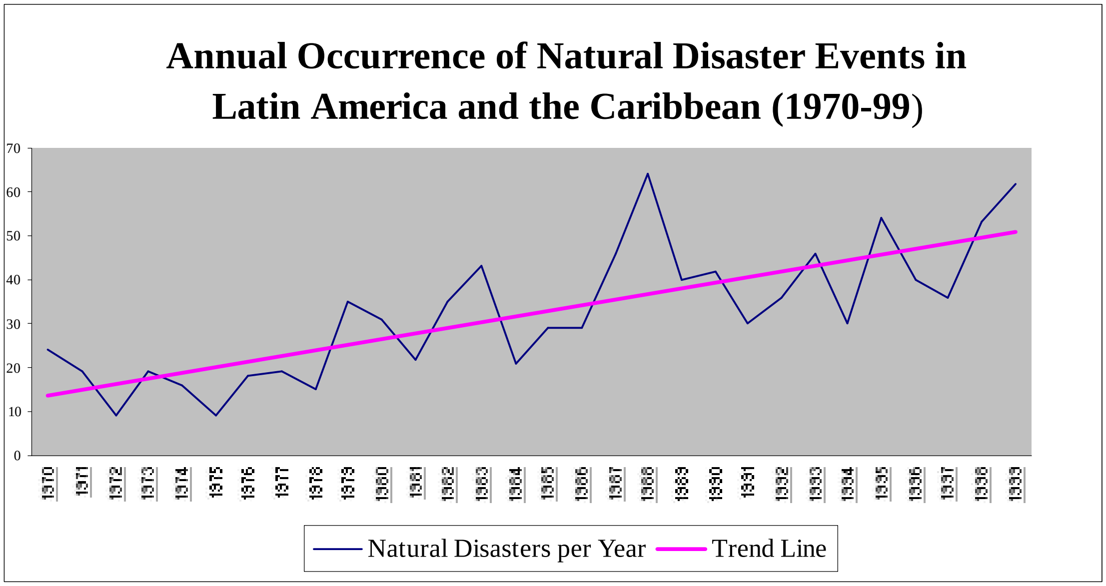
Major Natural Disasters, LAC (1970-99)					
Year	**Country**	**Disaster type**	**Killed**	**Affected**	**Damage US$ 1998 (m)**
1970	Brazil	Drought	n/a	10,000,000	0.4
1970	Peru	Earthquake	66,794	3,216,240	2,225.0
1972	Nicaragua	Earthquake	10,000	720,000	3,293.7
1973	Honduras	Landslide	2,800	0	n/a
1974	Honduras	Hurricane Fifi	8,000	730,000	1,784.6
1975	Brazil	Cold wave	70	600	1,817.0
1976	Guatemala	Earthquake	23,000	4,993,000	2,864.0
1978	Brazil	Drought	n/a	n/a	5,746.5
1979	Dominican Rep	Hurricanes David and Frederick	1,400	1,554,000	336.8
1983	Argentina	Flood	0	5,830,000	1,636.6
1983	Argentina	Flood	0	250,000	1,309.3
1983	Brazil	Drought	20	20,000,000	n/a
1983	Peru	Flood	364	700,000	1,618.3
1984	Brazil	Flood	17	159,600	1,568.9
1984	Brazil	Flood	10	120,400	1,568.9
1985	Argentina	Flood	12	206,000	1,969.4
1985	Chile	Earthquake	180	1,482,275	2,272.4
1985	Colombia	Volcano Nevado del Ruiz	21,800	12,700	1,515.0
1985	Mexico	Earthquake	8,776	130,204	6,059.8
1986	El Salvador	Earthquake	1,000	770,000	2,231.0
1987	Colombia	Earthquake	1,000	n/a	7,168.4
1987	Ecuador	Earthquake	4,000	227,000	1,003.6
1987	Ecuador	Tsunami	1,000	6,000	n/a
1987	Ecuador	Earthquake	4,000	227,000	1,003.6
1988	Brazil	Flood	289	3,020,734	1,378.4
1988	Jamaica	Hurricane Gilbert	49	810,000	1,378.4
1988	Mexico	Hurricane Gilbert	240	100,000	1,860.9
1988	St Lucia	Hurricane Gilbert	45	n/a	1,378.4
1989	NA-Caribbean	Hurricane Hugo	42	33,790	4,706.2
1991	El Salvador	Earthquake	1,000	n/a	n/a
1993	Mexico	Tropical storms Arlene&Beatriz	7	10,000	1,884.5
1994	Haiti	Tropical storm Gordon	1,122	1,587,000	n/a
1995	Virgin Is (US)	Hurricane Marilyn	8	10,000	1,604.6
1996	Mexico	Drought	0	n/a	1,247.1
1998	Argentina	El Niño, flood	19	360,000	2,500.0
1998	Brazil	Drought	0	10,000,000	97.8
1998	Dominican Rep	Hurricane Georges	288	4,515,238	2,193.4
1998	Ecuador	El Niño, flood	322	88,753	2,869.3
1998	Honduras	Hurricane Mitch	5,657	2,112,000	2,000.0
1998	Mexico	Flood	1,256	506,744	n/a
1998	Nicaragua	Hurricane Mitch	2,447	868,228	1,000.0
1998	Peru	Flood	340	580,750	1,200.0
1999	Colombia	Earthquake	1,186	1,205,933	2,837.9
1999	Venezuela	Flood/debris flows	30,000	483,635	1,957.2

Source: CRED (2000).

Note: Affected people are defined as those requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance; individuals are also considered affected when there is the appearance of a significant number of cases of an infectious disease introduced in a region or a population that is usually free from that disease.

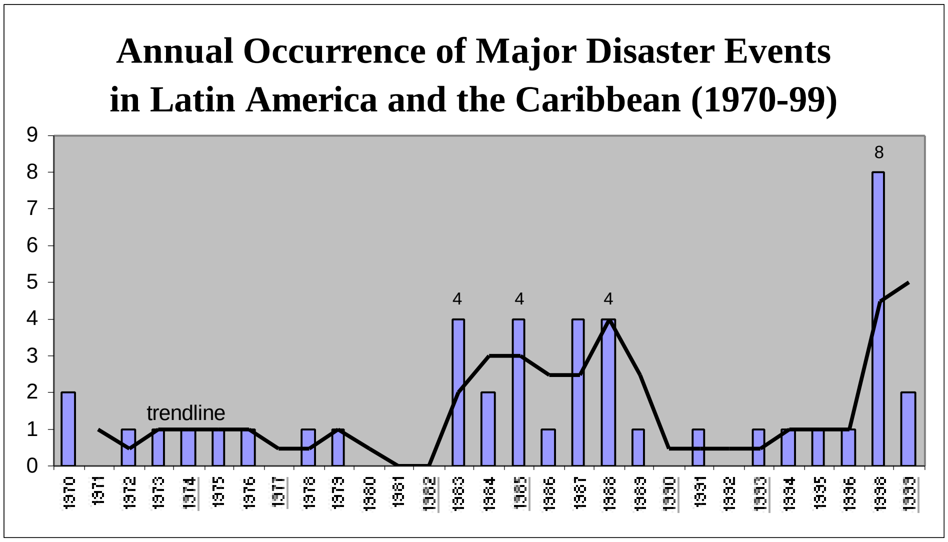
More interesting is the fact that disaster frequency has increased over the last 30 years, as shown in Chart 1.4. The occurrence of disasters by decade has been increasing by 100% between the 1970s and 1980s and 19% between the 1980s and 1990s. During the last ten years, the frequency rate of disaster occurrence reached a record 42.9 per year.

Chart 1.4



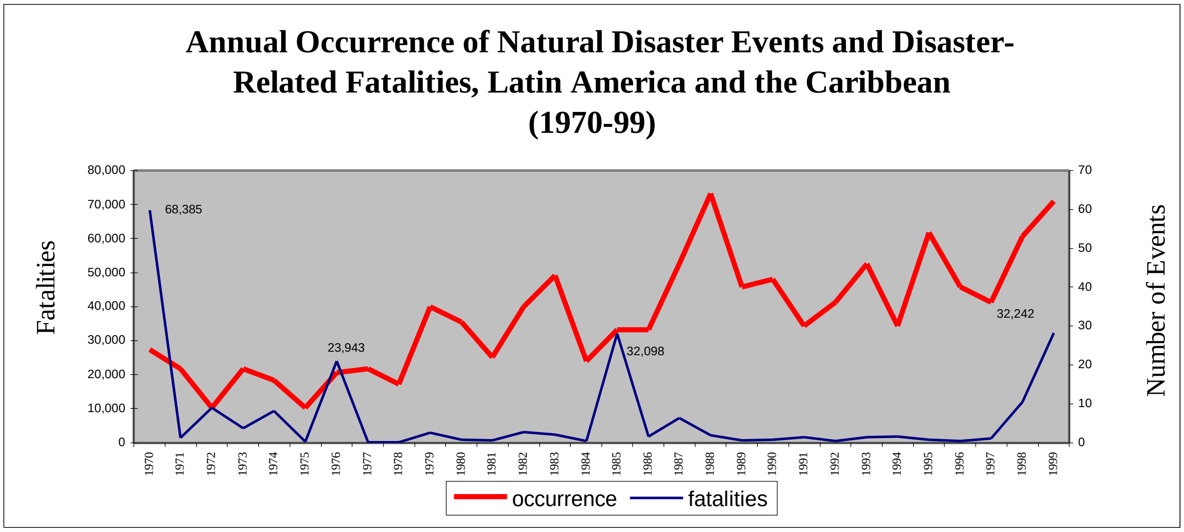
Despite the fact the record year for *major* disasters was 1998, with 8 occurrences, there is no noticeable increase in the number of such disasters between 1970 and 1999 (Chart 1.5). While the number of major disasters in the 1970s was the lowest, the 1980s witnessed on average more major natural disasters than the 1990s.

Chart 1.5



Moreover, it is worthwhile observing that there is no noticeable increase in the number of fatalities associated with disasters and no obvious correlation between disaster occurrence and fatalities at region level (see Chart 1.6).

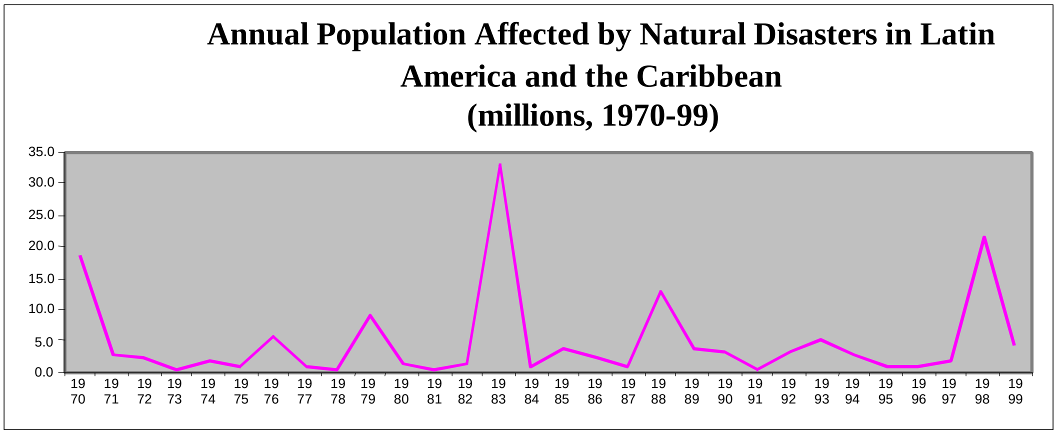
Chart 1.6



The number of fatalities per year does not seem to follow a general pattern, but appears, on the contrary, to be driven by the nature of single disaster episodes, in terms of hazard type, magnitude, and degree of vulnerability of the affected environment. The four peak years are linked with particularly lethal events: the 1970 earthquake in Chimbote, Peru (66,800 deaths), the 1976 earthquake in Guatemala (23,000 deaths) the 1985 volcano eruption in Nevado del Ruiz, Colombia (21,800 deaths) and the 1999 flood and landslides in Venezuela (30,000 deaths). The absence of correlation can also be observed in terms of affected population (Chart 1.7).[43] There were three marked peak years in terms of affected population, each caused by the occurrence of severe drought in several states in Brazil—the most populous country in the region—affecting 10 million people in 1970 and 1998, and a record 20 million in 1983.

[43] Note: Affected people are defined as those requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance; individuals are also considered affected when there is the appearance of a significant number of cases of an infectious disease introduced in a region or a population that is usually free from that disease.

Chart 1.7.



In terms of damages, the CRED data does not show a clear pattern of increase between 1970 and 1999. The two most expensive years during the period 1970-1999 were 1985 and 1998 because of several major disasters. The estimated cost of the 1985 Mexico City earthquake reached a record $6.1 billion in 1998 dollars. That same year, four other major disasters took place whose cost ranged between $1 and $2 billion (the Nevado del Ruiz Volcano eruption, floods in the Buenos Aires province, drought in Northeast Brazil and an earthquake near Concepción in Chile). In 1998, El Niño-related weather phenomena caused $6.6 billion of damages in Argentina, Peru and Ecuador, while Hurricane Georges caused $2.1 billion in damages in the Dominican Republic and Hurricane Mitch produced damages of $2.4 billion in Honduras and Nicaragua.

Given these results, it is quite difficult to pinpoint the cause of this increase in the frequency of disasters. This trend could result from the combination of a heightened vulnerability of assets and a possible increase in hazard frequency and intensity. But it could also stem from better reporting due to the improvement in communications and information capacities in the region, as well as the presence of incentives to report disasters (such as federal or international assistance).

The occurrence trend disaggregated by type of disaster shows that weather-related disasters have increased at a much faster pace than earthquakes (see Chart 1.8). The fact that the occurrence of meteorological disasters increased at a much faster pace than earthquakes could be explained by the fact that earthquake reporting has probably been of a comparatively better quality in the first part of the century than other hazards. It could also be due to a possible increase in vulnerability to meteorological phenomena due to migratory movements towards the coast. But a change in rainfall and hurricane patterns, indicative of a long-term climate change cannot be excluded (see Section 2 for a more extensive discussion of climate change).

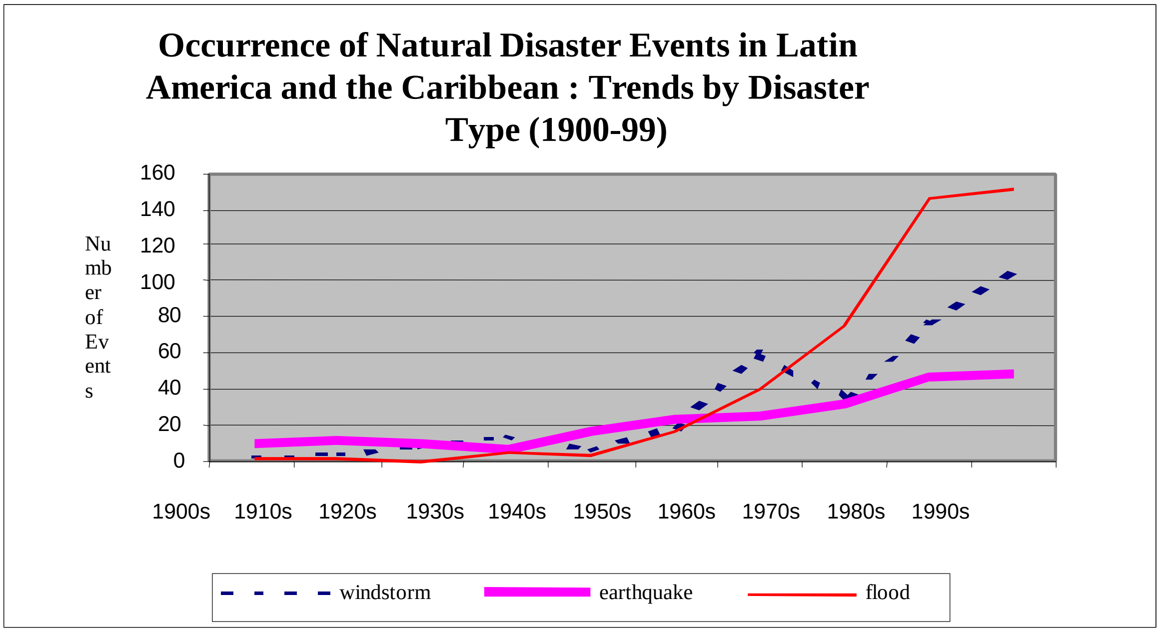


Chart 1.8.

In any case, it does not seem that this increase in frequency is solely a Latin American and Caribbean phenomenon. In fact, the region seems to be following worldwide trends (Chart 1.9). Over the past hundred years, the rate of occurrence of disasters worldwide has been rapidly increasing. The increase has been relatively steady until the last twenty years, when there has been a wider instability. Between 1980 and 1999, peak years (1983, 1987, 1990 and 1998) have almost reached or superseded 300 disasters per year, while lows were close to or under the 200 mark (in 1986, 1989, 1994 and 1996).

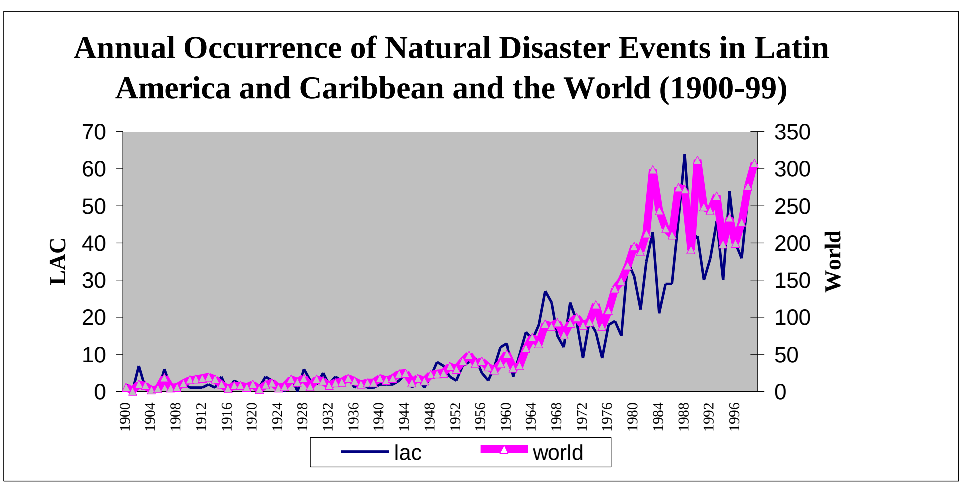


Chart 1.9.

According to the Munich Re group, the number of major natural disasters between the 1960s and 1990s has risen by a factor of three, with economic losses adjusted for inflation multiplied by nine.[44] Of course, part of the trend towards increasing damages can be explained by the improvement of damage assessments. But it also results from the accumulation of assets with economic development and the rise of economic interdependence and globalization, which inflates the costs of disaster-related business interruption.

1.3. The Geographical Distribution of Risk

This section analyzes how risk is distributed inside the region and also compares Latin America to the rest of the world. Such comparisons show that the level, type and frequency of natural disaster risk varies widely across countries, regions and continents, providing a further evidence of the complexity of disaster risk. Exposure to various natural phenomena and degree of vulnerability might vary widely even within a single country. These comparisons also show that disaster occureence and impact is related to the level of socio-economic development. Poorer regions and countries tend to have a higher percentage of fatalities as a share of the total population and higher levels of damages compared with their GDP.

1.3.1 Within Latin America and the Caribbean

The distribution of risk is far from even. Sub-regions and countries in Latin America and Caribbean have different records in terms of disaster occurrence, fatalities, affected populations and damages.

As shown by Table 1.8, 50% of the disasters in the region occur in South America as well as 65% of the fatalities, 75% of the population affected and 53% of total damages. Nevertheless, as shown in Table 1.9, South America's effective exposure to risk might not be as high as in Central America or the Caribbean. Occurrence per thousand km^2 is only 0.3, compared with 10.1 for the Caribbean; Central America has a greater proportion of population killed than South America does (especially if Mexico is not counted) and the Caribbean has a greater proportion of affected population than South America. In terms of damages, cumulative losses for 1970-99 represent only 3.9% of the combined GDP of South American countries, whereas they amount to 43.3% for the Caribbean.

Table 1.8.

