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National and Local Vulnerability to Climate-Related Disasters in Latin America: The Role of Social Asset-Based Adaptation

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The Latin American region is particularly prone to climate-related natural hazards. However, this article argues that natural hazards are only partly to blame for the region's vulnerability to natural disasters with quantitative evidence suggesting instead that income per capita and inequality are main determinants of natural disaster mortality in Latin America. Locally, the region's poor are particularly susceptible to climate-related natural hazards. As a result of their limited access to capital, adaptation based on social assets constitutes an effective coping strategy. Evidence from Bolivia and Belize illustrates the importance of social assets in protecting the most vulnerable against natural disasters.

Keywords: climate change, natural disasters, poverty, social assets.

The Latin American region experiences more climate-related hazards per capita than any other region. The relatively poor countries of Guatemala, Nicaragua and Honduras are particularly vulnerable (Biles and Cobos, 2007). The UN's Intergovernmental Panel on Climate Change (IPCC) estimates that climate change and variability will increase the region's risk of exposure to natural hazards in the near future. Yet, the risks of natural disasters, this article argues, stem less from the region's exposure to natural hazards, and more from the specific socio-economic profiles of the Latin American countries. The article, therefore, focuses on the disconnect between natural hazards and natural disasters. The article demonstrates that hazard hotspots are not necessarily disaster zones. Further, cross-country quantitative evidence suggests that the main determinants of natural disaster in Latin America are not only related to the frequency of natural hazards but also to income per capita and income inequality. These factors are all found to be significantly associated with higher natural disaster mortality per capita.

Such aggregate, cross-country analysis, however, provides little information on local susceptibility to disasters, and it does not uncover disaster vulnerability across different

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social groups. Although social assets are often found to play a key role at the community level, they are not easily captured by aggregate analysis. Social assets have not received much attention in disaster management because of the tendency to treat disaster management mostly as an engineering issue calling for technical solutions. While the 2010 World Development Report explicitly acknowledged that local communities typically precede national government in climate action (World Bank, 2009: 20), only 20 per cent of the National Adaptation Programs of Action (NAPA) documents prepared by environmental ministries incorporate local institutions as the focus of adaptation projects (Agrawal, 2008). This article illustrates the importance of social assets in protecting the vulnerable against natural disasters by drawing on experience from Bolivia and Belize. Building social assets at community level could be a cost-effective way of improving disaster management in Latin America.

Natural Hazards and Disasters in Latin America

Patterns and Trends of Natural Hazards

Flooding and landslides are common in Latin America, which has complex river basin systems and mountainous terrain (Biles and Cobos, 2007). Tropical storms and hurricanes, formed in both the Pacific and Atlantic Oceans, are frequent throughout the region. Cross-national statistics on natural disasters are being compiled by the World Health Organization (WHO) Collaborating Centre for Research on the Epidemiology of Disasters in their Emergency Events Database (EM-DAT). To date, the incidence of storm-related hazards has been highest in Mexico, along with the Central American sub-regions – areas that are in the pathways of both western Atlantic and eastern Pacific hurricanes and tropical storms (Charveriat, 2000; EM-DAT, 2010). Since 1970, more than 40,000 Atlantic and Pacific hurricanes and tropical storms have been recorded (EM-DAT, 2010). Floods are the most common natural hazard in the region accounting for 40 per cent of the region's total natural disaster incidents (EM-DAT, 2010). Flooding tends to be associated with hurricanes and other tropical storms, which generate very heavy rainfall continuing over several days (Charveriat, 2000).

The patterns of natural hazards reveal that areas most prone to hazards are also the poorest. The areas at highest risk from storms and flooding include Guatemala, Nicaragua and Honduras in Central America; and the Bolivian, Peruvian and Brazilian Amazon regions in South America. Areas highly vulnerable to drought include Northeast Brazil, the arid Andean region (particularly Bolivia and Peru), and the North of Mexico (United Nations Environment Programme (UNEP), 2005).