Distribution of Natural Disasters in Latin America and the Caribbean by Sub-region (1970-99)

Subregion	Occurrence (%)	Fatalities (%)	Affected (%)	Damages, $1998 (%)
South America	50	65	75	53
Central America	28	33	13	31
Carribean	22	2	12	16
Total	100	100	100	100

[44] Press release, 15 March 1999.

Table 1.9.

Disaster Exposure Indicators in Latin America and the Caribbean by Sub-region (1970-99)				
	Occurrence/ thousand km2	*Share of pop killed per million hab*	*Share of pop affected per thousand hab*	*Cumulative damages as share of 1998 GDP*
South America	0.3%	431.1	322.9	3.9%
Central America	1.2% [1]	555.1 [2]	147.7	7.1% [3]
Caribbean	10.1%	3.8	486.4	43.3%

1. 30% without Mexico; 2. 1,467 without Mexico; 3. 31.8% without Mexico.

Note: Affected people are defined by CRED (2000) as those requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance; individuals are also considered affected when there is the appearance of a significant number of cases of an infectious disease introduced in a region or a population that is usually free from that disease. The shares of population killed or affected are calculated by using the country's 1996 population. Therefore, these figures do not represent the real share of population killed or affected, but a proxy measurement to make comparisons between countries. Methodology from CRED (1997).

The nature of the risk is also different because the three sub-regions of LAC do not face the same type of disasters. Nearly half the disasters in South America have been caused by flooding. The two other important triggering events have been slides and earthquakes, while windstorms only caused 7% of disasters. In the case of the Caribbean, more than half of disasters were due to wind storms, while flooding was the second major natural event causing disasters. Central America is the region that by far faces the biggest variety of disasters, with 31% caused by floods, 26% by wind storms, 19% by earthquakes and 8% by volcanoes.[45]

At the country level, differences are even starker (see Table 1.10). In the Caribbean, the frequency of disasters per year is higher than 1 for Cuba and Haiti. On the other hand, the Bahamas witnessed on average one disaster every 6.7 years, while the Dominican Republic was affected every 1.7 years. In terms of occurrence per km^2, small islands which experienced 5 or more disasters, such as Antigua and Barbuda, the Barbados, St. Kitts and Nevis, St. Lucia and St. Vincent reached the highest ratios, while the Dominican Republic and Cuba, the two countries with the highest number of disasters, had very low ratios compared with their geographical sizes. Five islands had a significantly higher ratio of fatalities as a share of their 1996 population: Dominica, St. Lucia, the Dominican Republic, Haiti and Puerto Rico. Many small Caribbean countries have a high ratio of cumulative losses per 1998 GDP, ranging from 55% (Dominica) to 272.3% (St. Lucia).

In Central America, Nicaragua appears to be the country hardest hit by disasters in the last 30 years. With 26 disasters, which puts the country in the middle range in terms of occurrence and occurrence per km^2, Nicaragua has the highest ratio of fatalities as a share of population, as well as a very high ratio of cumulative losses/GDP (338.4%). By comparison, Costa Rica, which experienced 33 disasters—a high number given its small size—has a fatalities per population ratio 36 times lower, and a loss/GDP ratio 25 times lower. Compared with other Central America countries, Mexico, despite the highest number of disasters, enjoys much lower ratios in terms of occurrence per km^2, fatalities/population and losses per GDP. Belize and

Panama have the best record in the subregion, with a low number of disasters, fatalities and losses, both in absolute and relative terms. The performance of Honduras and Guatemala is similar to that of Nicaragua, but with a lower loss/GDP ratio.

Table 1.10

Disaster Exposure Indicators, Latin America and the Caribbean (1970-1999)							
	Disaster occurrence			***Disaster-related Fatalities***		***Economic losses***	
Country	Total occurrence	Occurrence rate per year	Occurrence/km2	Total Fatalities	Fatalities per thousand hab. (1995)	Constant losses (1998 $m)	Loss as % of GDP (1995)
Carribean							
Antigua & Barbuda	7	0.2	17.5	7	0.1	105.7	18.1%
Bahamas	4	0.1	0.4	5	0.02	290.4	9.5%
Barbados	5	0.2	12.5	3	0.01	148.4	6.3%
Cuba	35	1.2	0.3	181	0.02	578.0	n/a
Dominica	7	0.2	8.8	43	0.6	133.4	55%
Dominican Rep	17	0.6	0.4	1839	0.2	2,657.2	17.3%
Grenada	4	0.1	13.3	0	0.00	30.1	9.5%
Haiti	31	1.0	1.1	2031	0.3	288.7	7.3%
Jamaica	19	0.6	2.6	271	0.1	1,988.1	29.3%
St. Kitts & Nevis	7	0.2	17.5	6	0.2	312.5	116.5%
St. Lucia	8	0.3	13.3	54	0.3	1,554.6	272.3%
St. Vincent	9	0.3	22.5	5	0.04	47.0	16.5%
Trinidad & Tobago	8	0.3	1.6	9	0.01	16.7	0.3%
Montserrat[1]	5	0.2	50.0	43	3.4	323.7	899%
Central America							
Belize	6	0.2	0.3	5	0.02	33.8	5.4%
Costa Rica	33	1.1	0.7	287	0.08	1,117.5	13.4%
El Salvador	16	0.5	0.8	2880	0.5	2,713.9	22.9%
Guatemala	28	0.9	0.06	24139	2.2	3,062.5	17.3%
Honduras	28	0.9	0.3	17347	2.9	4,239.5	82%
Mexico	117	3.9	0.06	15594	0.2	13,822.5	3.60%
Nicaragua	26	0.9	0.2	13067	2.9	5,780.5	338.4%
Panama	15	0.5	0.2	152	0.06	170.0	1.8%
South America							
Argentina	48	1.60	0.02	685	0.02	11,201.0	3.8%
Bolivia	31	1.03	0.03	787	0.10	4,919.9	21.0%
Brazil	102	3.40	0.01	4462	0.03	1,756.7	2.2%
Chile	47	1.57	0.06	997	0.07	16,238.1	6.3%
Colombia	89	2.97	0.09	29857	0.80	4,457.8	11.5%
Ecuador	46	1.53	0.2	7091	0.61	6,824.5	42.5%
Guyana	5	0.17	0.1	0	0.00	29.8	4.6%
Paraguay	16	0.53	0.04	109	0.02	166.1	1.4%
Peru	78	2.60	0.06	72475	2.98	5,988.7	10.3%
Uruguay	7	0.2	0.04	2	0.00	30.0	0.2%
Venezuela	19	0.63	0.02	30446	1.4	2,055.2	2.2%

1. GDP, 97 est., CIA World Fact Book
Source: EM-DAT; World Bank Development Indicators

In the South America sub-region, Brazil has by far the highest occurrence of disasters, with 3.4 disasters per year on average, followed by Colombia and Peru with more than 2 disasters a year. By contrast, Uruguay experienced a disaster every four to five years. Despite a low rate of occurrence given its size, Venezuela has a high ratio of fatalities per population, exceeded only by Peru. The rest of the region has a rather low ratio of fatalities/population. In terms of the relative magnitude of damages, Ecuador has a surprising 42.5% of losses as a share of its 1998 GDP, due to the magnitude of declared losses after the 1987 earthquake and the 1998 El Niño. Only three other countries have a ratio of damages to GDP greater than 10%, Bolivia, Colombia and Peru, while the rest of the countries, including countries experiencing many disasters such as Brazil and Chile, have a fairly low ratio, between 0.1 and 6.3%.

These country indicators have to be interpreted with caution due to the limitations of the data. Nevertheless, they clearly corroborate the positive correlation between poverty incidence and vulnerability to disasters and the negative correlation between country size and economic vulnerability to disasters.

1.3.2 The Latin American and Caribbean Region and the World

Between 1970 and 1999, Latin America and the Caribbean experienced 16.3% of the 5,970 natural disaster events recorded worldwide. Compared with other continents, the Americas (excluding North America) rank second after Asia in terms of total disaster occurrence over the 1970-1999 period. Over the last ten years, Latin America faced an average of 42.9 disasters annually and Asia 100.2, with the worldwide frequency rate reaching 215.5 (Table 1.11).

Table 1.11

Cumulative Natural Disaster Occurrence and Human Impact by Continent (1970- 1999)

Continent	Number of Events	Disaster-related Fatalities	Fatalities per million hab.[1]	Population Affected (m)	Affected population (%).[1]
Asia	2330	1,459,318	393.8	3659.0	98.8%
Americas:	1476	237,529	290.2	160.3	19.6%
LAC	972	226,164	442.3	148.1	29%
North America	504	11,365	37.0	12.2	4%
Africa	851	1,699,863	2217.4	317.2	41.4%
Europe	772	46,299	49.2	301.3	32%
Oceania	541	4,962	165.4	198.3	661%
Total	5970	3,447,971	n/a	4186.4	78.7%

1. Using 1999 population figures. UNFPA (2000).

With regard to the total number of disaster-related fatalities, the Americas (excluding North America) seem to have the best record among developing regions, with only Europe, North America and Oceania achieving lower total fatalities. However, when considering fatalities as a share of total population,[46] Latin America ranks second among developing regions,

[46] 1999 world population figures were used to calculate the share of population killed by disasters, UNFPA (2000).

with 442 deaths per million, after Asia (392), but well before Africa (2,217). Statistics on affected population indicate that the Latin American and Caribbean region has fewer affected people, both in absolute terms and relative to its total population.[47] It is not surprising that Africa has more affected people, simply because it experiences more droughts than LAC; droughts represent 35% of total disasters in Africa and only 6% in LAC. The fact that Asia has many more affected people, even in relative terms cannot be explained by a difference in disaster type, but instead possibly by its higher average population density in hazard-prone areas. Floods and droughts alone (37% of disasters) affected three billion people in Asia over the 1970-1999 period.

Statistics on damages for the period 1990-98[48] show that the total amount of reported direct damages worldwide reaches $715 billion in constant 1998 dollars. Damages in Latin America and the Caribbean represent only 3.8% of the total amount of damages while the region contributes an estimated 6% to the world's GNP.[49] In terms of damage ranking, the region comes after East Asia[50] (40.5%), North America (20.5%), the Russian Federation (12.7%), South East Asia, South Asia, and the European Union (around 6% each). Regions below the level of Latin America and the Caribbean are Oceania, the rest of Europe, West Asia and all African regions. These results are confirmed by continent statistics from Munich Re for the period 1985-1999. The main difference is that damages in Latin America and the Caribbean represent only 1.2% of total reported damages (compared with 3.8% according to CRED data). Only the African continent fares better, with just 0.07% of worldwide damages. These results seem to confirm the assumption of a positive correlation between development and reported damages. Another explanatory factor is that reported damages tend to rise as a function of insurance coverage due to better asset valuation and financial incentives for reporting damages.

In terms of insurance coverage, statistics from Munich Re indicate that only 3.8% of the damages in Latin America and the Caribbean were insured, ranking last among the regions of the world (See Table 1.12). The fact that developed regions fare better than Latin America and the Caribbean can be easily explained, as insurance penetration is linked with GDP per capita.[51] But the better coverage of Africa compared with Asia and Latin America casts some doubt on the reliability of the data. This result might be due to the fact that underreporting of total damages (including assets of the poor) is even more important in Africa than Asia and Latin America. Nevertheless, the absolute amount of insurance coverage is still higher in Africa than Latin America, while their contributions to the world's GNP, which provides an indication of assets at risk, are 1.8% and 6%, respectively.[52]

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[47] Asia had 99% of its population affected, Africa 41% and LAC 29%. These figures do not mean that 99% of the current population; instead, they take the total 1998 population as a proxy for the period 1970-99. In addition, the same individuals tend to be repeatedly affected by disasters.
[48] This section studies only the period 1990-1998 in order to limit underreporting issues.
[49] Estimate calculated by using World Bank (1998, p. 38).
[50] Composed of China, Hong Kong, Japan and the Koreas.
[51] World Bank (1999, p. 26).
[52] Estimate calculated by using World Bank (1998, pp. 38, 42 and 43).

Table 1.12

Insured Losses by Region, 1985-1999		
	Insured losses ($m)	**% of total losses**
North America	116,940	34.5%
Europe	29,990	26.7%
Oceania	4,330	25.7%
Africa	610	8.9%
Asia	17,640	4.3%
LAC	420	3.9%

Source: Munich Re, Topics 2000: Natural Catastrophes-the Current Position, p.64.

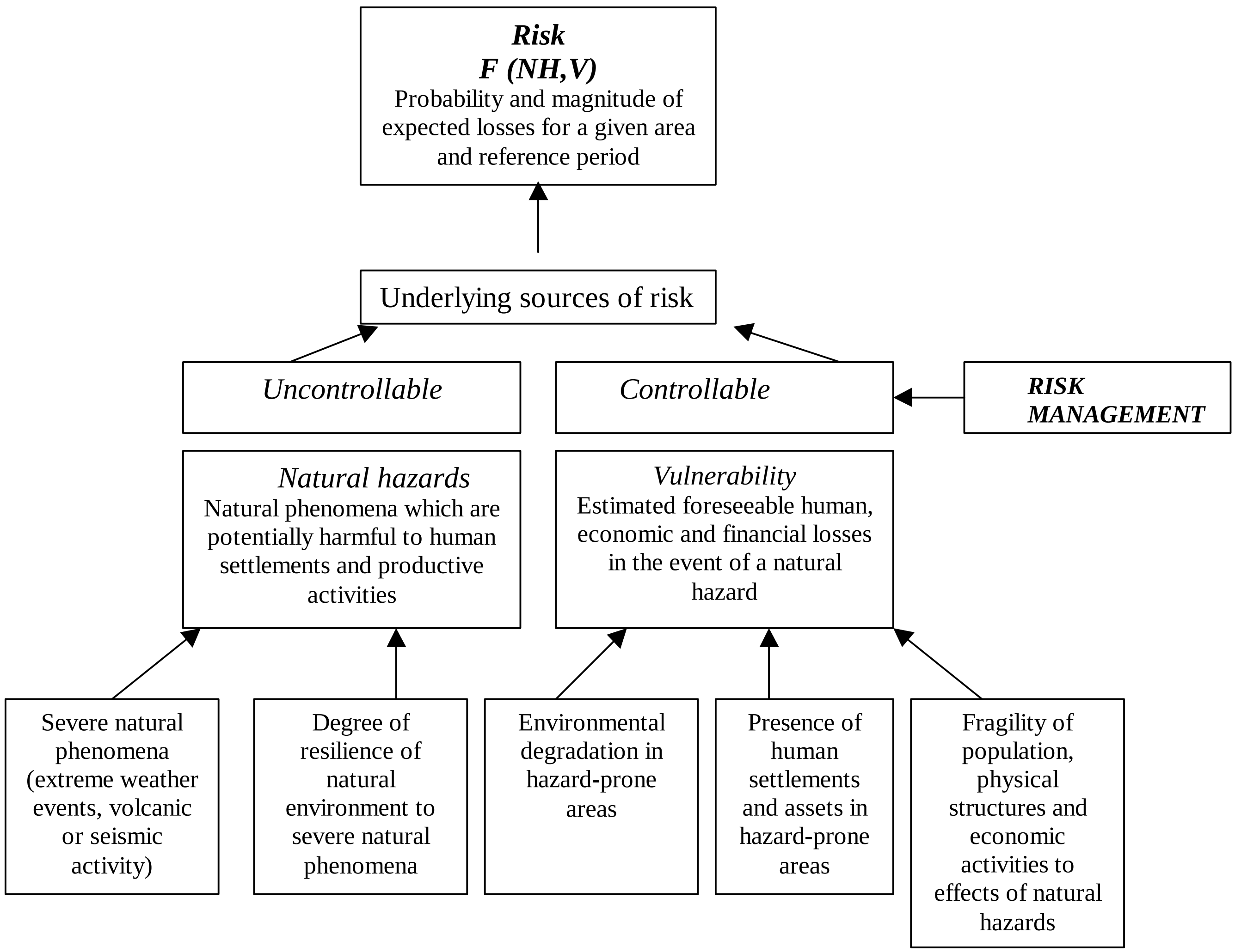
2. Sources of Natural Disaster Risk in Latin America and the Caribbean

Through the analysis of the specific sources of natural disasters in the region, this section shows that disaster occurrence in the region is as much the result of the unavoidable effects of the region's geographical conditions as a side effect of the pattern of regional development and inadequate policies. This duality of risk has important policy implications.

2.1. Sources of Disasters: A Conceptual Framework

From the point of view of risk analysis, natural disasters are the manifestation of a risk, which can be defined as the probability and magnitude of expected human and economic losses due to a particular natural hazard for a given area and reference period. Risk is a function of two factors: natural hazards and vulnerability (see Figure 2.1). Both elements constitute necessary conditions for the existence of risk. For instance, out of the 100,000 earthquakes recorded every year, only those that hit densely inhabited areas without earthquake-resistant infrastructure can become disasters.

Figure 2.1. Conceptual Framework of Risk



2. 2 Natural Hazards Occurrence in Latin America and the Caribbean

2.2.1 Natural Hazards: General Characteristics

Natural events likely to cause disasters can be of meteorological, hydrological, or geological origins. The main natural hazards are earthquakes, volcanic eruption, floods, droughts, hurricanes and other storms, landslides and forest fires. Others include tsunamis, tornadoes, lahars, avalanches, sharp temperature changes, etc. (See Box 2.1 for definitions.) While most events are the direct cause of destruction, some natural phenomenon can trigger associated hazards. For instance, hurricanes can cause landslides and volcanic eruptions, lahars. Similarly, El Niño is a change in the sea temperature: by itself it does not create a hazard, but it is estimated to be the direct cause of changes in rainfall patterns, which in turn cause floods and droughts. The succession of several hazards in a short period of time can also contribute to magnifying their effects, as in the case of Hurricane Mitch, when droughts and forest fires in early 1998 increased ecological vulnerability to flooding.

Box 2.1: Definition of Selected Natural Hazards

Geologic Hazards

An **earthquake** is a sudden vibration in the earth that occurs due to the friction of large rock masses along faults, tectonic plate boundary zones or along the mid-oceanic ridges.

A **tsunami** is a wave train, or series of waves, generated in a body of water by an impulsive disturbance (such as earthquakes) that vertically displaces the water column. Tsunamis may reach a maximum vertical height onshore above sea level, often called a run-up height, of 10, 20, or even 30 meters.

Slides are a downslope movement of soil, rock, mud or snow because of gravity. One of the most common sources of slides is prolonged or heavy rainfall. Earthquakes are another common mechanism that can trigger mass movement since seismic waves produced by earthquakes vibrate slope materials.

Lahars are mudflows caused by the melting of the icecap of a volcano by lava or the run off of ash downhill caused by rainfall.

A **volcanic eruption** is the process wherein volcanic materials such as lava, fragmented rocks or gases are emitted or ejected through a crater, vent or fissure onto the earth's surface to form new deposits.

Weather-related hazards

Hurricanes and tropical storms are large-scale closed circulation system in the atmosphere with low barometric pressure and strong winds that rotate counter clockwise in the northern hemisphere and clockwise in the southern hemisphere.

Floods are a temporary inundation of normally dry land with water, suspended matter and/or rubble caused by overflowing of rivers, precipitation, storm surge, tsunami, waves, mudflow, lahar, failure of water retaining structures, groundwater seepage and water backup in sewer systems.

Drought is a lack, or insufficiency, of rain for an extended period that causes a considerable hydrologic imbalance and, consequently, water shortages, crop damage, streamflow reduction, and depletion of groundwater and soil moisture. It occurs when evaporation and transpiration (the movement of water in the soil through plants into the air) exceed precipitation for a considerable period.

Forest fires are uncontrolled fires occurring in vegetation more than 6 feet (1.8 m) in height. These fires often reach the proportions of a major conflagration and are sometimes begun by combustion and heat from surface and ground fires.

Sources:

IDNDR (1992); Bell (1999); Swiss Re (1988, p.16); Pidwirny (1999); and Encyclopedia Britannica [http://www.britannica.com].