Looking ahead, various authoritative projections suggest that climate change will increase Latin America's exposure to natural hazards (Mendelsohn and Williams, 2004; Simms and Reid, 2006; Nagy et al., 2006; IPCC, 2007a; Vergara, 2007; United Nations Development Programme (UNDP), 2008; World Bank, 2009). The number of extremely hot days is likely to increase, while the number of very cold days will decrease. Average precipitation in the region is also projected to rise in the coming decades and so too is the intensity and frequency of extreme precipitation. The risk that these trends will lead to increased risk of flooding and landslides is high. The mid-continental areas such as the inner Amazon basin and northern Mexico, however, are projected to become dryer during the summer months – with a greater risk of drought and forest fires (UNEP, 2005; IPCC, 2007b). The IPCC (2007b: 588) notes that changes in these types of extreme events as a result of climate change and variability are already affecting several agricultural sectors today.

With respect to future small-scale atmospheric phenomena such as hurricanes, cyclones and storm surges, the IPCC projects an increase in precipitation intensity in future storms. This projection is supported by more recent higher-resolution models projecting increases in peak wind intensities with some consistency, and a rise in mean and peak precipitation intensities in future tropical cyclones with even greater consistency (IPCC, 2007a). The increased variability will also increasingly create surprises, such as hazards occurring in succession, or in places where they have never been experienced before. In 2004, for instance, a hurricane developed for the first time in recorded history in the South Atlantic, hitting Brazil, which left NASA hurricane researcher Robbie Hood puzzled: 'Hurricanes aren't supposed to be in that part of the world' (NASA, 2004).

Patterns and Trends of Natural Disasters

A natural disaster can be defined as a temporary event, triggered by a biophysical hazard that overwhelms local response capacity and seriously affects social and economic development (Hodell, Curtis and Brenner, 1995). There is a consensus that natural disasters have increased worldwide during recent decades, whether in frequency, numbers of people affected, or amounts of economic damage (UNDP, 2004a, 2008; Red Cross/Red Crescent, 2007; UNEP, 2007). The EM-DAT (2010) database reveals that the rise in natural disasters has been caused almost wholly by a doubling of weather-related hazards, which in part can be attributed to population movements (people are increasingly moving to hazard-prone areas) and economic development (people have more to lose). Globally, these disasters (mainly floods, droughts and storms) increased from about 125 annually in the 1980s to more than 300 annually in the 2000s (EM-DAT, 2010). The number of people affected worldwide increased from around 50 million annually in the 1970s to more than 200 million annually in the 2000s (EM-DAT, 2010). The brunt of this increase in extreme weather is being borne by the developing world, and, within the developing world, by the poorest parts of the population.

An analysis of weather shocks in Latin America in the 40-year period 1970–2009 is consistent with this general picture. Table 1 illustrates the incidence of the three major types of weather-related disasters during 1970–2009. It shows that floods and storms account for the clear majority of disasters, and that the trend is rising substantially, quadrupling from 79 in the period 1970–1979 to 332 in the period 2000–2009.

Table 1. Frequencies of Major Weather-Related Disasters (Floods, Droughts, and Storms) in Latin America, 1970–2009

Frequencies	Droughts	Floods	Storms	Total
2000–2009	33	239	93	365
1990–1999	24	123	63	210
1980–1989	14	101	28	143
1970–1979	9	60	19	88
Total	80	523	203	806

Source: EM-DAT (2010).
A disaster is identified if at least one of the following four criteria has been fulfilled: (a) more than 10 people killed; (b) 100 or more people reported to be affected; (c) declaration of a state of emergency; and (d) call for international assistance (EM-DAT, 2010).

Table 2. Key Natural Disaster Indicators for South America, Central America and Latin America, 1970–2009

	South America	Central America	Latin America total
Incidents annually	12.5	8.9	21.3
Incidents annually % Latin America	58	42	100
Incidents annually/million inhabitants	0.0	0.1	0.1
Incidents annually/km^2	0.0	0.0	0.0
Affected annually	2,705,868	581,346	3,287,213
Affected annually % Latin America	82	18	100
Affected annually/million inhabitants	9,160	5,310	8,119
Affected annually/km^2	0.2	0.23	0.16
Fatalities annually	1,085	951	2,036
Fatalities annually % Latin America	53	47	100
Fatalities annually/million inhabitants	4	9	5
Fatalities annually/km^2	0.0	0.0	0.0
Homeless annually	73,940	25,385	99,325
Homeless annually % Latin America	74	26	100
Homeless annually/million inhabitants	250	232	245
Homeless annually/km^2	0.0	0.0	0.0
Damage annually (US$ ’000)	782,718	841,322	1,624,040
Damage annually % Latin America	48	52	100
Damage (US$ ’000) annually/million inhabitants	2,650	7,684	4,011
Damage (US$ ’000) annually/km^2	0.0	0.3	0.1

Source: EM-DAT (2010).

The level, type, and frequency of natural hazards and their impacts vary widely across Latin America. Table 2 presents key natural disaster aggregate data for Central America, South America and Latin America as a whole.

Most of the weather-related hazards occur in South America, with 12.5 incidents a year compared to 8.9 for Central America. South America is also the sub-region where the disasters cause the greatest number of fatalities (53 per cent of the regional total) and which has the greatest share of affected population (82 per cent). The number of incidents and people affected are mainly driven by the large countries in the regions (Mexico for Central America and Brazil for South America), while the fatalities are mainly driven by two specific disasters in the relatively poor Honduras in Central America and the more affluent Venezuela in South America. Almost 15,000 lost their lives when Hurricane Mitch hit Honduras in 1998, and in 1999 Venezuela experienced torrential rains, which generated flash floods in Vargas killing around 30,000 people (EM-DAT, 2010).

By taking account of total land area and population size, however, the picture changes. Now Central America appears to be the most vulnerable region, with nine annual fatalities per population million compared to South America’s four fatalities/million per year. Honduras and Nicaragua increase the mortality average for Central America, while Venezuela augments the average for South America. Thus, although weather-related disasters are more frequent in South America, the disasters cause more fatalities per capita in Central America. One reason may be that relatively more infrastructure is in place in South America compared to Central America. Both Brazil and Mexico, despite having many disasters and affected people, experienced some of lowest per capita fatality ratios. Peru and Colombia experienced moderately fewer disasters but suffered significantly greater damage and fatalities. Guatemala, Nicaragua and Honduras, with moderate numbers of disasters, rank highest in fatalities per capita.

Table 2 also shows that for each person who died in climate-related calamities in Latin America during 1970–2009, another 1,615 were adversely affected to the extent that they required assistance to survive. While droughts only led to a negligible loss of life (less than a 100), they affected more than 60 million people between 1970 and 2009 in Latin America, while floods affected 54 million, and storms 14 million (EM-DAT, 2010).

Aggregate Vulnerability to Natural Disasters in Latin America

A natural hazard is a necessary but not a sufficient condition for a natural disaster. Though Latin America is likely to face more intense and/or more frequent weather-based natural hazards such as floods, droughts, storms and extreme temperatures, the extent to which these hazards will pose serious problems depends on local vulnerabilities. A comparison of weather-related hazards and actual disasters across Latin America shows only a limited relationship between numbers of hazards vis-à-vis numbers of people killed, people affected and people injured (all good indicators for whether a hazard has turned into a disaster).

According to UNEP's Global Environmental Outlook Data Portal (UNEP, 2008), the highest flooding hazard frequency in Latin America is found along the Amazon River through Bolivia, Peru and Amazonas in Brazil, but flooding fatalities are actually much more pronounced in parts of the region that only have a moderate flooding intensity: the northern parts of South America and Mexico, along with extensive parts of Central America. Similarly, while the most frequent storm hazards arise from the Pacific Ocean along the coast of Mexico, the highest mortality rates from storms are caused by the storms in the Atlantic Ocean, which affect the Caribbean region as well as Honduras and Nicaragua (UNEP, 2008).

The explanation as to why countries with extensive floods do not necessarily have high disaster mortalities could be that flooding along the Amazon occurs on a regular basis, and people living nearby have adjusted their way of living to this seasonal occurrence. Only when the floods are higher than usual – or indeed fail to materialize – does it cause problems. People living in areas that do not regularly experience floods have no social memory and little institutional response capable of preventing these hazards from turning into disasters. We will elaborate further on the importance of social memory later in the article.

Hence, for both types of disasters there appears to be only a limited overlap between frequencies and the mortality hotspots. Disaster occurrence and impact are related to the level of socio-economic development: poorer countries and areas tend to suffer proportionately more fatalities and injuries. This limited correlation between natural hazards and natural disasters begs the question of which socio-economic factors might influence Latin America's vulnerability to natural disasters.