The severity of natural hazards can be assessed by their physical magnitude, which usually describes the intensity of the phenomenon. In the case of earthquakes, the Richter Scale measures the strength and depth of the seismic shock. Hurricanes are ranked on the Saffir-Simpson scale according to the speed of winds and atmospheric pressure inside the hurricane. Flood indicators measure the deviation between measured rainfall/river level and annual averages. Other important indicators of the magnitude of a natural hazard are its duration and degree of suddenness. As shown in Section 1, hazards such as hurricanes, earthquakes and volcanic eruptions are sudden and generally last only a few minutes, hours or days.[53] On the other hand, floods (except for flash floods or storm surges), droughts and temperature changes are more progressive phenomena, which can span for several weeks or even months. The size of geographical coverage is another important factor in the magnitude of the hazard. For instance, the path and size of a hurricane provide important clues about the severity of its impact. Finally,

[53] Earthquake aftershocks and volcanic activity can sometimes occur up to a few months after the main event.

it is important to differentiate natural hazards from normal climatic or geological conditions. Low rainfall, leading to drought, becomes a natural hazard when it is an anomaly compared with average annual rainfall in a given area.

Natural hazards can be defined as exogenous since their occurrence is not related with, or within, the control of human activity. Nevertheless, human-caused pollution of the atmosphere is believed to be one of the causes of global warming, which is expected to have effects on the probability of occurrence of extreme weather events. Moreover, human activity has an impact on the magnitude of certain hazards. For instance, propensity to flooding can be increased by deforestation, soil erosion, and urbanization, which reduce the rainfall absorption capacity of the soil.

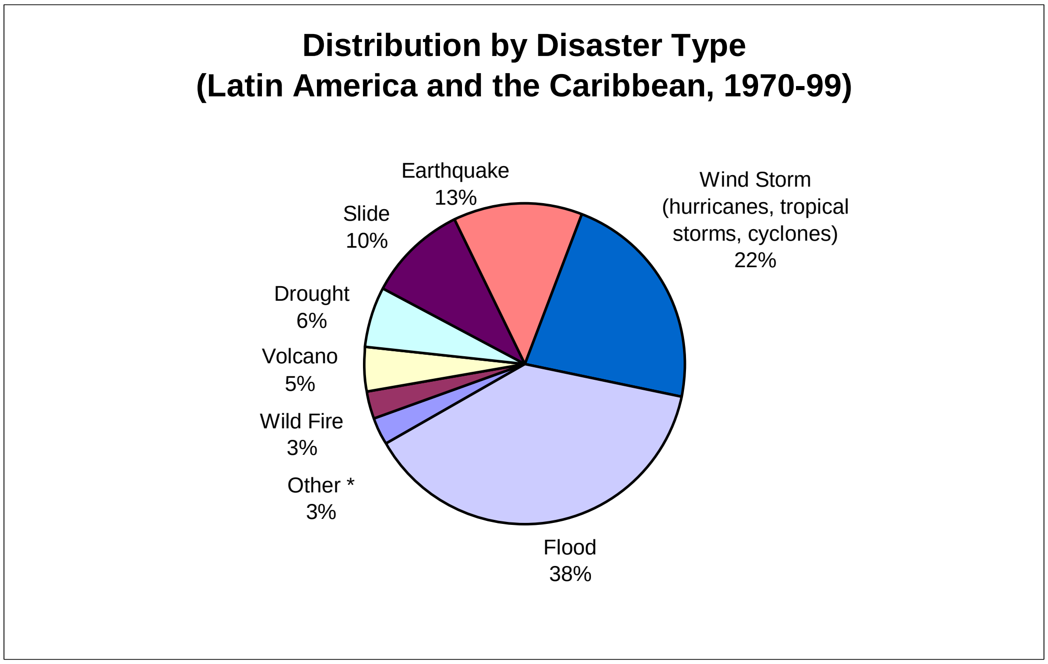
2.2.2 Natural Hazards in Latin America and the Caribbean

2.2.2.1 Hazard Distribution and Relative Impact in the Region: Some Empirical Evidence

From 1970 to 1999, more than 70% of natural hazards that resulted in disasters were of meteorological origin, the remaining 30% resulting from geological phenomena.[54] Within the category of weather-related phenomena, floods were the most important trigger of disasters, followed by wind storms, droughts and wild fires. On the geological side, earthquakes were the most important triggers, followed by slides (both mudslides and landslides) and volcano eruptions (Chart 2.1).

[54] It is important to emphasize that the data below only includes those natural hazards that resulted in a disaster. Therefore, it does not give indication about the distribution of all hazards. Another shortcoming is that disasters are here classified according to the triggering primary event, and not associated phenomena. For instance, a landslide caused by hurricane-related intense rainfall will be classified as a hurricane.

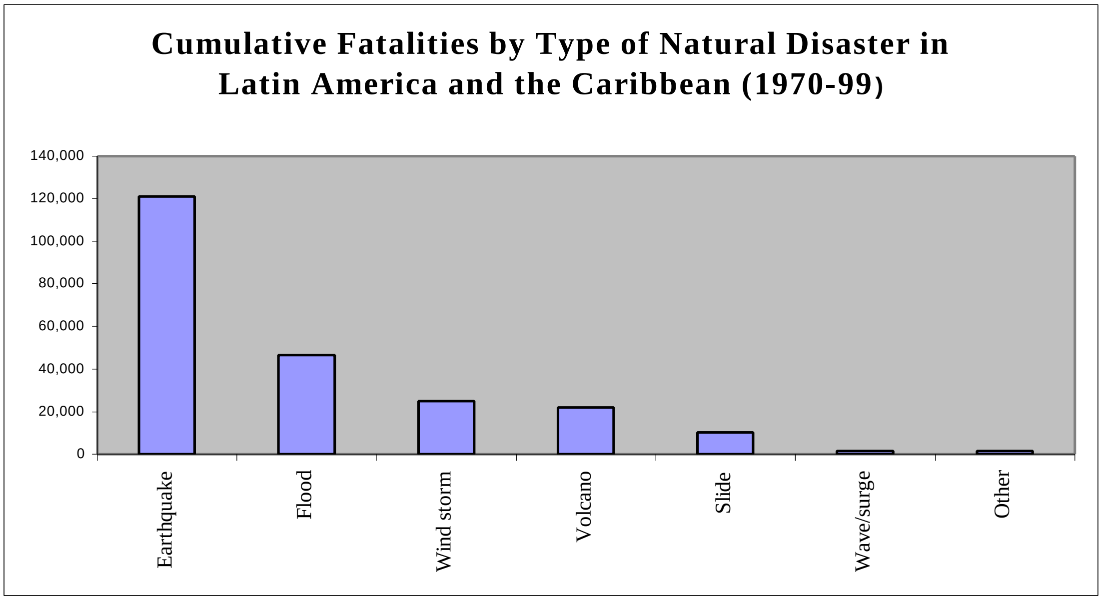
Chart 2.1



Source: Data from CRED (1999).
*Famine, insect infestation, wave/surge and extreme temperature.

Between 1970 and 1999, earthquakes were the deadliest type of disasters causing 53.4% of the total fatalities in the region (Chart 2.2). This is not due to the fact that there were many earthquakes, but that these phenomena tend to have a very high ratio of fatalities per event. In the case of Latin America and the Caribbean, the death/occurrence ratio between 1970 and 1999 was 950, whereas for floods and windstorms the ratio was around 100. Given their higher rate of occurrence, floods and windstorms still end up ranking second and third as the cause of disaster-related fatalities with 20.5% and 11% of total fatalities respectively. Though rare, catastrophic volcano eruptions caused 10% of total fatalities, due to a fatality/occurrence ratio of nearly 500.

Chart 2.2



*Note: "Other" includes famine, insect infestation, wave/surge and extreme temperature.

Droughts affected 58 million people between 1970 and 1999 in the LAC region, while floods affected 44 million, windstorms 25 million, and earthquakes 18 million. These results derive from the nature of these various phenomena in the region (for instance, droughts affecting large parts of Brazil) and their respective rates of occurrence. The fact that wind storms and earthquakes affected fewer people is linked to the fact that these phenomena are generally smaller in terms of geographical coverage than floods or droughts (Chart 2.3).

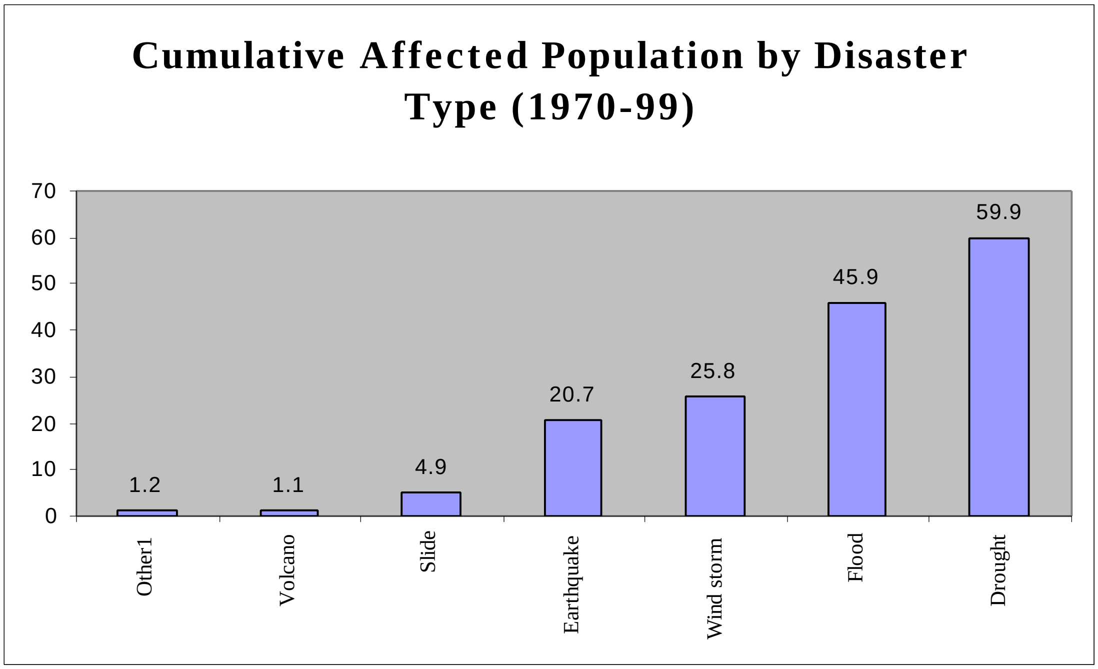


Chart 2.3

1. "Other" includes famine, insect infestation, wave/surge and extreme temperature.

The most expensive disasters, in terms of cumulative cost during the 1970-1999 period, were floods, followed by windstorms and earthquakes and droughts. When the average cost per event is considered, earthquakes turn out to be the most expensive, followed by windstorms, droughts and floods (Table 2.1).

Table 2.1

Economic Losses due to Disasters in LAC, 1970-99, $ constant 1998		
Disaster Type	**Cumulative cost ($bn)**	**Average cost per event ($m)**
Flood	31.8	85.8
Wind storm	27.2	126.0
Earthquake	25.9	203.6
Drought	10.4	179.9
Other	2.9	14.6

2.2.2.2 Sources of Natural Hazards in the Region

Seismic, Volcanic and Geologic Hazards

Sitting atop five tectonic plates, Latin America and the Caribbean is a region prone to intense seismic activity. Seismicity is concentrated along the South American, Caribbean, Cocos and Nazca plate boundaries (see Maps 1 and 2). According to historical catalogs, about 3,000 earthquakes with a magnitude greater than 5.0 were recorded in South America between 1900 and 1981, and 120 in Central America, Caribbean and Mexico between 1900 and 1979.[55] As a matter of comparison, the energy released by a 5.0 magnitude earthquake is equivalent to the

[55] USGS (2000).

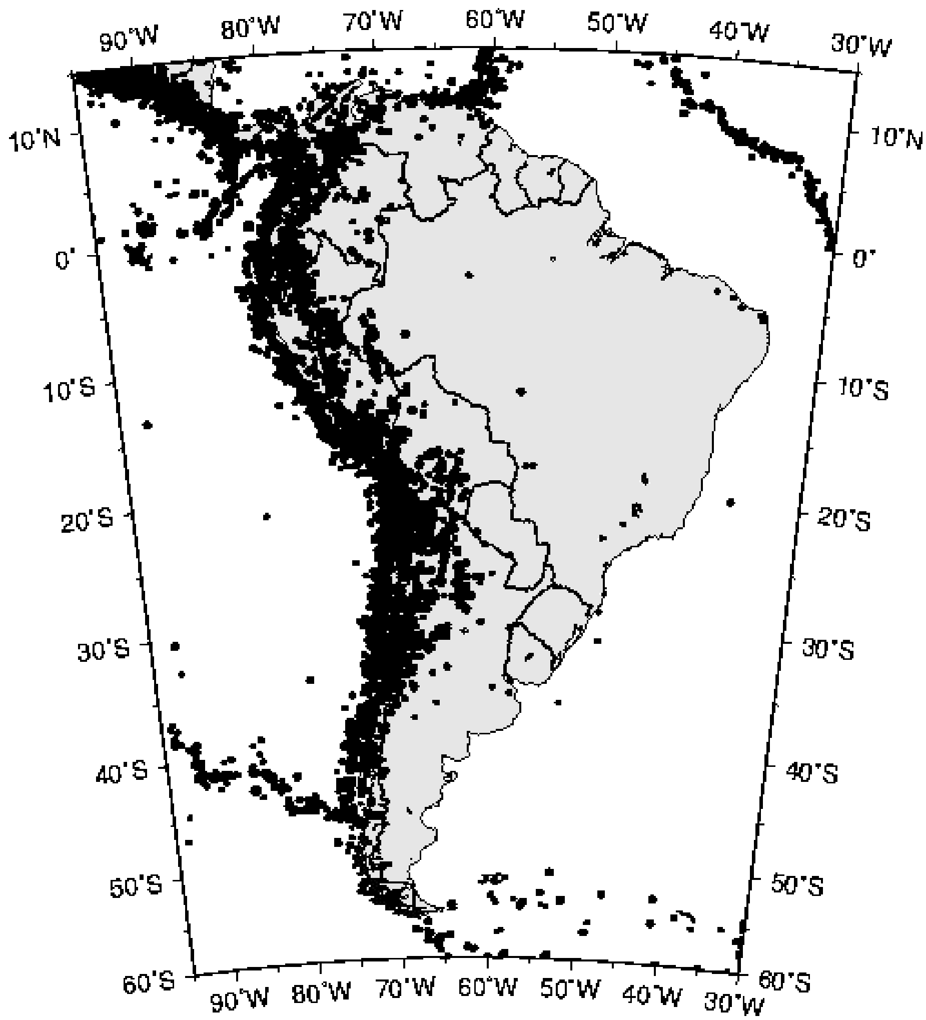
energy created by the Hiroshima Bomb.[56] The largest earthquake ever recorded in the Americas occurred in the South of Chile, reaching 8.5 on the Richter scale (See Box 2.2). Several earthquakes with magnitudes superior to 8 have been recorded over the last 100 years along the coasts of Ecuador (1906), Chile (1906, 1922, 1943 and 1960) and Peru (1940, 1942, 1966, and 1974).[57]

[56] Pidwirny (1999).
[57] Shedlock and Tanner (1998).

Map 1. Tectonic Plates and Fault Lines in the Americas

Source: Swiss Seismological Service
`http://seismo.ethz.ch/gshap/paigh/shedams_1.gif`

Map 2. Concentration of Seismic Activity in Central and South America



Source: Swiss Seismological Service,
`http://seismo.ethz.ch/gshap/paigh/shedams_5.gif`

Box 2.2. The 1960 Earthquake in Chile

The most powerful earthquake of this century happened in May 1960 in South Chile. This earthquake, which yielded a magnitude of 8.5 on the Richter scale and a 9.5 on the moment magnitude scale (Mw), was caused by the downward movement of a subducting oceanic plate over 1,000 km in length. The epicenter of the earthquake was 60 meters below the ocean floor about 100 miles off the coast of the South of Chile in the Pacific. The cities closest to the epicenter, such as Valdivia and Puerto Montt, suffered extensive devastation, as well as other regions of Chile, up to Valparaiso. The death toll, amounting to 5,700 people, was relatively modest compared with the violence of the earthquake. It was due to the fact that the earthquake occurred at daytime and that most people vacated buildings after feeling the powerful foreshocks. Due to the violence of the seismic shock, huge landslides and flows of debris and rock were sent tumbling down mountain slopes. Some landslides were so enormous that they changed the course of major rivers or dammed them up, creating new lakes. The land along the coast of Chile, particularly in the Port city of Puerto Montt, sank as a result of the movement of the ground during the quake and the coastal city was flooded with ocean water. Finally, several tsunamis formed in the ocean, causing destruction and fatalities in the Philippines, Japan and Hawaii.

Sources: *Time Magazine*, July 4, 1960; Website of the Department of Civil Engineering at the University of Washington
[http://tsunami.ce.washington.edu/tsunami/general/historic/chilean60.html]

As many as 95% of the earth's 550 historically active volcanoes are located along plate subduction zones or at the mid-oceanic ridges. Latin America has 250 historically active volcanoes and has witnessed 1,300 volcanic eruptions in the last 10,000 years.[58] With a current total of 204, South America has more active volcanoes than any other region of the world. Its volcanoes are located on the western side of the continent, along the South American, Nazca and Cocos plates, in three distinct volcanic belts.[59] The region is second only to Japan in terms the number of volcanoes with dated eruptions and matches Japan in terms of the number of documented eruptions over the past 200 years with a Volcanic Explositivity Index (VEI) greater than 4. Chile has the largest number of historically active volcanoes in the region, followed by Ecuador. In Central America and Mexico, there are 36 active volcanoes produced by the subduction of the Pacific oceanic crust beneath the North American and Caribbean plates.[60] Volcanic activity in that region has been very important in the last 25 years. In 1999-2000 alone, three of Central America's volcanoes—Pacaya (Guatemala), Cerro Negro and San Cristobal (Nicaragua)—have erupted.[61] In the Caribbean, the Lesser Antilles, formed by the subduction of the oceanic crust moving westward from the Mid-Atlantic ridge, are also a volcanically active area with a total of 7 active volcanoes, including the recently active Soufriere Hills in Montserrat.[62]

Tsunamis—tidal waves—usually arise in the Latin American and Caribbean region because of powerful earthquakes off the Pacific Coast. 61 of the 405 tsunamis recorded in the Pacific basin between 1900 and 1983 originated from the West coast of Latin America.[63] Following the 1960 Chile earthquake (see Box 2.2), a tsunami caused 200 fatalities in the coastal

[58] OAS (1990, Chapter 11, p .41).
[59] Simpkin, Siebert *et al.* (1994).
[60] Simpkin, Siebert *et al.* (1994).
[61] Smithsonian Institution (1999-2000).
[62] Simpkin, Siebert *et al.*(1994).
[63] OAS (1990).

area. More recent episodes include tsunamis in Nicaragua (1992, 170 fatalities) and Peru (1996, 12 fatalities).[64]

Landslides, mudslides and lahars are geological natural hazards, which are fairly common in Latin America due to the nature of soils and topography. The lahars created by the eruption of Nevado del Ruiz in Colombia in 1985 caused the deaths of 21,800 people. A rock and snow avalanche triggered by an earthquake in the region of Chimbote, Peru, caused more than 20,000 fatalities, completely destroying the communities of Yungay and Ranrahirca.[65] More recently, intensive rainfall caused deadly landslides in Venezuela (see Box 2.3).

Box 2.3. The 1999 Floods and Debris Flows in Venezuela

Unusually heavy rainfall in December 1999 triggered a disastrous chain of events in the several states of Venezuela, in particular in Vargas and Miranda. In the worst-hit areas, more than twice the average annual rainfall, which ranges between 400 and 900 mm, fell in the span of 72 hours. This heavy precipitation resulted in flash floods, fluvial torrents and debris flows, as well as landslides in densely populated areas. Major infrastructure including dikes, bridges, drains, and dams were undermined or destroyed, feeding into the flows.

It is estimated that 30,000 people were killed, 600,000 affected and 114,000 homeless. 64,700 houses were damaged and another 23,000 destroyed. Roads, hospitals, schools suffered extensive damage in the regions affected. The estimate of the total damage ranges between $2 and $9 billion. Major factors that contributed to the magnitude of the disaster included erosion along the coastal belt and basins, as well as concentration of population both on steeply sloped hillsides and flat ground areas directly below these hillsides.