This question can be approached quantitatively by testing the link between socio-economic factors and people killed or affected by natural disasters. A few studies have approached this subject (UNDP, 2004a; Kahn, 2005; Toya and Skidmore, 2007; Roberts and Parks 2007; Noy, 2009). The first comprehensive study is the 2004 quantitative study conducted by the UNDP's Bureau for Crisis Prevention and Recovery in the Reducing Disaster Risk report (UNDP, 2004a). The report contains analyses of the link between various socio-economic variables and people killed by different types of natural disasters. By performing numerous stepwise linear regressions of the effect of different socio-economic variables on people killed by floods and storms, the UNDP identified the most robust model specifications and significant variables. What seemed to determine much of the variation in the number of people killed by floods was the physical exposure to floods, the local population density in watershed areas (with a counter-intuitive negative sign) and gross domestic product (GDP) per capita (UNDP, 2004a: 111). In the case of storms, the number killed by cyclones was significantly correlated with physical exposure to cyclones, each of the two key proxies for development (UNDP's Human Development Index and GDP per capita), and the percentage of arable land.

This article augments the UNDP analysis by including additional socio-economic variables and focusing on Latin America. It places a stronger emphasis on poverty and inequality by adding the following socio-economic variables (averaged over the period): undernourishment (per cent), people below the national poverty-line (per cent), income share of the poorest 20 per cent, mortality rate for children under five, and the Gini-Index. In order to test the widespread hypothesis (most famously forwarded by Nobel Laureate Amartya Sen, 1999) that democracies are pressured by opposition parties and the free press to promptly mitigate the adverse affects of disasters, the regression will also contain proxies for the political system (the Political Rights Index devised by Freedom House (2010)), a proxy of written press impact (newspaper circulation) and an interaction term of the two to capture any synergetic effects. A list of variables and their sources is presented below in Table 3.

Besides the usual data-related problems (present in all quantitative analyses of complex socio-economic relationships) of having to work with limited observations, measurement errors and poorly designed proxies, an analysis of disasters suffers from at least two additional caveats. First, natural disasters are unique events that are difficult to compare cross-country. What appear to be quite similar natural hazards can generate vastly different outcomes because the differences are neither caught in the frequency (or even intensity) measures nor are they caught in the country's socio-economic variables. A slightly different path of a hurricane or the timing of an earthquake can mean the difference between a small calamity and a major catastrophe. This kind of 'butterfly effect' that renders the disaster outcome highly sensitive to minor variations makes it difficult to quantify disasters and to compare them diachronically or cross-country. While being able to work with a large number of occurrences might reduce this bias, disasters are by their very nature idiosyncratic, extreme events, which brings us to the second caveat. Rare, extreme observations make it difficult to operate with panel data because one is faced with many zero value observations (no disaster) and a few high value observations (disaster).

The bias can be minimised by relying on zero-inflated negative binomial models (as in Kahn, 2005; Neumayer and Plümper, 2009) or, as chosen by the UNDP (2004b) and Roberts and Parks (2007), by transforming the data to cross-country data of period averages. Even such cross-country data averaged over several years might produce high average values as a result of a few large-scale disasters in certain countries. The authors of the UNDP report have chosen to exclude such observations in order to reduce variance and thus optimize the robustness of the results. Accordingly, Venezuela, with the extreme 1999 flood, is excluded from the flood-regressions and the hurricane Mitch-exposed

Table 3. List of Variables and Their Sources

Variables	Source	Transformed $\hat{y}_i = y_i/(1 - y_i)$
Dependent		
Killed per capita of natural disaster	UNDP (2004b) and WDI (2010)	No
Independent		
Population living in exposed area multiplied by the frequency of the hazard	UNDP (2004b)	Yes
Natural disaster frequency	UNDP (2004b)	No
Human development index	UNDP (2004b)	Yes
Political rights	Freedom House (2010)	No
Interaction term newspaper circulation and political rights	WDI (2010) and Freedom House	No
Mortality rate, under-5 (per 1000)	WDI (2010)	No
Daily newspapers (per 1000 people)	WDI (2010)	No
People below the national poverty-line (%)	WDI (2010)	Yes
Income share of the poorest 20 per cent (%),	WDI (2010)	Yes
Arable land (% of land area)	WDI (2010)	Yes
Prevalence of undernourishment (% of population)	WDI (2010)	Yes
Poverty headcount ratio at rural poverty line (% of rural population)	WDI (2010)	Yes
GPD per capita	WDI (2010)	No
Gini-Index	WDI (2010)	Yes
Latin American dummy	n/a	No