Source: Inter-American Development Bank (1999); Venezuela Floods Fact Sheet #11, 4 February 2000, USAID/BHR/OFDA; Oxford Analytica Brief, Venezuela: Disaster Impact, January 20, 2000.

Note: Affected people are defined by CRED (2000) as those requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance; individuals are also considered affected when there is the appearance of a significant number of cases of an infectious disease introduced in a region or a population that is usually free from that disease.

Meteorological and Hydrological Hazards

There are several climate zones in the region, with different rainfall patterns and associated propensity to floods, hurricanes and droughts.

Mexico, Central America and the Caribbean are in the pathways of both western Atlantic and Eastern Pacific hurricanes and tropical storms. According to the US National Hurricane Center database, 985 Atlantic hurricanes and tropical storms have been recorded between 1886 and 1996, as well as 701 Pacific storms between 1949 and 1996. Long-term average annual

[64] Website of the Department of Civil Engineering at the University of Washington: http://tsunami.ce.washington.edu/tsunami/general/historic/chilean60.html

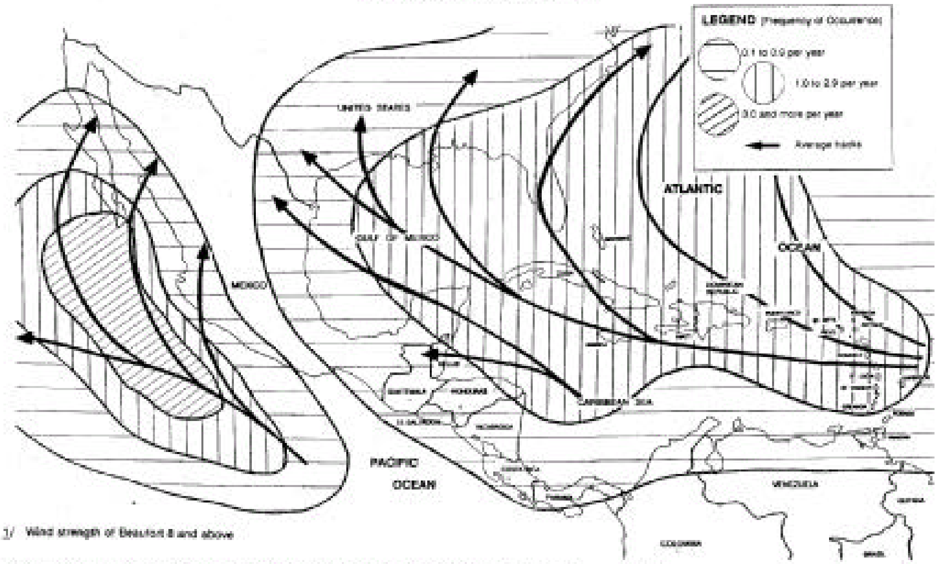
[65] Bell (1999, p. 71).

occurrence is 10 for Atlantic hurricanes and 16 for the East Pacific. During the 1990-99 period, 10.9 hurricanes occurred in the Atlantic, with peak years in 1994 and 1995.[66]

[66] National Hurricane Center, NOAA (1999). ftp://ftp.nhc.noaa.gov/pub/tracks/tracks.atl.

Map 3

OCCURRENCE OF TROPICAL STORMS AND CYCLONES
IN THE WESTERN HEMISPHERE 1/



1/ Wind strength of Beaufort 8 and above

Source: Munchener Ruck, Mapa Mundial de los Riesgos de la Naturaleza. (Munich, Federal Republic of Germany, Munchener Ruckversicherungs: 1988)

The magnitude of hurricanes is assessed with the Saffir-Simpson Scale, which takes into account maximum sustained winds and minimum storm pressure. A category 5 hurricane, Hurricane Mitch was one of the most powerful Atlantic hurricanes, with 290 km/hr winds and a minimum storm pressure of 906 mb, and had quite a long life span (14.5 days), which explains why it turned out to be the deadliest of the century. According to historical records, despite its 11,000 fatalities, Mitch was not the deadliest of all Atlantic hurricanes: in 1780, a hurricane killed an estimated 22,000 people in Martinique, St. Eustatius and Barbados.[67]

Floods are the most common natural hazard in the region—and the world—and are a function of the climate (variability in rainfall pattern, occurrence of storms) as well as hydrology (shape of river beds, intensity of drainage, and debit flow of rivers) and soil characteristics (capacity of absorption).

In Central America and the Caribbean, the weather is dominated by storms that develop along the intertropical convergence zone and the subtropical high-pressure zone. Given these patterns, flooding is usually associated with hurricanes and other tropical storms, which generate heavy rainfall in a few days. A major factor in the occurrence of floods in the South American region is El Niño. An anomalous warming of the Central Equatorial Pacific ocean, El Niño results in higher rainfall in Peru and Ecuador, Argentina, Paraguay and South Brazil. El Niño events occur every three to seven years. The 1982-83 and 1997-98 El Niños were the strongest recorded warming events of the Pacific Ocean of the twentieth century. The damages caused by the 1997-98 El Niño were by far the most extensive, amounting to 34 billions of dollars worldwide.[68]

The hydrological system in the region also contributes to risks of flooding. The major drainage divide is far to the west along the crest of the Andes. West from this divide, in the mountainous regions, slopes of the riverbeds are very steep, which, in the event of storms, increases risk of the most dangerous type of floods, flash floods. The major basins lie east of the Andes, and the main rivers flow to the Atlantic Ocean. The four largest drainage systems—the Amazon, Río de la Plata (Paraguay, Paraná, and Uruguay rivers), Orinoco, and São Francisco—cover nearly three-fourths of the continent. In the lower parts of these intensive drainage systems, as flows from tributaries meet, the risk of flooding is very high, especially when there is sedimentation or when river channels are not well defined.

Seasonal drought occurs in climates that have well-defined annual rainy and dry seasons. The arid (Northeast Brazil, Mexico) and cold climate zones (South Chile) in the region have a higher propensity to drought episodes. In these areas, the risk of desertification is high when prolonged period of drought are coupled with environmental degradation.[69] In the region, several parts of Chile and Argentina are at severe risk of desertification due to overgrazing, improper use of water and deforestation. Unpredictable drought involves an abnormal rainfall failure; it may occur almost

[67] Rappaport and Fernández-Partagas (1995).
[68] Swiss Re (1998, p. 9) and WMO (1999, pp. 35, 37 and 61).
[69] Bell (1999, p. 436).

anywhere but is most characteristic of humid and subhumid climates. In the region, the most important trigger event of this type of droughts is El Niño, which results in dryer conditions in North East Brazil during the Northern Hemisphere winter. During the Southern Hemisphere winter, the climatic impact of El Niño is drier conditions in Central America, Colombia and Venezuela.[70]

Forest fires are associated with the dry season and drought conditions. But many forest fires are the result of human intervention, usually for land clearing purposes. The danger of fire in a wilderness setting varies with weather conditions: drought, heat, and wind participate in drying out the timber or other fuel, making it easier to ignite. Topography also affects wilderness fires, which spread quickly uphill and slowly downhill. The type of vegetation and degree of humidity are also important factors: dried grass, leaves, and light branches are considered flash fuels.[71]

2.2.3 Future Hazard Occurrence in the Region: The Impact of Climate Change

An important component in the assessment of the probability of occurrence of future natural hazards in the region is whether global warming can be expected to have an impact on the occurrence of disasters.

Over the past 150 years, there has been a rise in the average global temperature at the Earth's surface paralleling a significant increase in greenhouse gases in the atmosphere that has been interpreted by scientists as an indication of a global climate change.[72] A further increase in the earth's temperature would contribute to a further rise in sea level, endangering coastal zones, by making them much more vulnerable to surge flooding in the events of storms or hurricanes, high tides and tsunamis. In the islands of the Caribbean, a rising sea level would increase risks of coastal erosion and inundation, threatening key tourism, energy, transportation and communications infrastructure.[73] In addition, warmer waters may cause the bleaching and extinction of coral reefs around the world, which act as natural barriers against tsunamis and other damaging coastal waves.

There is an emerging consensus among scientists about the effects of global warming on natural disaster occurrence. Global warming is likely to result in increased frequency, severity and duration of existing hazards (such as droughts or El Niño) and reduction in other hazards (such as frost or cold wave).[74] In Latin America and the Caribbean, the impact of climate change can be expected to be an increase in intensity of heavy rainfall and more frequent El Niño-like conditions leading to floods on the west coast of Central and South America and droughts in parts of Latin America and the Caribbean.

[70] World Meteorological Organization (1999, p.22), Swiss Re (1998, p. 9).
[71] Encyclopedia Britannica. http://www.britannica.com.
[72] World Meteorological Organization (1999, p. 23).
[73] Caribbean Planning for Adaptation to Global Climate Change (1997).
[74] Downing, Olstoorn and Tol (1999, p. 10).

Current modeling efforts do not provide a clear indication of the impact of global warming on the frequency and intensity of tropical storms.[75] Nevertheless, given the relationship between tropical sea surface temperatures and storms, it is reasonable to expect that global warming might have an effect on the intensity of the most severe storms.[76] In any case, given the expected increase in sea level, damages caused by storms—whether more frequent and intense or not—will increase.[77] The Coastal Zone Management unit of Barbados estimated that a meter sea-level rise (the upper range of Intergovernmental Panel on Climate Change projections) combined with a category 3 hurricane (on a scale of 1 to 5) would entirely flood coastal development zones, including tourism infrastructure.[78]

In the case of Central America, the US Climate Study Program estimated that changing rainfall patterns and a greater frequency of high-intensity tropical cyclones would have seriously adverse economic effects due to the region's high dependency on agriculture, the importance of hydroelectricity in the energy sector and the concentration of people and assets in coastal areas.[79]

2.3 Vulnerability of Exposed Elements

2.3.1 Vulnerability: Theoretical Elements

Vulnerability is usually defined as the degree of losses, from 0 to 100% of the assets exposed, that a given natural hazard would generate in a specific zone. But vulnerability also describes the propensity of a given population to suffer injury or death in the event of a natural event. As shown in Figure 2.1, the vulnerability of human settlements and economic activities is the function of the combination of three factors: the presence of people and assets in hazard-prone areas, the degree of sensitivity of people and assets to the effects of natural hazards and environmental degradation in hazard-prone areas. These three factors are obviously the result of human activity and are controllable, at least in principle (it can also be said that they are endogenous to the socio-economic system). Due to the importance of vulnerability in explaining the occurrence of disasters, many theories of disasters reject the terminology of "natural" disasters (see Box 2.4).

[75] Intergovernmental Panel on Climate Change (1999).
[76] Downing, Olstoorn and Tol (1999, p. 213).
[77] Downing, Olstoorn and Tol (1999, p. 213).
[78] Caribbean Planning for Adaptation to Global Climate Change (1999).
[79] Climate Study Program (1994).

Box 2.4. Are Disasters Natural?

Because of their sudden, unforeseen and inexplicable occurrence, natural disasters have been historically seen as "acts of God" upon which humans had no control and therefore had to learn to accept as inevitable. If natural hazards can in fact be seen as exogenous shocks, independent of human actions, the occurrence of natural disasters are at least partially controllable: they are the result of the vulnerability of human settlements and productive activities in hazard-prone areas, which makes many social scientists reject the terminology of "natural" disaster. Behavioral theorists see disasters as the manifestation of ineffective social adjustment to the physical environment. To avoid the harmful effects of disasters, these theorists advocate technological responses to natural hazards, or a so-called "technological fix" to the environment. Similarly, some theories link the increase in the occurrence of natural disasters in both developed and developing countries to the unsustainable path of their economic and social development, which ignores environmental constraints. This body of thought denies that economic development in the Third World will resolve the disaster issue and emphasizes the importance of environmental conservation. In the 1980s, theories emerged that emphasized the fact that socio-economic and political factors were of paramount importance in understanding why people are vulnerable to the environment and experience disasters. Marginalization theories of disaster emphasize the differential degree of vulnerability among social classes, explaining disasters as the "interface between an extreme physical environment and a vulnerable human population" (Susman, O'Keefe, Wisner, 1983). These theories were in part a response to the Guatemala earthquake in 1976, which hit slums more severely than other areas and was characterized as a "class quake." These theories have been criticized because they make poverty a necessary condition for natural disasters and presuppose that a high-income population has perfect scientific knowledge about risk and mitigation strategies, which has not always been confirmed empirically.

Sources:

Bernstein (1998), Maskrey (1993); Main and Williams (1994); Hewitt (1983).

2.3.2 Sources of Socio-Economic Vulnerability in Latin America and the Caribbean: The Pattern of the Region's Development

- Demographic Growth, Distribution and Migration Patterns

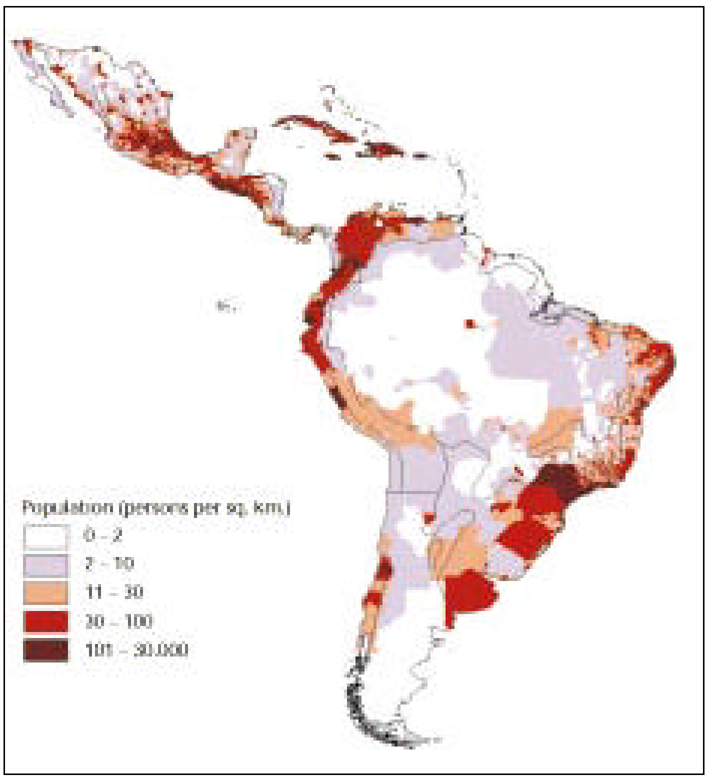
The Latin American and Caribbean region has witnessed a rapid demographic growth in the last three decades, amounting to roughly 70% between 1970 and 1999. This demographic growth mechanically increases the region's vulnerability to disasters as the average population density increases. Today, with a total of 511.3 million inhabitants, the region has an average population density of 26 hab/km^2.[80] Of course, population density is not distributed evenly across the continent and does not, by itself, give a precise indication of how much vulnerability has increased. But evidence suggest that most of the population increase has led to migration movements to already vulnerable zones, such as coastal, urban and marginal lands.

As shown in the population density map below,[81] the highest concentration of population in South, Central America and the Caribbean are located on the coasts, which

[80] UNFPA (2000).
[81] Inter-American Development Bank (2000a, p. 119).

are particularly vulnerable to weather-related disasters such as hurricanes, storm surges and El Niño-type events. It is estimated that around 60% of the region's population lives in coastal states and provinces. 60 of the 77 largest cities are located on the coast, and many of these cities are growing at a faster rate than the national average.[82] The economic activities present on coastal regions, such as tourism, fishery export industries, and maritime trade, constitute a significant part of the region's GDP.[83] Should global warming result in an increase of the sea level and a higher frequency of tropical storms, the region's vulnerability might significantly increase in the years to come. In addition, the concentration of population is above 100 hab/km^2 in many zones prone to earthquakes and tsunamis such as the Pacific Coast of Central America and the Andean region, as well as in the South Pacific Coast. While the rate of demographic growth will decrease in the years to come due to the demographic transition, the total population is still expected to increase by 36%, adding almost 200 million inhabitants by 2025.[84] If migration patterns remain stable, this additional population will continue to feed into the already high levels of human concentration in the coastal zones.

Map 4. Population Density in Latin America



Source: Inter-American Development Bank (2000a).

[82] Lemay (1998, p. 7).
[83] Lemay (1998, p. 13).
[84] UNFPA (2000).

Urban Growth and Emergence of Mega-Cities

The rapid demographic growth that has taken place in the region has resulted in an impressive expansion of cities in Latin America and the Caribbean. Today, the Latin American and Caribbean region is more than 75 per cent urban, a level almost equal to those in Europe, Northern America and Japan.[85] By their nature, cities are particularly vulnerable to natural disasters because they have a high density of population and assets. The economic impact of disasters in a large city tends to be much higher due to the high concentration of industry and transportation webs in or around major cities. As such, disasters affecting big cities can result in massive costs and represent an aggregate shock at the country level. For instance, current estimates of the cost of an earthquake in Tokyo could reach as much as 1,500 billion dollars.[86]

Inhabitants of cities seem to be, on average, more at risk than rural populations. Three quarters of the people killed by the 1993' hurricane that swept over Venezuela were inhabitants of Caracas, where landslides demolished informal neighborhoods.[87] Major factors of urban vulnerability involve dense settlement, lack of drainage, poorly-designed multi-story buildings and infrastructure complexity. Multi-story buildings can prove extremely risky when they are not hazard-resistant and pose accessibility issues: it might be more time consuming for an individual to leave these structures at the onset of an earthquake or hurricane than small individual dwellings in rural areas.[88] In addition, major cities depend on a complex infrastructure for their effective functioning. Urban inhabitants are dependent on common food, water, power and fuel distribution networks, which are particularly vulnerable in times of disasters.[89] For example, the destruction of gas lines in an earthquake can ignite fires, at a moment when the water distribution system might be out of service.[90] Finally, due to the high concentration of population, the spread of water-borne diseases might also be more likely than in rural areas.

In the case of Central and South America, risks are even higher because of several factors specific to the region. First, the gigantic size of most of the region's cities worsens typical urban risks as interdependence and problems of accessibility tend to increase with size. In 1995, 28% of the population of the region lived in cities of a size greater than 3 million inhabitants.[91] Urban concentration in Latin America, or the percentage of people living in the country's main city, is the highest in the world.[92] Moreover, many of the region's cities are located in hazard-prone zones. For instance, Mexico City (15 million inhabitants in 1990), and Lima (5.8 million inhabitants in 1990) are located in zones where seismic activity is fairly high. Already among the 30 biggest cities in the world, Lima's population is expected to almost double by 2015, while Mexico's should increase

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[85] UNFPA (2000).
[86] Munich Re (2000, p. 102).
[87] Main and Williams (1994, p. 7).
[88] Main and Williams (1994, p. 7 and p. 35).
[89] IDNDR (1999, p. 11)
[90] Clarke (2000, p. 7)
[91] World Bank (2000, p. 219).
[92] IDB (2000a, p. 139).

by 27%.[93] Most of the other principal cities in the region are located along the coasts and in zones of high seismic activity. A more careful look at 20 major cities in Latin America[94] shows that all of them are built in areas that have one of the following characteristics: steep slopes, swamps, floodable land or seismic activity.[95] Many of the worst disasters in the region have taken place in cities. Earthquakes have repeatedly hit Guatemala City and San Salvador and Lima, devastated Managua in 1972, and caused heavy destruction in Popayán (1983), Mexico City and Santiago (1985). San Salvador, moreover, was hit by four significant earthquakes between 1900 and 1999. In other cities, such as Caracas, Manizales, or Rio de Janeiro, landslides following heavy rainfall have been fairly common and destructive over the last thirty years.[96] For instance, severe floods and mudslides were reported in the Rio de Janeiro area at least nine times during the past thirty years.[97]

Like many other urban areas in developing countries, Latin America and Caribbean cities are also extremely vulnerable because of the poor quality of housing, inadequate urban planning and insufficient investments in infrastructure. As of 1993, it was estimated that at least 37% of the total housing stock in Latin America provided inadequate protection against disaster and illness.[98] Low-income housing is usually made of materials such as adobe, brick and unreinforced masonry, whose resistance to natural hazards is very poor. In the case of earthquakes, these types of construction are by far the most susceptible to incur damages: on the Modified Mercalli scale, in earthquakes of an intensity of 8 (moderate magnitude), loss-susceptibility is estimated at 40 to 50%, while reinforced masonry would have a loss-susceptibility of only 5%.[99] In addition, traditional building techniques often use tile roofs instead of safer building techniques (such as shear walls of wooden structures, used in Asian countries). More modern multi-story buildings in Latin America do not necessarily constitute better shelters against disasters when they are not built in conformity to hazard-resistant building codes. In Mexico City, the type of housing that experienced the highest incidence of damages were high-rise buildings of between six and twelve stories.[100]

Due to rural-urban migration and the development of transportation, Latin American cities have so greatly expanded in size that low-income neighborhoods, traditionally at the cities' outskirts, have been pushed so far back that commuting became impossible, despite the existence of public transportation.[101] Therefore, low-income groups settled in hazard-prone areas closer to the city center, such as hill-slopes or flood plains. In these areas, the land is not usable for productive or residential purposes and

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93 Munich Re (2000, p. 73).
94 Bogota, Caracas, Cartagena, Guatemala City, Guayaquil, la Paz, Lima, Managua, Medellin, Mexico City, Quito, Recife, Rio de Janeiro, Salvador, San Jose, San Juan, San Salvador, Santiago, Sao Paulo, Tijuana.
95 Gilbert (1998, p. 158).
96 Gilbert (1998, p. 123).
97 CRED (1999).
98 Pan-American Health Organization (1998) as cited in Inter-American Development Bank (2000a, p. 135).
99 Main and Williams (1994, p. 41).
100 Degg (1989, pp. 237-46) as cited by Main and Williams (1994, p. 38).
101 Main and Williams (1994, p. 162).

chances of demolition or eviction are minimized.[102] The percentage of population living in self-help housing in many cities of Latin America and the Caribbean has dramatically risen, reaching 60% of the total population in Mexico City in 1990 and around 40% for Lima and Caracas.[103] The combination of poor quality housing (built without any technical input), settlements in hazard-prone areas, narrow streets, paved roads and inadequate surface drainage makes these settlements extremely vulnerable not only to earthquakes, but also to weather-related hazards and associated land and mudslides, as shown in the recent floods and debris flows in Venezuela.[104]

- *Persistence of Widespread Poverty*

Empirical evidence suggests that there is a correlation between poverty incidence and vulnerability to disasters. Countries with widespread poverty tend to experience more frequent natural disasters than developed countries; and natural disasters in these countries cause more fatalities and damages relative to their population and GDPs. An estimated 70% of all disasters and 91% of disaster-related fatalities occurred in developing countries between 1970 and 1999,[105] while the population in developing countries represented between 70 and 80% of the world's population over the same period.[106] As a result, on average, the risk of dying for an individual living in a developing country is higher than in developed countries.

Comparison between similar events also sheds some light about the particular vulnerability of developing nations. The San Francisco earthquake of 1989, with a 7.1 magnitude, caused 63 deaths, while a 6.2 earthquake near Guatemala City in 1976 resulted in 22,780 fatalities.[107] Similarly, Hurricane Camille, a category 5 hurricane on the Saffir-Simpson Scale caused 259 deaths in 1969 in the United States whereas Hurricane Mitch killed 9,000 in Central America in 1998.[108] Countries with comparable rates of occurrence of natural hazards, like Japan and Peru, have very different disaster-related death statistics. Between 1970 and 1999, Peru had 2,420 fatalities on annual average, while Japan counted only 315.[109]

While damages related with disasters are greater in absolute value in developed countries, loss/GDP rates are 20% higher in developing countries.[110] In the case of the United States, Hurricane Andrew in 1992—the costliest hurricane ever—cost $26.5 billion or a mere 0.4% of GDP, while disasters in developing can represent a cost of over 100% of annual GDP. Nevertheless, the relationship between development and occurrence of disasters is not necessarily linear across all levels of GDP/ per capita. The wealthiest country in the world, the United States, experienced more disasters between

[102] Main and Williams (1994, p. 12).
[103] Gilbert (1998, p. 82)
[104] Inter-American Development Bank (2000a, p .53).
[105] Using the classification of low, middle and high-income countries of the World Bank. CRED (1999).
[106] UNFPA (2000).
[107] Main and Williams (1994. p.33); BRG (1999).
[108] Rappaport and Fernández-Partagas (1995).
[109] CRED (1999).
[110] Funaro (1982, p. 1) as cited in Anderson (1990, p. 4).

1970 and 1999 than any other region. With development, vulnerability can increase because the value of assets and level of economic interdependence increase, but also because of the moral hazard associated with the development of insurance coverage and the availability of public relief programs. But, contrary to the experience of developing countries, the rate of fatalities by event and the magnitude of economic hardship borne by affected individuals are much lower in richer countries. Therefore, disasters have much less of an impact of individual welfare.

About 33% of the population in Latin America and the Caribbean lives in moderate poverty, while 16% lives in extreme poverty.[111] The incidence of poverty, moreover, has increased in the 1990s compared with the 1980s. Poverty is not evenly distributed in the region. Some countries like Nicaragua and El Salvador have 70% of their population living in poverty while Argentina, Chile and Venezuela have only an estimated 20% of the population living in poverty.[112] Large countries such as Brazil and Mexico have on their soil respectively 46% and 13% of the total poor population in Latin America and the Caribbean.[113]

The presence of many poor people in a given region can constitute a clear factor of vulnerability, as the poor are more vulnerable than other income groups because of the more hazardous location of their dwelling, the poor quality of their housing, their different perception of risk and difficulty to recover from disasters (see Box 2.5).

Box 2.5. Household Characteristics and Vulnerability to Disasters: The Example of the United States

Research gathered during recent cases of hurricanes, such as Andrew in 1992, shows that household characteristics are an important determining factor for vulnerability to disasters. Poor households suffer more from the effects of disasters than higher income levels due to:
- insufficient financial resources to risk reduction and post-disaster recovery expenditures;
- poorly built and inadequately maintained housing (such as mobile homes);
- hazardous location of dwellings;
- poor access to transportation for evacuation;
- unstable employment;
- less-attractive insurance compensation;
- inability to fully recover, increasing future vulnerability.

Other important household characteristics increasing vulnerability include age, gender, household living arrangements (single-parent), number of dependents, access to social networks, power and autonomy in community decision-making process. Vulnerability appears to increase exponentially when these characteristics are combined.

Source: Morrow (1999).

As shown in the preceding section, low-income settlements in major cities in Latin America and the Caribbean are located in inhospitable areas, which are usually

[111] Londoño and Székely (1997, p. 18).
[112] Attanasio and Székely (1999, p. 80).
[113] Londoño and Székely (1997, p. 31).

prone to natural hazards. In rural areas, the same rules tend to apply, as the low-income population is constrained in its of settlement choice by property rules and landowners. Moreover, low-income populations might willingly choose hazard-prone areas to improve their access to resources or increase their income-generation possibilities. Environmental hazard might be outweighed by the perceived benefits of residence in hazard-prone areas such as fertile volcano slopes, plains nourished by flood alluvia or river banks.[114] Poverty in rural areas is also a direct cause of environmental degradation, as the extreme poor, which constitute a high percentage of the rural poor, are often forced to deplete surrounding natural resources for survival purposes.[115] Finally, there is a clear link between poor quality housing and low income, especially in countries where mortgage financing might be unavailable to low-income groups. An aggravating factor is the lack of ownership of land or absence of renting possibilities.

Given the level of their income, the poor are likely to have a different perception of risk. The poor tend to be more risk-averse than richer income groups, because of their absence of savings or assets. But the poor are usually less likely to be informed of the risks they incur, as they are less likely to have access to risk information or early warning because of their lack of education, as well as low levels of access to modern information technologies and insurance coverage. In fact, according to the World Bank, countries in the region have a lower access to information and communications than developed countries, ranging from Barbados (24th rank) and Haiti (159th).[116] Given high levels of inequality and the nature of goods involved, a very unequal distribution of access among different income groups can be expected, with the poor having little access to information and communications. For instance, early warning systems are often absent or malfunctioning in rural poor areas at risk.

Even if low-income groups had access to information, they might not engage in a risk reduction strategy. Resettlement, retrofitting of housing or insurance coverage might be too costly compared with these groups' saving capacities and perceived benefits. As most of their income is allocated to immediate survival, the low frequency risk of a natural disaster—though catastrophic in its effects—might not be sufficient to warrant a change in behavior.

Finally, low-income households are less likely to be able to cope with the effects of a disaster, causing further impoverishment in low-income communities, which in turn feeds future vulnerability. Vicious circles might therefore develop in particularly hazard-prone areas affected by recurrent disasters such as the coastal areas of Peru and Ecuador or Northeast Brazil.

[114] Rapp (1991, p. 214) as cited by Main and Williams (1994, p. 5).
[115] Echeverría (1998, pp. 2 and 5).
[116] WDR (2000, pp. 166 and 167).

Environmental Degradation[117]

Often the result of the widespread poverty persisting the region, environmental degradation is one of the major factors contributing to the increasing vulnerability of the Latin American and Caribbean region to natural hazards. Environmental degradation directly magnifies risk of occurrence of natural hazards, or, by destroying natural barriers, leaves human settlements and productive activities more vulnerable to their effects.

Due to deforestation, the region has lost 61 million hectares, or 6%, of its forest cover between 1980 and 1990. An additional 5.8 million hectares, or 3% of the remaining total cover, was lost between 1990 and 1995. During these five years, the highest rate of deforestation, 2.1 % annually, occurred in Central America. Deforestation in the region is due to the extension of cultivation areas, through traditional slash-and-burn or more modern agricultural techniques, as well as to mining, logging and building of new roads and settlements. Deforestation contributes to multiply risks of droughts, forest fires and desertification in arid and semi-arid areas. In the case of the Amazon, selective logging contributes to significantly worsening the risk of forest fires, as the forest loses some of its humidity. The risk is especially high when rainfall decreases as a result of dry season conditions, sometimes worsened by El Niño. In 1998, large forest fires occurred in the Amazon. 14% of the state of Roraima was burnt, resulting in the loss of cattle, silos and rural houses, which affected 12,000 people, most of them indigenous. Finally, deforestation contributes to soil erosion, which contributes to the occurrence of other hazards, as described below.

An estimated 313 million hectares of land (around 75% of total agricultural land) are affected by mild to severe degradation in Latin America because of soil erosion caused by deforestation, overgrazing and chemical contamination (via pesticides).[118] Degraded soil is less able to absorb heavy rainfall, which results in more frequent flash floods. Deforested slopes can also become less stable and more susceptible to collapse.[119] One of the causes of the many landslides and flashfloods associated with Hurricane Mitch and floods in Venezuela is without a doubt the high rate of deforestation of hill slopes and watersheds ongoing in the affected countries.

In coastal areas, deforestation of mangroves, erosion and destruction of coral reefs makes the coastlines more vulnerable to storm surges and tsunamis. The degradation of coastal areas is due to migration movements towards coastal areas (especially in zones where ecosystems are too fragile to support additional human settlements), tourism, commercial fishing, mariculture/aquaculture and maritime trade. In Mexico, a country prone to the coastal hazards described above, more than 65% of its mangroves have already been lost.[120] In the Caribbean, 29% of the sub-region's coral reefs are considered at high risk because of increased runoff and sedimentation associated with deforestation, sewage from hotels and shipping, and coastal construction and mining. The already

[117] This section is primarily based upon UNEP (2000, pp. 120-135 and 270-292.).
[118] Pichon, Uquillas (1997, p. 483)
[119] Bell (1999, pp. 117-120)
[120] Suman (1994) as cited by Lemay (1998, p. 14).

higher level of risk of hazard-related destruction and fatalities might further increase if global warming results in a higher sea level and a higher frequency of extreme weather events.

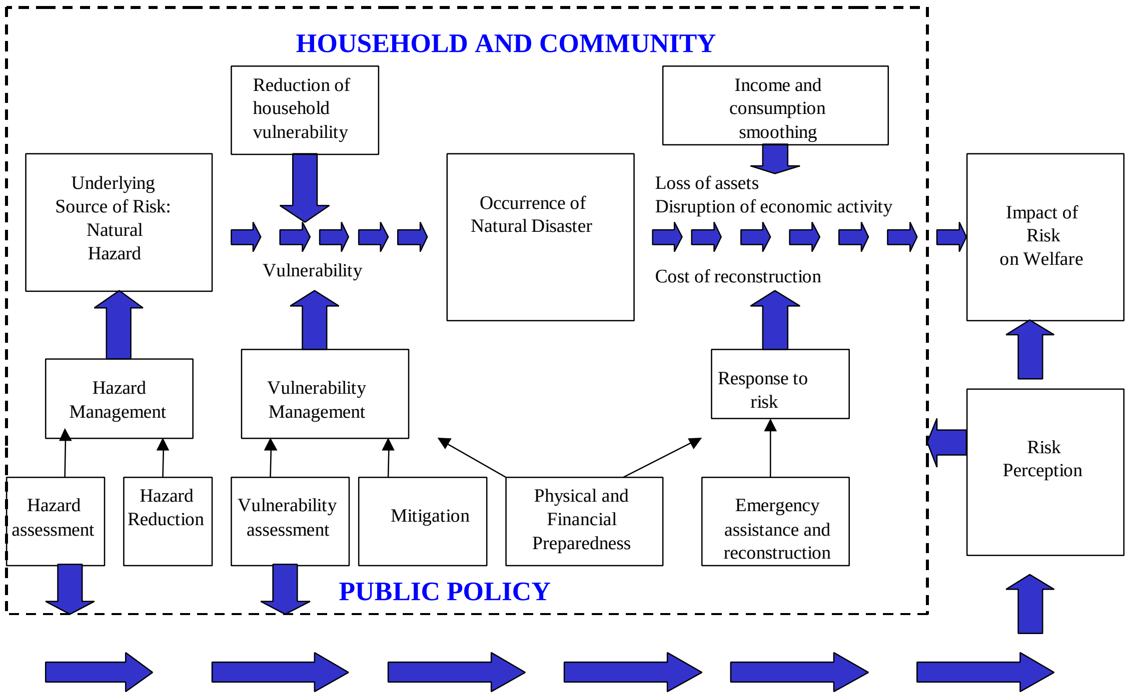
3 Risk Management

Disaster risk management is a set of various activities at individual, community or society level designed to protect welfare against physical and economic risks associated with the occurrence of natural hazards. Risk management involves reducing risk to an acceptable level and coping with its consequences, once the risk materializes. Given the complexity of natural disasters, the imperfection of available information and the variety of risk management options available, finding the correct policy mix, which maximizes welfare, is extremely difficult. After presenting risk management options available to households and public policy, this section analyzes the risk management practices in the region.

3.1 Risk Management: A Basic Framework

There are numerous risk management options available taking place before and after disasters, and focusing on hazards themselves, economic or physical vulnerability, or post-disaster damage control (see Figure 3.1). As can be seen in this figure, the main divide of risk management is whether the goal is to prevent the occurrence of a natural disaster through risk reduction policies or to focus on preventing the occurrence of a disaster from reducing welfare by addressing the economic consequences of a disaster on individual income, employment and economic activity. There is nevertheless a gray area between risk reduction and coping activities, as preparedness activities can both reduce risk of occurrence of disasters, by preventing deaths for instance, and limit economic consequences of a disaster by preparing networks of responders in advance to jump-start rehabilitation activities.

Figure 3.1: Risk Management: A Conceptual Framework



This diagram also shows that risk management is a direct result of risk perception, and therefore has an important link to welfare protection or lack thereof. Compared with other risks (such as unemployment, illness, or accidents), the risk of natural disasters is characterized by its low frequency. Frequency also widely varies according to geographical location, type and magnitude of disasters. For instance, when the Soufriere Hills in Montserrat started to become active again, the last recorded eruption dated from 250 years ago. In the case of El Niño, the frequency is much higher: over the last twenty years, there have been three recognized episodes of El Niño—in 1982-1983, 1991-92 and 1996-97.[121] A major flood is described as a flood that happens every 30, 50 or 100 years on average. Frequency over an individual's lifetime is even lower, as the risk for an individual to be affected is lower than for a whole country. This low combination of low and highly variable frequency makes it difficult for individuals and policy decision-makers to make rational and informed decisions about risk (see Box 3.1).

According to economic theory, firms' and individual' decision-making regarding risk is usually irrational, involving a systematic set of biases in dealing with probabilities, and using simplified "rules of thumb" to make decisions (Kahneman, Solvic and Tversky, 1982; Camerer and Kunreuther, 1989). In the case of disasters, a low frequency risk, decision-making is least susceptible to be rational because of the complexity of risk and the cost of obtaining accurate information.

[121] World Meteorological Organization (1999, p. 35).

Instead, real-life risk management decisions at the individual and public policy level primarily depend on the perception of what constitutes an acceptable level of risk. At the community level, the perception of disaster risk usually derives from collective memory. These traditional mechanisms might not portray risk accurately (because frequency of major hazards can be more than 100 years apart) or might break down with migration, social and demographic changes. Moreover, some hazards generate much more emotive reaction (such as nuclear waste), which can result in a sub-optimal allocation of resources available for risk management if other hazards that represent greater risk are ignored. The perception of risk also varies with time: demand for protection will be much greater after a major disaster than otherwise, while demand for protection should be based upon future risks rather than past events (although past events provide some indication of future risks).

Another set of difficulties arises because of the absence of consensus on acceptable risk. As Bell points out,[122] the acceptable level of risk is inversely proportional to the percentage of people exposed to a hazard in society. This means that a risk, even medium or low-level, that affects a large number of individuals has a greater chance of to being reduced by public policy than an extremely severe risk affecting a minority. Given the low frequency of risk involved, demand for risk reduction might also depend on inter-temporal preferences. Investments in risk reduction might not bring benefits to the individuals living at the time of the decision, but for the next generation. In terms of public policy, this low frequency tends to lessen incentives for politicians to invest in prevention, as the expected political benefits of investing, or the drawbacks of failing to invest, might not occur during a political mandate.

3.2 Risk Management Options

The degree of efficiency, cost and feasibility of the various options presented in Figure 3.1 is explored in this subsection, as well as major risk management trade-offs for public policy.

3.2.1 Household and Community Level Strategies

3.2.1.1 Risk Reduction

At the household level, risk reduction consists of reducing vulnerability to an existing risk by mitigating its potential impact on an individual's physical integrity, assets and income. Given that vulnerability is often the result of collective choices (such as location of cities or centers of activity, public infrastructure design and maintenance, environmental degradation), risk reduction strategies at the household level are limited.

The most obvious way to reduce risk is to limit physical exposure to hazard by moving out of hazard-prone areas. Such a measure presupposes a good knowledge of the location and magnitude of existing hazards and requires that the marginal cost of the move is inferior to the perceived gain in security. There are, though, several obstacles to such a risk reduction strategy in the region. First of all, many of the households living in

[122] Bell (1999, pp. 5-7)

high-risk areas have low-income and/or have no access to land in alternative locations. Moving out of a risky area might also induce a loss of income generation potential if the hazardous land is extremely fertile (such as on volcanic slopes) or produces other benefits than low-risk areas would not (such as access to water). Moreover, for cultural and economic reasons, households might place a high value on remaining in their location of birth, where they can rely upon extended family or community solidarity.

Investing in hazard-resistant technology is another way of reducing physical and economic vulnerability. Housing protection can be achieved by, for instance, adopting lighter and more flexible construction materials in an earthquake-prone area. Crop fields can be protected from floods by retaining walls or by a change in cultivation techniques (such as terracing). Most households—especially low-income—are nonetheless unlikely to make such investments because natural hazards are a very low frequency phenomenon. Moreover, these risk reduction investments are generally costly and might be of limited efficiency if neighbors or the whole community do not adopt similar practices.

At the community level, the level of investment in disaster mitigation and preparedness is likely to be less than optimal because of the public good nature of safety and differences in levels of risk and risk perception inside a community. Nevertheless, they are many examples of community risk reduction strategies such as land terracing, and silos to store grains and prevent food losses in hurricanes and floods.[123] The community is also an important channel for the transmission of risk information. Disaster risk information at the community level usually derives from collective memory, as elders pass on their experience of disasters to younger members.[124] This is why many disaster specialists attribute increased vulnerability to the breakdown of these mechanisms because of demographic, social and migratory patterns.