Source: WDI 2010; Freedom House 2010; UNDP 2004(b).
All variables averaged over the period 1980–2000. Variables were transformed (when needed) to constitute a continuous variable, and then logged to allow for linear regressions of the models: $\ln(K) = \ln(C) + \alpha_1 \ln(V_1) + \alpha_2 \ln(V_2) + \ldots \alpha_p \ln(V_p)$ where K is the number of persons killed per capita by floods or cyclones, and Vi are the above exogenous variables where α is the exponent of V.

Honduras and Nicaragua are excluded from the storm-regressions. However, there do not appear to be any valid theoretical arguments for excluding countries based on the extremity of the disaster. The analysis in this article will therefore be based on a larger sample of countries despite adverse effects on the robustness. Very convincing arguments are needed to exclude countries such as Venezuela, which accounts for one-fifth of the flood-related deaths globally; the extremity of the event by itself does not appear to be a valid argument in an analysis of disasters. On a final note, before turning to the results, the UNDP report operates with the number of people killed (logged) as their dependent variable, while we have chosen to focus on the number of people killed *per capita* (logged) as this better reflects people's vulnerability to natural disasters (Roberts and Parks, 2007; Cavallo et al., 2010).

Column 1 in Table 4 presents the determinants of floods. The significant variables emerging from the stepwise logged linear regressions are the percentage of people exposed to floods (which increases natural disaster fatalities), the income per capita (which decreases fatalities) and income inequality (which leads to higher fatalities). To separate out the effect of Latin America, a dummy for the region was included in column 2, which undermined the significance of the inequality variable, thus indicating that much of the correlation is driven by the many flood-related deaths in the highly

Table 4. Summary of Reduced Form Regressions Predicting Mortality for Floods and Storms, 1980–2000

	1. Log (killed/capita floods) (reduced form, $N = 91$)			2. Log (killed/capita floods) (incl. dummy, $N = 91$)			3. Log (killed/capita storms) (reduced form, $N = 30$)		
Variable	*B*	*SE B*	*B*	*B*	*SE B*	β	*B*	*SE B*	β
Log (exposure)	0.64	0.11	0.45*	0.55	0.13	0.38*	0.51	0.32	0.30
Log (GDP/capita)	−0.59	0.13	−0.38*	−0.63	0.14	−0.40*	−0.79	0.38	−0.33**
Log (Gini-index)	0.94	0.35	0.23*	0.63	0.43	0.15	—	—	—
Log (arable land)	—	—	—	—	—	—	0.58	0.30	0.30***
Dummy LA	—	—	—	0.60	0.84	0.14	1.11	0.70	0.25
R^2		0.46			0.47			0.36	

*$p < 0.01$; **$p < 0.05$; ***$p < 0.1$.

Source: WDI 2010; Freedom House 2010; UNDP 2004(b).

income-unequal Latin American region. The political proxies all turned insignificant in the smaller sample of countries for which data were available. Excluding all factors relating directly to the natural events (frequencies, exposure and density) only produces two significant variables, namely that being a Latin American country will increase the risk of dying as a result of natural disasters, while a high income level will decrease the risk. Our analyses also revealed that the annual number of people exposed to floods depends on the frequency of floods as well as just being located in the Latin America region, while the overall number of people killed in the disaster is mostly dependent on the country's GDP per capita.

With storms in column 3, the results were less robust but, in general, fairly close to those reported by the UNDP's Bureau for Crisis Prevention and Recovery. Hence, expanding the number of countries, changing the dependent variable to per capita and including additional socio-economic variables as well as a dummy for Latin America did not alter the basic findings. We still found a significant negative effect of each of the two key proxies for development (UNDP's Human Development Index and GDP per capita) on storm mortality and a positive significant (10 per cent level) impact of arable land.