Income diversification is another option available to individuals and households facing risks. Such a strategy makes sense only when the principal wage earner has an activity especially vulnerable to natural hazards, such as agriculture or tourism. Income diversification can involve diversifying the types of crops cultivated in terms of harvest season, resistance to flood and strong winds, so as to reduce the average level of risk associated with climatic variability. But the most effective way of reducing risk by diversification is to diversify income sources by geography and sector of activity. For instance, traditional societies often use marriage as a risk diversification strategy by choosing out-of-area spouses for the communities' children.[125] The difficulty lies in choosing sectors and areas unlikely to be affected by a hazard at the same time. Off-farm work, which is often used as a mechanism to mitigate agricultural risk (i.e., loss of harvest) might be ineffective at protecting income when an entire area is hit by a disaster.

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[123] Anderson and Woodrow (1989, p. 165); Clarke (1992, p. 96).
[124] Clarke (1992).
[125] Clarke (1992).

3.2.1.2 Risk Coping Mechanisms

Risk coping strategies are meant to limit the reduction of economic welfare caused by damages associated with disasters. They do not intend to reduce the amount of physical damages, but focus on reducing economic consequences on welfare by smoothing the shock over time. Coping strategies can include a combination of pre and post-disaster mechanisms (see Table 3.1).

Table 3.1

List of Disaster Coping Mechanisms

Pre-disaster
Saving
Informal insurance
Formal insurance
Post-disaster
Dissaving
Consumption reduction
Sale of household assets
Additional/alternative employment
Borrowing
Transfers (private remittances/public assistance)
Migration

Insurance as a coping mechanism presupposes that the individual or household perceives a risk, wants to spread it over time by purchasing insurance and has access to insurance. The rationality of purchasing insurance depends on the price of premium paid over the life-cycle compared with the potential disaster losses. Access to insurance is a critical issue in most developing countries. Several studies indicate that there is an unmet demand for flood and drought insurance in developing countries, such as India.[126] Market failures are often resolved by self-insurance mechanisms at community level (such as crop insurance managed by local cooperatives), which might not function when disaster strikes because of the co-variant nature of disasters.

Post-disaster coping mechanisms are meant to reduce the final effects of disasters on households' present welfare. To compensate for the shortfall in income caused by the disaster, households can reduce their savings, investments and consumption as well as attempt to increase their income. The size of assets of the household before the disaster might modify the composition of the coping strategy and its sequencing. For instance, higher income groups will tend to smooth their consumption, while low-income groups, whose consumption level is closer to subsistence level will need to use a combination of consumption and income smoothing. Donahue (1998) lists three stages in loss management strategies: (1) reversible mechanisms and disposal of self-insurance assets (wage-labor, reduction of consumption and human capital investments, extended family networks, small scale credit), (2) disposal of productive assets (selling land or tools, massive borrowing at high interest rate, further reduction of consumption, reducing land

[126] Alderman, Gautam and Hazell (1994).

farmed and types of crops used), and (3) destitution (charity, household break up, migration).[127] A study of households affected by the death of an adult in Thailand—a shock similar to disasters when members of family die—shows that dissavings were the principal response (60% of households), followed by consumption reduction (52%), additional employment, asset sale, transfers and finally borrowing.[128]

Evidence shows that households coping with severe drought in Zimbabwe reduced the number of meals in order to reduce consumption. They primarily used asset sale (livestock) and, to a lesser extent, informal credit, public assistance and additional employment. Panel surveys show that many households had to deplete their asset base (through livestock sales) to cope with the shock. Consequently, households with few assets suffered the most from the drought and were left more vulnerable to the next drought.[129] An accounting model of a farm household liquidity in Sudan generated similar results. Only a substantial injection of additional income, through outside work or higher yields, enabled households to smooth the effects of the shock without reducing consumption or selling assets.[130]

As shown by Bright, if a severe shock hits an asset-poor household, credit, even at a favorable rate might not be enough to absorb the shock, unless there is a subsequent increase in income. Similarly, in her analysis of consumption data for 1,072 households affected by floods in Bangladesh, Zaman (1999) concludes that the positive impact of micro-credit on poverty and vulnerability depended on how poor the household was to start with and whether the amount borrowed reached the cumulative loan threshold necessary to smooth the shock adequately.[131] The beneficiary effect of credit also depends on whether the credit is used to replenish income-generating assets or finance immediate consumption. In the aftermath of a correlated shock, the supply of credit tends to dry up (as credit providers reduce their exposure to risk in order to cut losses) while demand for credit is likely to increase because of reconstruction and/or input purchases. This high price seriously limits the efficiency of credit as an income smoother. Finally, institutions providing formal credit are likely to have their portfolio diversified among regions with uncorrelated natural hazard patterns, which will reduce the credit crunch. But informal credit will be even more affected, with negative consequences on poorer households, who tend to rely more on informal credit.

Asset sale is an expensive method of income smoothing in the aftermath of a catastrophic or correlated shock. Papers by Sen and De Waal[132] show that the ratio of livestock per grain is extremely unfavorable in the aftermath of a disaster affecting agricultural production due to high supply of livestock compared with low local availability of grain and poor health of animals. Furthermore, distress sales of income-generating assets have long-term adverse consequences on production capacity and collateral availability.

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[127] Donahue (1998) as cited by Joint United Nations Program on HIV/AIDS (1999, p. 18)
[128] Janjareon, Kongsin and Pitayanon (1997, p. 17).
[129] Kinsey, Burger and Gunning, (1998, p. 107).
[130] Bright (1999, p. 90)
[131] Zaman (1999).
[132] Sen, 1981 and De Waal, 1991 as cited in Bright (1999, p. 90).

To smooth income, households might seek additional employment, such as off-farm work or participation in food-for-work programs. Women might join the labor force and children might be pulled out of school. In the case of economic crises, which constitute covariant shocks similar to disasters, there is empirical evidence in several Latin American countries that child labor participation increases and school enrollment decreases.[133] There is similar evidence in communities stricken by AIDS in South-East Asia.[134]

When disasters severely disrupt production for several months and generate massive unemployment in an affected zone, migration is a commonly used coping strategy. For instance, migration patterns showed an upsurge of migration to African cities in the aftermath of droughts.[135] In the wake of hurricane Mitch, irregular migration of Hondurans and Nicaraguans was expected to increase throughout Central America and the United States.[136] Migration is also justified when assets are totally lost, which reduces the opportunity cost of moving. Finally, massive destruction of housing is likely to drive up rental prices in the affected zone, providing another incentive to move. Unless victims move to even riskier areas, migration also reduces future vulnerability of the household to future disasters. If only one member of the household leaves, he will be able to send remittances in the case of a future disaster to his relatives, providing an income smoothing mechanism.[137]

Private and public transfers are an important coping mechanism for families affected by disasters. Public transfers in the form of food, emergency employment programs and subsidized credit for inputs and tools can play a key role in smoothing the shock for the most vulnerable population. Private remittances are equally important, especially when public transfers are inadequate or nonexistent. Out-of-area remittances to Central America amounting to an estimated $1,672.7 million in 1998[138] increased significantly after Hurricane Mitch. In the case of Honduras, remittances increased by 50.3% in 1999.[139]

Affected communities can rarely cope with a natural disaster without at least some external assistance because of the covariant nature of the shock. But this does not mean that communities are powerless. In Central America, several communities developed their own early warning systems through local radios, which contributed to saving many lives during Hurricane Mitch, such as in La Masica, Honduras.[140] Communities also have post-disaster traditional coping mechanisms such as mutual aid groups or leadership arrangement to divide labor, define priorities and distribute

[133] IDB (2000b, p. 27).
[134] Janjareon, Kongsin and Pitayanon (1997, p. 17).
[135] The population of Nouakchott, Mauritania doubled after a severe drought. Potts (1995) as cited in Fay and Opal (2000, p. 12).
[136] IDB (1999b).
[137] Lucas (1998) as cited in Fay and Opal (2000, p. 5).
[138] Inter-American Development Bank (1999).
[139] Economist Intelligence Unit (2000, p. 41).
[140] Inter-American Development Bank (2000, p. 8).

assistance during the emergency and reconstruction phases.[141] These capacities can be strengthened after disasters by using local NGOs to channel international assistance and fostering community participation in reconstruction. Moreover, the organization of shelters, water and food distribution, rehabilitation and reconstruction activities at the community level makes it possible to reduce risks of corruption and misuse of resources for political purposes. Local organization can also improve targeting within the community to reach to the poorest and/or most affected. Finally, post-disaster community empowerment is an important component of a sustainable risk reduction strategy.

3.2.2 Risk Management at Public Policy Level

3.2.2.1 Risk Reduction Options

Risk Identification

Risk identification is the most important component of risk management, since risk reducing and preparedness policies directly depend on the original assessment of risk. Individuals and policy makers are much more likely to make welfare optimization decisions if they are fully informed. Risk identification involves a risk assessment, which quantifies the probability of disaster-related losses for a given period and place. Risk assessment is based upon the spatial and time evaluations of natural hazards and vulnerability.

To assess the level of hazard associated with a specific natural event, it is necessary to gather information based upon which one can predict the location, frequency, duration and magnitude of events in the future. Methods to assess hazards include the study of historical records, topographic information, remote-sensing imagery and aerial photography. The principal problem of hazard assessment is that historical records might be incomplete or unreliable, and that the pattern past events might not provide an accurate enough indication of future events. Medium to long-term forecasting is still essential to predict risk with a reasonable margin of error (see Box 3.1) and implement risk-reduction strategies. In the agricultural sector, climate forecasts (for periods longer than two weeks) are essential to reduce losses: in response to drought forecast, crops can, for instance, be switched. In several Latin American countries, such as Peru and Brazil, such forecasts, together with agronomic research on suitable crops, have contributed to significantly reduce destruction of crops in drought years.[142]

In the absence of long-term predictability, or as a complementary approach, monitoring and short-term forecasting can be used for disaster preparedness (early warning and evacuation). Recent technological innovations such as remote sensing techniques, GIS and GPS can make hazard assessment and forecasting much easier. At the same time, long-term forecasting abilities are limited by the possibility of changing climate patterns due to global warming.

[141] Clarke (1992, pp. 97-98).
[142] Mjelde, Hill, Griffiths (1998, p. 1093).

Box 3.1. The Forecastibility of Selected Natural Hazards

Earthquakes

The exact time, location, and size of an earthquake cannot be assessed. According to Raleigh *et al*. (1982), severe plate boundary earthquakes recur at intervals that may vary by as much as 50 years. Still, it is possible to have an indication of the probability of an earthquake by studying historical record and the magnitude of present movements along active faults.

Volcanic Eruption

In the case of many volcanoes (such as the Soufriere Hills in Montserrat) major volcanic eruptions occur at interval of hundreds or even thousand of years, which makes prediction difficult. Nevertheless, geological study and dating of the volcano's deposits make it possible to determine the risk factor of a volcano: the smaller the ratio between the time elapsed since the volcano's last eruption and the longest repose between eruptions, the higher the risk of a future eruption. Shorter-term forecasts are much easier, since there is generally a time lag between the onset of an eruption and its catastrophic impact. Nevertheless, it is very difficult to predict the magnitude of an eruption and the delineation of danger zones, even in the short term, which often leads to unnecessary evacuations. In addition, because of costs incurred and accessibility problems, intensive monitoring—which provides best chances of success—only takes place in 12 volcanoes in the world.

Hurricanes

Hurricanes are easier to predict than earthquakes and volcanic eruptions because they tend to be seasonal. The degree of deviation from the average annual amount of events is much smaller than for other hazards. They also occur at shorter interval, which boosts the quality of the historical record available because of a high number of entries. Geological studies of coastal zones can also provide longer term historical data about hurricane occurrence.

El Niño

El Niño can be predicted through the monitoring and prediction of sea level surface. Predictions for 1997-1998 by the NCDEP (US) correctly forecast the occurrence of an El Niño event by November 1996, i.e., eleven months in advance. However, the magnitude of the event was underestimated until April 1998. Data gathered during this latest episode should contribute to improving the quality of forecast in terms of length of forecasting and reduction of margin of error.

Floods

The likelihood of flooding is more predictable than earthquakes, volcanic eruptions and landslides since floods are the result of excessive rainfall or snowmelt which can span over several weeks (except for flash floods created by storms). Flood prediction involves the determination of the amount of precipitation and resultant run-off in a given catchment area.

Sources: World Meteorological Organization (1999, p. 63); Raleigh *et al*. as cited in Bell (1999, p. 81); Bell (1999, pp. 38 and 76 and 261-263); Swiss Re (2000).

Vulnerability assessments are based upon information about the presence of population and assets exposed in the hazardous zones as well as their vulnerability to death, injury, damage and destruction. Vulnerability is very difficult to assess because it is multi-faceted, multi-sector and constantly evolving with changes in the economy and society, demographic growth migratory patterns and environmental degradation.

Nevertheless, several techniques can give some indication of a community or region's vulnerability. A survey of dwellings, commercial buildings and infrastructure (especially life-line infrastructure such as hospitals, potable water and electricity networks) and their construction type can provide a fairly accurate prediction of their resilience to the natural hazards present in a specific zone. In addition to this technical approach, a social approach based on selected social indicators can be used. For instance, poverty incidence maps provide a good basis for quantifying socio-economic vulnerability. At the community level, a more precise analysis would include the following information: poor households, women-headed households, ethnic minorities, recent residents or immigrants, concentration of children or elderly, renters, group living facilities, etc.[143] Surveying disaster experience at the community level is also extremely useful because it provides important information about the impact of past events, including smaller disasters, which are usually not taken into account into regional or national studies.

Prevention and Mitigation

Prevention and mitigation are designed to reduce risk by actively limiting natural hazards or reducing human and asset vulnerability to them. Hazard reduction is designed to directly reduce, when possible, the magnitude of a hazard. For instance, the construction of dams or the re-channeling of rivers can regulate the river flow and limit probabilities of floods downstream. Reforestation of watersheds and stabilization of unstable slopes can prevent the occurrence of landslides and floods. Water reservoirs and irrigation might reduce risks of seasonal droughts. Vulnerability reduction, on the other hand, focuses on reducing vulnerability of human settlements, infrastructure and economic activities to natural hazards. It includes structural activities such as retrofitting of infrastructure using hazard-resistant techniques; building mitigation infrastructure such as retaining walls; maintaining infrastructure and resettling populations at risk. It can also be based on non-structural instruments such as land-use planning, building codes and other regulatory instruments, economic incentives for pro-mitigation behavior and campaigns for education, training and awareness about risks and prevention.

3.2.2.2. Responses to Risk

Physical and Institutional Preparedness[144]

Disaster preparedness aims at lessening the impact of a disaster by structuring in advance the countries' ability to cope quickly and effectively with the emergency. Physical and institutional preparedness activities usually include hazard monitoring, forecasting, early warning systems, evacuation plans and shelters, specialized networks of responders and contingency plans in critical sectors. When warning is delivered in time and populations at risk are evacuated and gathered in shelter facilities, preparedness can save many lives. During the emergency phase, contingency plans for hospitals, utility companies and transportation infrastructure facilitate taking care of victims as well as reducing risks of epidemics following disasters. Contingency planning can also reduce recovery time by pre-establishing procedures and earmarking resources for the rapid rehabilitation of

[143] Morrow (1999, p. 10).
[144] This section is based on PAHO/WHO (1994, pp. 51-69).

infrastructure. Public campaigns that inform the general public about risks and disseminate life-saving tips in times of disasters are also part of preparedness. All these activities can be seen as reducing the risk associated with natural hazards because they save lives and reduce economic disruption. At the same time, they do not always provide for a long term and sizable reduction of risk because they focus on short–term damage control rather than reduction of vulnerability.

Financial Preparedness

Financial preparedness requires the quick mobilization of low-cost funds to finance emergency, rehabilitation and reconstruction activities through insurance, national reserve funds, or contingent financing. It also involves a quick disbursement capacity of funds both at the national and local level as well as transparent procurement practices to maximize the efficiency of reconstruction funds

Natural disasters can also be distinguished from other risks by their catastrophic nature. Like other disasters (epidemics, wars, technological disasters), natural disasters affect, albeit to various degrees, all individuals and assets in a given area and time. Losses associated with natural disasters are therefore correlated, violating one of the key rule for insurability: the law of large numbers, which predicts that a large enough group has almost no chance of experiencing the same adverse event at the same time.[145] Informal insurance arrangements are also less likely to function as all members of a community are hit simultaneously. Similarly, this correlation of risk has consequences on the availability and price of insurance, as well as risks of bankruptcy of the insurance sector and need for reinsurance schemes (Box 3.2).

[145] Kunreuther and Roth (1998, pp. 24-26).

Box 3.2. Are Disaster Risks Insurable?

Insurance is an economic institution that allows the transfer of financial risk from an individual to a pooled group of risks. The offer of disaster insurance is constrained by economic viability, assessibility of losses, adverse selection and, to a lesser extent, moral hazard. All the elements can result in market failure, whereby the supply of disaster insurance is null despite the existence of demand.

Economic Viability
Insurance markets exist because of the law of large numbers, which states that for a series of independent and identically distributed random variables, the variance of an average amount of a claim payment decreases as the number of claims increases. In the case of natural disasters, the variance associated with an individual loss is the variance of all the losses that occur from a specific disaster, making disasters catastrophic risks (Kunreuther and Roth, 1998). The higher degree of variance endangers the profitability of disaster insurance as companies face a sizable risk of insolvency (Albrecher, 1998). Solutions to this constraint include limitations to the coverage provided (deductibles, maximum pay-outs), pooling losses between territories with uncorrelated weather or seismic patterns or different hazards, purchasing reinsurance or using alternative risk transfers on the international financial markets, such as catastrophe (CAT) bonds.

Assessibility
The difficulties in assessing probable losses stems from the difficulty in evaluating the chances of occurrence of events and predicting the losses that might result from them, i.e., the degree of vulnerability. The necessary information can be gathered through the advancement of weather and geologic sciences, investments in risk assessments as well as better models for catastrophic loss prediction. If risk cannot be reduced to an acceptable level at a viable cost, then a limitation of the supply of disaster insurance will occur.

Adverse Selection
Disaster insurance demand tends to be lower than optimization would require. Demand for coverage tends to exist only in areas where risk cannot possibly be ignored due to its high severity and higher frequency, such as riverbanks. Adverse selection causes high premiums, on the order of several thousandths of the sum insured, which further depresses demand. Solutions include risk awareness campaigns and compulsory insurance schemes.

Moral Hazard
The availability of insurance might cause individuals to increase their exposure to risks, by choosing more hazardous locations or building materials. Moral hazard can be reduced through deductibles, premium differentiation according to the level of risk, or supply of insurance cover conditioned to adoption of mitigation techniques.
Source: Swiss Re (1998); Kunreuther and Roth (1998, pp. 23-25); Kahneman, Solvic and Tversky (1982); Camerer and Kunreuther (1989)

Public provision of insurance or reinsurance constitutes an alternative solution when markets fail to function (see Box 3.3). Nevertheless, this solution can be quite risky in fiscal terms due to the huge liability taken on by public finances, unless there are specific conditions set for state responsibility. The following box shows examples of public provision systems.

Box 3.3. Examples of Public Provision of Disaster Insurance or Reinsurance

United States
The National Flood Insurance Program provides insurance coverage against floods in eligible communities (where there is a flood risk assessment and a mitigation program in place), which results in adverse selection of communities. By the end of 1997, $430 billion was covered by the NFIP ,or 30-35% of assets in areas at risk of flooding. The NFIP does not seek reinsurance on international markets. This mechanism, supported by the Federal Emergency Management Agency, is currently indebted to the amount of US$800 million. In the case of the declaration of a national disaster area—50% of disasters—the Federal government grants loans at subsidized rates to victims of disasters, which discourages purchase of insurance.

Spain
Natural hazards are covered via the public corporation "Consorcio de Compensacion de Seguros", which receives a fixed proportion of every premium of property insurance contracted by the insurance industry. In the case of the declaration of a national disaster, the state is responsible for loss compensation, exempting the Consorcio from liabilities. Thanks to this mechanism, the penetration of disaster insurance is very high, but all risks are borne by the state alone, which can lead to huge liabilities.

Brazil
The Instituto de Resseguros in Brazil, which had a monopoly over reinsurance in the country, has been recently transformed into to into a joint stock company, whose majority of the shares is held by the Government. Fire risks (which include floods, the main hazard in Brazil) are its major line of business accounting for 33% of the total retained premium volume.

New financial instruments such as catastrophe bonds are also being developed to complement, or provide an alternative to, insurance and reinsurance. A catastrophe bond is a debt instrument whose principal is subject to reduction or even cancellation in the event of large catastrophe losses. A high interest rate premium is calculated to compensate investors against this sizable risk. This instrument, which appeared on the US market a few years ago, could be purchased by insurers of the region as a replacement for reinsurance. Companies, regional or federal states could directly issue their own CAT bonds to bypass insurance markets entirely. Another instrument available on international markets is weather derivatives, which protect companies from climate variability. These disintermediated instruments, which can be based on objective criteria such as maximum/minimum temperatures, rainfall and stream flow, are advantageous because they reduce moral hazard and enable countries and companies to tap directly into markets that are deeper and more liquid than the reinsurance market. From an investor's point of view, they offer an attractive portfolio diversification opportunity since weather events are highly uncorrelated to market fluctuations.[146]

Regional risk retention groups, or self-insurance, represent another alternative to dependence on insurance. The goal of a risk retention group is to constitute a reserve fund to be disbursed in the case of a disaster. It works as a self-insurance mechanism between participants (such as utility companies in various countries). It is based on the premise

[146] Shann (1999, pp. 26-30).

that weather or seismic patterns facing the various participants are not correlated. Risk-retention groups can also seek reinsurance on much better terms than individually through an insurance company. Nevertheless, such a system requires a great deal of monitoring and elaborate procedures for balancing obligations and benefits between the various contributors—which explains why there are no examples of such groups in the world.

Calamity funds are another alternative to insurance. They are reserve funds constituted out of budgetary resources designed to avert the need for emergency borrowing in the event of disasters. The advantage of a disaster fund is that funds can be made available immediately after a disaster and without restrictions, unlike external assistance, private debt or even insurance payments. Of course, the cost of accumulating reserves needs to be compared with the cost of obtaining contingent financing. In order to avoid the crowding-out of private insurance, funds should be spent on the reconstruction of uninsurable public and private assets exclusively. Funds could also be used to provide low-cost insurance schemes for the poorer segments of population.[147]

Contingent financing is still the main financial instrument used by developing countries affected by disasters. Most of the contingent financing is made of bilateral or international assistance in the form of grants and concessional or non-concessional lending. For heavily indebted countries, aid can also come through debt relief, which is common in the aftermath of major disasters. Only countries that have better access to international private markets resort to private funds on international markets. The availability of low-cost contingent financing tends to create perverse incentives to rely on post-disaster reaction rather than managing risks. Countries that prove unable to face the emergency are de facto rewarded by international aid, while countries willing to invest in prevention receive much less attention.

Outside of the moral hazard issue, the main problem of this mode of financing is the availability of funds and timing of disbursements. According to a 1988 estimate by Zupka, international aid following disasters rarely exceeds 4% of the losses incurred.[148] In 1993, Bender estimated that cumulative losses associated with disasters since 1960 amounted to 42% of all the development assistance to the region over that 33-year period.[149]

The IFRC estimates that the aggregate amount of official development assistance by principal donors has decreased by 16% between 1992 and 1996 in real terms, and a further 7% in 1997, reaching $43.8 billion. Other sources of funds such as NGOs and other donors, reached around 13% of total ODA in 1997.[150] After six years of growth, private funds have also decreased, starting in 1997. This overall decrease is happening at a time when the occurrence and costs of disasters in developing nations keep increasing. Because of these rising costs, the share of emergency-related assistance in total aid is

[147] OAS (1996).
[148] Zupka (1988) as cited by Anderson (1990, p. 20).
[149] Bender (1993, p. 1).
[150] IFRC (1999, p. 103).

increasing, to the detriment of long-term development aid. Emergency assistance, usually directed at disasters and civil wars (about 7% of total aid) has been increasing in the last few years.

The other issue facing affected countries is that international assistance is very slow to materialize, and sometimes comes too late, enabling irreparable damages or fatalities to occur. As shown by the study of IAASA (see Box 1.4), a one-year delay in assistance, which is standard for most massive reconstruction loans, results in adverse macroeconomic effects. The reasons for these delays are often internal to the affected country: they can include to delays in parliamentary ratification of loan contracts, lack of institutional capacities to design and implement reconstruction projects and the inability to fulfill disbursement conditions.

Emergency Response, Rehabilitation and Reconstruction[151]

This last phase in disaster management is critical to the economic recovery of an economy in the aftermath of a disaster. It includes humanitarian assistance, clean-up, temporary repairs and restoration of services, rehabilitation and reconstruction of damaged critical infrastructure, and revitalization of affected sectors (exports, tourism, agriculture, etc.). When disasters cause major damages, this phase can last up to five years and represent a very high financial cost for public finances if most of the reconstruction is financed by fiscal resources. While addressing the reconstruction issue in detail is beyond the scope of this paper, two key aspects should be stressed, the importance of adequate macroeconomic and social management and priority setting in reconstruction.

In the case of an extreme and widespread disaster, such as Hurricane Mitch, central and local governments have to put into place an adequate macroeconomic management scheme to tackle the expected shortfall in tax revenues, increased public expenditures, decline in exports and increase in imports. In addition, given the decline in foreign exchange earnings and the inflows of capital due to international assistance, foreign exchange policy might have to be modified. In order to lessen the impact of the shock on the poor, difficult choices have to be made at the macroeconomic level. In the case of the Dominican Republic, the government managed to keep a high growth rate in 1999, despite Hurricane Georges, by loosening both its fiscal and monetary policy. But this policy necessitated the postponement of debt service and resulted in the rise of inflationary pressures, which might endanger the country's future macroeconomic performance.[152] Similarly, while worsening the trade deficit, a timely increase in imports of basic food crops in Ecuador after 1997-98 El Niño prevented an increase in food prices and sheltered the poorest members of the population.[153] A pro-growth and pro-equity recovery and reconstruction program can also involve several public interventions on markets, including the expansion of workfare programs to absorb unemployment and the provision of targeted assistance for the most vulnerable populations. In the United States,

[151] Inter-American Development Bank (2000a, pp. 68-72).
[152] Economist Intelligence Unit (2000).
[153] Vos, Velasco and de Labastida (1999).

final effects of disasters on individual welfare are limited thanks to disaster unemployment benefits and Small Business Administration Programs.[154] During the 1979-1984 drought in Northeast Brazil, the program Frente de Trabalho employed 3 million workers in construction and drought-related jobs.[155] To avoid a credit crunch and encourage the revitalization of affected sectors, tariff exemptions on imported inputs and reconstruction materials should be granted, interest rates lowered and, when appropriate, credit institutions replenished.

Priority setting in reconstruction is a difficult process that responds more to political pressures than economic priorities or equity concerns. The economic priority should be to replace the lost capital stock, increase its productivity and decrease future vulnerability. Due to corruption, time pressure and lack of financing, though, low quality infrastructure is often rebuilt. The reconstruction period also constitutes a window of opportunity for correcting past mistakes or at least avoiding their amplification. Unfortunately, lack of funding and emergency needs often prevent the incorporation of a pro-mitigation component in reconstruction projects. According to UNDRO, reconstruction programs in Mexico City left unanswered most of the pre-disaster vulnerability issues of the city, because of the magnitude of direct losses ($3.8 billion) and an adverse macroeconomic environment that severely restrained public expenditures and the urgency of rehabilitating the capital of the country.[156]

Moreover, the reconstruction process often reinforces existing inequalities as political pressures influence reconstruction activities. Many low-income households and communities are left behind in the reconstruction process, which worsens poverty and inequality. For instance, a case study of the reconstruction after the 1970 earthquake in Peru shows that landowners were the first to receive new housing.[157] Finally, the lack of housing alternatives or access to property often pushes low-income populations to settle again in the same hazard-prone areas. To correct these biases, defining reconstruction plans through a transparent consultation process at the community level appears to be essential, as well as channeling reconstruction assistance via local NGOs.

3.3. Risk Management in the Region: Strengths and Weaknesses

Whereas the region's emergency response capacities and physical preparedness have improved, the Latin America and the Caribbean region still suffers from an under-investment in risk identification an disaster prevention compared with its level of risk (in terms of hazard occurrence, human lives and value of assets at risk). Moreover, the region's level of financial preparedness is inadequate, which magnifies risk of long-term adverse growth effects and increase of public indebtedness. Finally, the management of the reconstruction phase still needs improvement to avoid long-term growth and distributional effects.

[154] Barnett (1999, p. 141).
[155] Magalhaes and Glantz (1992, p. 25).
[156] PAHO/WHO (1994, p. 35).
[157] Blaikie, Cannon, Davis and Wisner (1994, p. 199).

3.3.1 Risk Identification

Except for projects sponsored by international assistance (see Box 3.4) and concerted efforts in some countries, risk assessments are still rarely undertaken in the region.

Box 3.4. The RADIUS Project in Latin America

In 1996, the Secretariat of the International Decade for Natural Disaster Reduction (IDNDR) launched a project for developing Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters (RADIUS). Three cities were analyzed in the region, Antofagasta (Chile), Guayaquil (Ecuador) and Tijuana (Mexico). Risk was evaluated for a given earthquake, whose location and magnitude was chosen in as a function of the local seismology. Vulnerability was estimated by combining estimated seismic intensity distribution with inventories of infrastructure and structures present in each city (see Table 3.2).

Table 3.2: Risk Assessment Studies of the RADIUS project in Latin America

	City characteristics			Earthquake hazard		Estimated impact or assessment of vulnerability		
City	*Population (m)*	*Area (km2)*	*Contribution to country's economy*	*Magnitude*	*Distance to city*	*Fatalities*	*Damages*	*Other information*
Antofagasta	0.22	90	6.5% of country's GNP; 31% of its exports	8	60 km	3,000	6% of buildings destroyed and 37% damaged	7,000 requiring hospitalization; 43,000 left homeless; 6 months to clear debris
Guayaquil	2.1	340	20% of country's GNP; 60% of its exports	8	200 km	26,000	$200 million in direct damages	53,000 requiring hospitalization; one week disruption of power supply and two weeks for potable water.
Tijuana	1.25	250	3.8% of country's GNP	6.5	10 km	18,000	1% of building destroyed and 35% severely damaged	37,000 injured; 130,000 homeless; 2 months for recovery of water supply

Source: Radius Initiative, http://unisdr/casela.htm.

Insurance companies, among the primary users of risk assessment, develop their own risk assessment systems but usually keep their information confidential for profitability reasons. A study of disaster management achievements for Central America and the Caribbean shows that most countries still lack decision-making tools as a result of the poor level of information available about risks. There are few hazard maps available, and multi-hazard maps are almost non-existent. Although the general features of hazards are well understood, there is especially a deficit in the identification of seismic activity on the Caribbean coast of Central America. The classification of risks by type of hazard is based upon past occurrence, without taking into consideration their destruction potential, which results in underestimating the risk represented by earthquakes. Meteorological hazards are generally better known, but research is still lagging in the area of long-term forecasting. Studies of vulnerability are very limited in scope and number and are not based on current vulnerability conditions due to a lack of current social data. Some countries, though, are comparatively more advanced than others, such as Cuba, Trinidad and Costa Rica. For instance, Costa Rica has strong research capacities with research institutions in the field of geology, geophysics and volcanology, climatology and meteorology as well as structural engineering. Almost all risk areas are mapped and integrated in a GIS available to the National Emergency Committee.[158]

3.3.2. Disaster Prevention and Mitigation

Governments in the region have focused their policies on getting prepared for and responding to disasters, rather than actively reducing risks. Almost none of the countries in the region has a national mitigation plan, with corresponding budgetary allocations and progress measurement indicators. Initiatives to mitigate risk have been few in the region and remain small-scale, uncoordinated efforts.[159] Despite overall underinvestment, there are examples of large-scale prevention and mitigation activities, which have been regarded as successful. In Argentina, El Niño and other climate or weather anomalies cause excessive rainfall in the wet Pampa, resulting in massive floods of several provinces of the country in the Great La Plata Basin along the Paraná river. The annual risk of flooding was estimated as a 1-in-10 chance that losses would reach $2 billion and 1 in 1,000 that damages reach or exceed $12 billion dollars or 0.92% of the country's total capital stock.[160] In 1997-98, the cost generated by El Niño amounted to more than $1 billion according to the Argentinean government. It is estimated that the $300 million in protective works carried out by the government between 1992 and 1997 prevented $950 million in damages.[161] The reinforcement of the Sabaneta Dam in the Dominican Republic provides another concrete illustration of a successful mitigation project (see Box 3.5).

[158] CRED (1997, pp. 60-65).
[159] CRED (1997, pp. 67-75).
[160] Freeman, McKellar, Martin, *et al.* (1999, pp. 8 and 13).
[161] Inter-American Development Bank (1998, p. 7).

Box 3.5. A Success Story of Mitigation:
The Case of the Sabaneta Dam in the Dominican Republic

Built by the Dominican Government in the 1980s, the Sabaneta Dam, designed to regulate water flows down the San Juan River, posed a sizeable risk of disaster, as leaks and damaged emergency spillways reduced the resistance of the dam structures and significantly increased risks of rupture in the event of heavy rainfall associated with hurricanes.

At the request of the Dominican government, the Inter-American Development Bank approved in 1993 the financing of an investment project that included preventive retrofitting works to overhaul the dike and other critical dam structures. Repair works, amounting to $10.7 million, were completed in the first part of 1998, just in time for Hurricane Georges, a category 3 hurricane with sustained center winds of 240 km/h. Among the hardest-hit areas in terms of rainfall associated with Georges, was precisely the province of San Juan de la Maguana, site of the Sabaneta Dam. In fact, 320 mm of rainfall were dumped in the San Juan River basin, and an estimated 255 mm poured directly on the dam. Nevertheless, the dam, spillways, powerhouse and stilling basin functioned to norm and experienced no significant damage, prompting a panel of experts to conclude that the works completed had proved highly effective.

The gains associated with the normal functioning of the dam during the hurricane were substantial. The San Juan river basin is the home of 174,900 people, most of them living downstream from the Sabaneta dam. The San Juan Valley is also the second most productive agricultural region in the country, with more than 10% of the total arable land and irrigable area of the country. A rupture of the dam would have resulted in heavy losses in human lives and agricultural production as well as major indirect losses caused by the disruption of production and related increases in unemployment and poverty rates.

Source: Inter-American Development Bank (2000b, p. 17)

In light of the low priority accorded to risk reduction, sectoral policies, which are essential for reducing risk in the long-term in the region, have largely contributed to increasing rather than decreasing risk.

Infrastructure Construction and Maintenance

Construction of infrastructure vulnerable to hazards and the general lack of maintenance is a major cause for the increase of disaster risks. The resilience of key infrastructure is an essential condition for avoiding disasters. Dam failures, collapse of bridges, hospitals and schools contribute to increase the disaster-related death toll throughout the region. For instance, the collapse of the modern wing of the Júarez Hospital in Mexico City during the 1985 earthquake caused many fatalities and paralyzed health care services at a time of urgent need.[162] Moreover, the vulnerability of infrastructure contributes to increasing the indirect costs of a disaster by paralyzing economic activities and increasing costs of reconstruction.

[162] PAHO (1994, p. 72).

Not only are infrastructure investments lagging in the region, but the quality of existing infrastructure also tends to be poor because of its original design and/or lack of maintenance. A survey conducted by the *Financial Times* estimates that the cost of maintenance and modest expansion of existing infrastructure in the region to amount to more than $60 billion a year for the power, transport, telecommunications and water and sewerage systems.[163] In terms of maintenance, only 27% of the total region's road network is in good condition, which puts $70 billion in road assets at increased risk of destruction in the event of hazards.[164]

In the region, the responsibility for building and maintaining infrastructure lies primarily with the public sector. Among the reasons for the failure of infrastructure management are the lack of public resources devoted to maintenance due to fiscal constraints and misallocation of resources. The transfer of maintenance responsibilities to state or local governments, which is part of ongoing decentralization efforts, has often worsened already bad situations as states have not been endowed with the financial resources needed to accomplish this task. Designs of new projects do not always include hazard-resistance techniques, even when they are built in hazard-prone zones, which results in their extreme vulnerability, as illustrated by the destruction of some of the infrastructure built by social investment funds in Honduras.[165] Retrofitting of existing infrastructure is quasi-absent in the region, except for some noteworthy projects such as hospital renovations conducted by PAHO in Costa Rica. Finally, the lack of transparency in procurement sometimes leads to corruption and poor quality of execution of works, reinforcing the weakness of infrastructure.[166]

Land Use, Development and Housing in Urban Areas

Faced with rapid demographic growth and rural-urban migrations, public authorities have largely failed to control the urbanization process in terms of its location, quality and pace. Malfunctioning land and housing markets, largely a result of inadequate regulations, have led to the exponential increase of informal settlements on squatted land, in hazardous areas, and using improper construction techniques. For instance, the total housing stock on squatted land amounted to $8.3 billion in Lima in 1982.[167] Evictions have been few because of the risk of urban protest. Regularizations have also been limited because of costs and fear of encouraging further squatting. This disrespect of property rights has led to decreased investments in the housing sector on the supply side. On the demand side, the insecurity of land tenure has had similar effects. Instead of making housing more affordable for the poor, government interventions (public housing, regulations of mortgages, rent controls, subsidies) have further distorted markets and dried up rental housing supply. Due to the high cost of formal construction, low-income groups resort to self-help. Finally, the overall lack of transportation and other infrastructure has made it more attractive to live closer to the city center, even on marginal lands. Given this

[163] *Financial Times*, Survey on Infrastructure in Latin America, September 13, 1996.
[164] World Bank (1992, pp. 3 and 5).
[165] Inter-American Development Bank (1992, p. 38 and 1999, p. 15).
[166] IFRC (1999, p. 89).
[167] World Bank (1993, p. 116).

situation, enforcing hazard-resistant standards and building codes is rarely a political priority or even a feasible policy.

Environment and Natural Resources Management

Although most countries have begun to adapt their legal and regulatory framework in order to achieve more sustainable development, environmental degradation and misuse of natural resources remains a pervasive problem throughout the region. Existing conservation and resource management rules are rarely implemented due to inadequate monitoring and enforcement mechanisms and the weakness of public institutions in charge of the environment. Most public policies still give a priority to economic growth without internalizing environmental costs and addressing the socio-economic roots of environmental degradation.[168] They have largely failed to decrease the rate of deforestation, promote sustainable agricultural practices and protect coastal areas. The region's forests, largely publicly-owned, have not been adequately protected against land-clearing by local settlers and migrants and expansion of agriculture. Zoning and land use regulations that would discriminate between areas suitable for agriculture and forests to be protected do not exist or are not enforced. The insecurity of land tenure in rural areas has made more attractive rent profit by depleting natural resources. It has also discouraged intensification of agriculture and on-farm long-term investments.[169] Effective economic incentives for sustainable agriculture and forest management are still rare. In coastal areas, public policy has focused on attracting investments by financing large-scale infrastructure projects and giving explicit or hidden subsidies to coastal activities via, for example, the sale of underpriced public land. Combined with the absence of a sustainable coastal management plan and clear property rights on natural resources, these massive investments have contributed to natural resources depletion, coastal erosion and coral reef disappearance, endangering the profitability of the very activities they were supposed to foster.[170]

3.3.3 Preparedness

For a long time, disaster management was mainly understood in the region as an issue of public order. Therefore, response to disasters was largely conducted by military forces. The quality of disaster response in the Americas improved as Civil Defense Committees were established both at national and local levels during the 1970s to organize and coordinate relief and rescue operations.[171] As a result, the average death toll of disasters has decreased or remained stable despite the larger number of people at risk.

In the 1980s and 1990s, some countries started to formulate national preparedness plans and create new institutions in charge of disaster management, such as the National System for Disaster Prevention and Response in Colombia or the Comision Nacional de Emergencias in Costa Rica. National emergency plans were drafted and coordination between various agencies reinforced to pre-define priorities for handling emergencies.

[168] UNEP (2000, p. 279).
[169] Jaramillo and Kelly (1999, pp. 6-8); Laarman (1999, p. 6 and 25).
[170] Lemay (1998, pp. 16-20).
[171] PAHO/WHO (1994, chapters ii,iii and iv).

Forecasting, monitoring, early warning, evacuation and sheltering capacities were also strengthened at the national and local levels. Seismograph and accelerograph networks were put in place in earthquake-prone countries such as Peru and Mexico. Monitoring of flood risks also improved in vulnerable regions, such as the Atlantic Coast of Costa Rica. Preparedness information, such as information campaigns in the Caribbean in preparation for the hurricane season, started to be disseminated at the community level. Finally, contingency plans were put into place in the health care, water supply and sanitation systems. A common System for the Management of Relief Supplies (SUMA) was introduced in most countries of the region to rationalize the emergency phase. Border and regional cooperation also improved with the creation of common institutions, such as CEPREDENAC and CDERA, and bilateral cooperation agreements.

Financial preparedness is much less developed in the region. Given that disaster self-insurance at a community scale appears to be of limited utility, formal insurance is an important tool to spread catastrophic risk among groups and across time. Among other factors, large insurance payments, which reached 2% of the country's GDP, enabled real growth of GDP in the Dominican Republic to accelerate to an estimated 8% in 1999, despite the shock of hurricane Georges (loss-to-output ratio of 13%).[172]

Notwithstanding this example, disaster insurance coverage is fairly limited in the region. Insurance coverage is generally low in the Latin America: premiums as a share of GDP range between 0.5% and 2.7% (in comparison, the US has 3.4% coverage). Penetration is even lower in the case of natural disaster insurance. According to the World Bank, only 150,000 houses out of 16 million (i.e., less than 1%) had disaster insurance coverage in Mexico in 1998. This very low coverage is due to the fact that many houses are not insurable because they are not built with solid materials or lack access to potable water (about 50% of total housing stock). It is also a function of very high premium prices in earthquake-prone zones, which amounts to 0.5% of the value of housing on an annual basis. In the formal sector, the rate of coverage was 90% for industrial enterprises and 50% for commercial enterprises. But the estimated rate of coverage in the informal sector was only 2%.[173] Similarly, an insurance market survey by Swiss Re in Argentina, Ecuador and Brazil indicated that the rate of coverage of flood insurance (despite floods being the most frequent natural disaster) is in the low to very low range for individuals and moderate for the businesses.[174] This low rate of coverage means that the share of insured losses in total losses is extremely small: in the case of the disaster that hit Venezuela in 1999, Swiss Re reports that only $400 million were insured, i.e., 1.4% of total losses. In Colombia, the rate of insurance coverage for the Quindio earthquake was 4.4%.[175]

The degree of risk retention by insurers in the region is usually very low, unless the state has a legal monopoly over reinsurance. This low risk retention means that insurance prices are closely related to the price of world reinsurance, whose rate depends

[172] Economist Intelligence Unit (2000, p. 6); IMF (1998).
[173] World Bank (1999a, p. 26).
[174] Swiss Re (1998).
[175] Swiss Re (2000, pp. 10, 17).

primarily on the losses experienced in developed countries such as the US, Europe and Japan. In the Caribbean, national insurers keep only 15% of the risk involved in disaster insurance.[176] Similarly, in Mexico, insurance companies retained between 20 and 30% of the risk on fire insurance (which includes disaster insurance); 68% of the 1.1 billion pesos collected for disaster insurance in 1997 went to reinsurance companies. The rates on line paid (reinsurance premium paid as a percentage of the layer of catastrophe reinsurance purchased) reached 4.5% in 1995 in Mexico, after huge losses incurred by the industry worldwide.[177] In the Caribbean, property insurance rates increased sharply without any relationship with the underlying risk (see Table 3.3).

Table 3.3

Indicative rate for Caribbean Property Insurance (premium as percentage of amount insured)							
1990	1991	1992	1993	1994	1995	1996	1997
0.4	0.45	0.5	1	1.3	1	0.95	0.8

Source: World Bank (1999b).

In addition to the limitations inherent in disaster insurance (see Box 3.3), reasons for this lack of coverage include the non-insurability of many assets in the region, high insurance premium prices, regulatory obstacles to the development of insurance and perverse incentives given by the unconditional availability of national and international assistance.

Irregular settlements without property title or valuation and dwellings built without solid materials or lacking access to potable water or adequate drainage constitute a significant part of the housing stock in the region, and these dwellings are considered uninsurable. The relatively high price of premiums (as a percentage of property value) stems from many factors, among them the high level of risk in the region, high administrative costs, and low risk retention by insurers. Moreover, there are regulatory obstacles to the development of insurance. First and foremost restrictions on foreign entry into insurance markets results in the existence of too many small insurance companies, unable to spread risks on their own due to their limited capitalization and geographical coverage. Reserve requirements can be quite cumbersome, especially when they are not exempted from taxes or cannot be invested overseas. In Mexico, for instance, the reserve requirement amounts to 35% of total catastrophe premiums.[178] Finally, the amount of national and international assistance, which represents an unconditional subsidy to risk-takers, can be detrimental to the development of demand for disaster insurance.[179] In extreme cases, when many of the factors above feed into each other, the availability of disaster insurance can be null. In several instances, such as Montserrat in 1997, reinsurers withdrew entirely from some of the Caribbean islands in an effort to reduce exposure to risk.[180]

[176] OAS (1996, p. 3).
[177] World Bank (1999b, p. 27).
[178] World Bank (1999a, pp. 2-8).
[179] Kunreuther and Roth (1998, p. 3).
[180] Oxford Analytica Brief September 3, 1997:1; Worldwatch Institute Press Briefing, March 26, 1999.

As a result of the unavailability of insurance, some countries have put into place their own calamity funds. Since most of these funds are very recent, it is still too early to draw conclusions about their usefulness (see Box 3.6).

Box 3.6. Natural Disaster Funds in Latin America and the Caribbean

In 1996 Mexico created a federal calamity fund of 200 million dollars in the federal budget. [181] One of the explicit goals of this fund is to reduce dependency on external funds for managing disaster risks. The Fondo para Desastres Naturales, whose funds come from federal and state fiscal resources, earmarks funds for the repair of uninsured infrastructure, immediate assistance to restore the production of subsistence farmers and relief to low-income victims of disasters.

The Assembly of Puerto Rico in 1994 voted for the creation of a Reserve for Catastrophe Losses under which a portion of property insurance premiums is passed, with tax deduction, to a trust. It is anticipated that this mechanism will improve the availability and affordability of catastrophe insurance and reduce the dependency of Puerto Rican insurers on foreign reinsurance.

In Colombia, the federal government, regions and localities are all obligated by law to dedicate a part of their budget to the constitutions on natural disaster reserve funds. In October 1999, Costa Rica and Nicaragua reformed their institutional disaster management systems and created national funds for financing future emergencies. Honduras also announced its intention to create a similar fund.

Source: Inter-American Development Bank (2000d); Organization of American States (1996).

In fact, the region still largely depends on international assistance to cope with disasters. In the case of the Inter-American Development Bank, disaster-related assistance in response to natural disasters has substantially increased reaching $1.5 billion over the last four years, 10 times more than in the past 15 years on an annual basis.[182] The bulk of that aid was directed towards reconstruction efforts in the Dominican Republic, Honduras, Venezuela, Colombia, Peru and Ecuador. While increasing, international assistance remains largely insufficient to cover rising disaster costs in the region. Here again, the case of Honduras is instructive. The estimated $544 million in committed official development assistance for 1999[183] pales in comparison with the total cost of the hurricane (amounting to several billions of dollars). Moreover, most of the reconstruction funds have still not been disbursed today, i.e., 18 months after Hurricane Mitch.

Moreover, international assistance is largely unconditioned, providing perverse incentives for countries to adopt reactive policies towards disasters. PAHO cites the example of Cuba, which has managed to improve its preparedness, preventing most fatalities in the case of hurricanes, but has received little international assistance for reconstruction.[184] By contrast, official development assistance commitments to Honduras

[181] Information given by Mexican Minister of Social Development Esteban Moctezuma in his keynote address at the IDB Conference on Social Protection and Poverty on February 4, 1999.
[182] Inter-American Development Bank (2000b, p. 1).
[183] This figure includes only aid from governments and multilateral intergovernmental agencies. Non-govermental organizations are excluded. OECD (1998).
[184] PAHO (1994, p. 68).

increased by an estimated 500% between 1998 and 1999.[185] Instead of requiring future investments in prevention, most funds are delivered without conditions to countries affected by disasters. Projects that would encourage autonomous risk management such as initial funds to encourage the creation of risk-retention groups, the purchase of insurance or use of other financial instruments, are either non-existent or at a very nascent stage.

3.3.4 Emergency and Reconstruction

The experience of recent disasters shows that the overall quality of post-disaster macroeconomic management has improved as social programs expenditures were protected and social investment funds were used to quicken delivery and improve targeting of the assistance to affected victims. Nevertheless, efforts still need to be made to improve the disbursement capacities of line ministries in charge of post-disaster activities, as well as transparency and equity in the use of funds. Too often, these funds are still used by governments as political bargaining chips to reward their supporters and punish opponents. Moreover, the reconstruction is still barely used as an opportunity to reduce future vulnerability. In Central America, some of the destroyed infrastructure was rebuilt at the same place, using the same techniques. On the other hand, due to the severity of the disasters that hit the region in the last three years, there is a renewed willingness on the part of governments to better manage risk, which is fueled by the demand for safety in civil society. This change might contribute to improving the quality of future reconstruction efforts.

3.4 Improving Public Policy: Finding an Adequate Policy Mix

As highlighted in above sections, the goal of public policy is to determine the nature and level of disaster management that maximizes society's welfare. A short discussion follows of essential questions that need to be answered to achieve a better policy mix in the region. The answer to these questions might vary according to the level of hazard proneness, socio-economic vulnerability and institutional capacities of the countries in the region.

Risk Reduction or Post-Disaster Response?

Because disasters cause fatalities, mitigation and preparedness policies should be considered a priority. It is well established that adequate investments in mitigation and preparedness contribute to saving lives. In pure economic and financial terms, the cost of risk reduction has to be inferior to the economic cost of a disaster to justify an investment in mitigation. At the project level, the cost-benefit analysis of disaster mitigation should measure the internal rates of return with or without mitigation as well as the coefficient of variation of return with or without disasters.[186] General studies about the benefits of mitigation tend to indicate that the cost of prevention of disaster is generally much lower than the toll taken by a catastrophic event. The World Bank and USGS have calculated that economic losses worldwide from natural disasters in the 1990s could have been

[185] OECD (1999).

[186] Kramer (1995) in Munasinghe and Clarke (1995, p. 72).

reduced by as much as $280 billion by investing around $40 billion in risk reduction strategies.[187] A recent study of costs and benefits of risk reduction reported that the $3.15 billion invested in China to control floods over the last 40 years has averted losses of an estimated $12 billion to the Chinese economy.[188] In terms of infrastructure, the US Federal Emergency Management Agency (FEMA) estimates that the cost of including hurricane and earthquake resistant techniques in larger scale projects amounts only to 0.5% to 2% of the total initial cost of the building.[189] The retrofitting of a bridge, though expensive, is only 23% of its replacement cost. A study of three counties in the Los Angeles area showed that equipping them with high seismic design standards would reduce the costs of a major earthquake by $24.8 billion, or 66%.[190] Moreover, investments in disaster mitigation and preparedness yield economic benefits on their own, creating employment and generating activity. By providing a safer environment, they might also encourage greater investment rate in the economy. Finally, investments in risk reduction might avert irreversible—or close to irreversible—loss of natural resources such as arable soil or forests.

Even if the benefits of mitigation are clearly identified, there seems to be a clear under-investment in mitigation and preparedness, not only in developing countries but also in developed countries. The causes of under-investment in risk reduction are many, among them the fact that safety from natural disasters is a public good, which explains why it is not adequately provided by markets. From a political economy point of view, several factors seem to explain why public policy tends to fail at providing adequate levels of safety. First, due to the absence of perfect information and the absence of rationality in the face of risk, demand for safety from constituents seems to be limited, except during the immediate aftermath of a disaster. Moreover, there are no specific and organized interest groups that experiences losses from disasters and would be ready to invest in lobbying politicians for more safety. On the supply side, investment in disaster prevention is essentially a strategy of long-term protection of welfare. Therefore, incentives for investing political power into long-term safety benefits are limited for decision-makers as benefits are intangible and occur in a period longer than most political mandates. On the contrary, post-disaster situations can yield political benefits. Insurance coverage and international assistance that are not conditioned upon adoption of mitigation are other disincentives to investments in prevention.

What Type of Risk Reduction?

Choosing an adequate mix among various types of risk reduction is essential to ensure the effectiveness and sustainability of prevention initiatives. The trade-offs and synergies between preparedness and mitigation are a first element to consider. Depending on the type of hazard and the level of vulnerability, it might be more effective to invest in preparedness than structural mitigation. For instance, it might be more feasible, both

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[187] Twigg (1997, p. 12).

[188] This observation does not provide a straightforward picture of the cost-benefit of these mitigation measures, since it does not give the present value of these past investments, but one could assume that the bulk of them were made fairly recently. Twigg (1997, p. 12).

[189] PAHO/WHO (1994).

[190] FEMA (1996).

politically and financially, to evacuate communities located in the vicinity of a volcano when early signs of volcanic eruption occur, rather than relocate these communities in a safer area. But preparedness is generally not sufficient: while it saves lives, it leaves assets vulnerable to destruction, resulting in massive costs for individuals and communities. Moreover, preparedness is more effective for certain hazards than others. For instance, hurricanes and volcanic eruptions can often be predicted in time for evacuation, while earthquakes cannot. In terms of mitigation, preventive policies such as land use planning and standards guiding density, type, construction and rate of development in hazard-prone areas are much more effective and feasible than corrective policies. Once settlements and assets exist, viable options for mitigation are few, as relocation and retrofitting or mitigation infrastructure can be very costly, both at the financial and political levels.

The Share of Responsibilities Between Local, Regional and National Levels

The occurrence of disasters mainly depends on local conditions such as the presence of a specific hazard and the vulnerability of the zone potentially affected. Therefore, a significant portion of the information, regulatory and budgetary capacities should be decentralized. Risk assessment mitigation and preparedness activities are much more effective when they are based on community participation at the local level. With the technical support of national agencies, local governments should be in charge of defining risk reduction strategies, disseminating risk information and enforcing land use regulations.

Nevertheless, several studies in the United States have shown that local communities, even when aware of hazards, tend not to invest in mitigation by themselves unless there are federal incentive programs in place.[191] Central intervention is essential to provide political pressure on local governments, identify priorities, ensure an adequate allocation of resources and settle conflicts of interests. Special attention has to be devoted to smaller and poorer localities that have fewer risk management capacities, as they tend to receive less funding than more organized and larger communities.[192] Moreover, when threats are regional or national, there might be a need for close cooperation among local authorities at regional, national or even international levels, as in the case of many of the region's watersheds, which run over borders. Finally, since disasters are covariant phenomena (for the community or region affected), the cost of rehabilitation and reconstruction has to be financed in part with funds external to the area affected. Financial solidarity is necessary to accelerate the recovery of the stricken area. When the most common hazards are nationwide, as in Central America or the Caribbean, resources should be put in common at the international level. But external funding raises the issue of moral hazard, which should be minimized by conditioning access to funding on the use of mitigation techniques during reconstruction.

[191] Berke (1998, p. 80).
[192] Berke (1998, p. 84).

Direct Intervention or Market-Based Solutions?

In the absence of public intervention, normally functioning markets do not seem to guarantee adequate protection of welfare against natural hazards, mainly due to a lack of accurate information, public good and moral hazard issues. Nevertheless, experience has shown that public policy solely based on a regulatory approach is less effective than market-based interventions.

In many areas in the region, land-use regulations and building codes are already in place but are not enforced. In certain cases, too-stringent regulations have contributed to worsening risk as they have forced low-income populations into illegal settlements. Economic incentives such as tax-credit and other financial incentives for pro-mitigation behavior can be developed to complement regulations. Moreover, public policy must contribute to better-functioning land, housing and mortgage markets so as to encourage the adequate pricing of risk by the market.

The role of the state in the production of accurate risk assessments and forecasting is essential since markets do not provide by themselves high quality, publicly available information on risk. Fostering scientific research, improving available technology and ensuring the dissemination of results to end-users is a logical responsibility for the state. Nevertheless, institutions in charge of research and prevention of disasters are generally grossly under-funded in Latin America and the Caribbean. International cooperation and partial privatization might provide better results. For instance, the commercialization of the products of meteorological agencies might provide them with additional resources as well as better links with end-users.[193]

Public responsibility for construction, maintenance and reconstruction of infrastructure is a huge liability for the state in hazard-prone countries, especially when assets are not insured. The privatization of infrastructure has the advantage of limiting such liability. It is nonetheless necessary that privatization plans take into account the risk of disasters and, more specifically, the need for prompt rehabilitation of water, electric and transportation systems in the aftermath of a disaster. Public monitoring of insurance coverage and contingency plans of privatized utilities might be necessary to avoid bankruptcy and paralysis of key infrastructure.

In the presence of low insurance coverage, governments might be tempted to provide insurance directly, as in the case of the National Flood Insurance Program in the United States, or play the role of insurer of last resort through explicit reinsurance mechanisms or implicit guarantees. In countries extremely prone to hazards, such a strategy implies a huge liability on the part of state. This can be extremely costly in the long run as it encourages moral hazard on the part of individuals and insurers, and implies massive mobilization of fiscal resources or contingent financing when disasters occur.

[193] IDB (2000c).

Alternative approaches should be explored. On the supply side, opening markets to foreign competition, encouraging mergers and the formation of reserves should improve the quantity and quality of the availability of insurance and the capacity for risk retention. On the demand side, incentives to purchase insurance can be put in place both for individuals and firms through tax credits, mortgage access regulations, or the inclusion of disaster insurance in fire insurance. The purchase of insurance for public infrastructure would also provide a sizable increase in demand, as would a limitation of the type of assets and households eligible for reconstruction assistance.

Conclusion

As demonstrated in this paper, the risk of natural disasters in the Latin American and Caribbean poses a sizable threat to the preservation and continuation of the regional socio-economic development process. In fact, as Woodrow and Anderson point out, "Development is the process by which a nation's capacities are increased and vulnerabilities decreased."[194] Instead of decreasing the exposure of the region to severe natural hazards might be increasing because of climate change. Despite improvements in disaster preparedness and response capacities, the region's population and economic activity is still extremely vulnerable to the adverse effects of disasters.

In contrast with the 1980s, the economic progress achieved in the last decade puts the region on a better foot to manage these rising disaster risks thanks to the improved macroeconomic stability and wider access to financial markets. Nevertheless, given that markets are unlikely to achieve a level of safety guaranteeing welfare against natural disasters, government intervention, together with international assistance, appears essential to the better management of risk.

Until recently, national governments and international aid have focused on emergency response and the reconstruction of destroyed assets instead of the reduction of risk. These reactive policies have contributed to the increase of risk by encouraging vulnerability-enhancing behavior on the part of individuals, firms and public services. Too often, public interventions have ignored market mechanisms and tried to create safety through regulations or public control of disaster insurance. Finally, risk management projects have more often than not tried to impose "one size fits all" solutions, whereas the level of hazard proneness, disaster vulnerability and management capacities widely varies at the local level.

The probable increase in the cost and frequency of disasters makes this traditional approach unsustainable. A more comprehensive approach to disaster management, which attempts to maximize protection of welfare through an adequate policy-mix, is badly needed. Given the importance of local conditions, the complexity and inter-sectorality of vulnerability, dialogue at local, national and regional levels is necessary to define an acceptable level of risk, identify risk reduction priorities and implement concrete initiatives.

[194] Woodrow, Anderson (1989) as cited by Anderson (1992).

To comply with its development objectives for the region, the international donor community should encourage the adoption of more proactive policies by providing financing for risk identification and reduction programs in the region. Instead of focusing resources on post-disaster assistance, development programs should attempt to bolster the financial preparedness of the region by encouraging the development of insurance and other risk-spreading mechanisms. This new focus would give autonomous coping capacities to the countries affected and provide incentives for risk reduction. But it would also guarantee that other important development goals are not jeopardized by the need to reallocate resources, disaster after disaster, to costly emergency and reconstruction activities, which could have been largely avoided through appropriate risk management.

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