Contrary to Kahn's analysis where one of the regressions produced a negative correlation between the level of democracy and total death toll from natural disasters, the political variables in this analysis all turned out to be insignificant. The inconsistency could be caused by two factors (besides working with different model-specifications). First, according to Kahn's (2005) analyses it appears that although democracies experience natural disasters more frequently, the mortality per disaster is lower than in autocracies. Thus, we have two opposing forces that could be responsible for cancelling out the effect of democracy in cases where the dependent variable measures mortality per year. Second, Kahn's result does not appear robust enough to support his conclusion that 'all else equal, democracies do experience less death from disaster' (Kahn, 2005:14). In the majority of Kahn's regressions, the level of democracy turns out to be insignificant, and in the few cases it enters significantly it undermines the significance of the GDP per capita because of problems with multicollinearity: because democracy and GDP per capita are so closely correlated, it is difficult to separate out any independent effect. Hence, the political system might have an effect on the impact from natural disasters (whether in the form of reducing exposure or mortality), but more research is necessary to establish the correlation more rigorously.

Cuba is an often cited case of an authoritarian regime with an effective natural disaster management system that has been highly praised by the UN (UN, 2004, 2011). The disaster response is very well organised, building on a clear system of accountability, strong local government institutions and a high degree of social learning. All Cubans, for instance, are obliged to participate in a two-day disaster exercise each year (Bermejo, 2006). The results are noticeable. While 600 people lost their lives in the Caribbean because of 1998 hurricane George, only four perished in Cuba. More than 3,000 died when hurricane Jeanne hit Haiti in 2004 but no one died when it struck Cuba with even greater force. In 2004, Hurricane Charley claimed the lives of 30 in Florida, while only four succumbed to the disaster in Cuba (Bermejo, 2006).

In conclusion, it appears that one of the most robust findings was the effect of income on lowering flood and storm disaster mortality in Latin America. This is consistent with most existing global studies (UNDP, 2004a; Kahn, 2005; Toya and Skidmore, 2007; Noy, 2009). With their more structural perspective on the determinants of natural disaster vulnerability, Robert and Parks (2007), however, hypothesise that income might be an intervening variable accounting for historically determined disadvantaged positions in the world economy. While this is indeed plausible backed as it is by convincing quantitative evidence (Robert and Parks, 2007: 222–223), it does not reduce the fact that wealth, regardless of deeper historical and structural injustices, is a strong predictor of natural disaster mortality.

By including social variables, this study supports another finding of Roberts and Parks (2007: 128–129), namely that income inequality appears to increase the number of fatalities per capita from natural disasters. In this study, countries with greater income inequality appeared to experience higher flood mortalities even after controlling for frequency and income-level. This result, however, appears to be driven by the Latin American countries. The significance of the Latin American dummy was also quite a robust result (for floods), and it could indicate that additional factors not captured in the model might explain Latin America's susceptibility to natural disasters. In Kahn's (2005) analysis the Latin American dummy also enters significantly in both his total disaster regression and the flood regression. One explanation for the Latin American susceptibility to natural disasters could relate back to the more structural explanations that have already been covered by Roberts and Parks (2007). Another explanation, pursued in this article, could ascribe them to more local dynamics not easily captured in national-level quantitative proxies and model specifications. This is in line with Satterthwaite et al.'s (2007: 62) findings that community adaptive capacity is a stronger determinant of the distribution of vulnerability to climate change than differences in biophysical responses. Thus, the significance of the Latin American dummy coupled with the relatively few robust findings emerging from the quantitative studies appear to merit more context-specific studies of climate change and disasters in Latin America.

One important caveat concerning the studies above is that they are based on national data, while the impact of disasters will often be local. Thus, disaggregated analysis at sub-national level is very much called for. A related caveat with the studies above is the fact that it leaves out the central question of which groups are affected by natural disasters. Different groups are not equally exposed to natural hazards, but rather the exposure depends on people's income, class, citizenship, gender, age, disability, ethnicity, and so on. Thus, the question of interest is not only how many have succumbed to a particular disaster but also who? The vulnerability of a community, based on IPCC's (2007c) definition of vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, depends on location-specific geophysical, social and economic circumstances.

Local Vulnerability to Natural Disasters in Latin America

One of the key determinants of vulnerability on both the national and local level is poverty. Not only do low-income countries suffer more from natural disasters, but poor people in low-income countries also suffer disproportionately (Simms and Reid, 2006; Satterthwaite et al., 2007; Rossing, Rubin and Brisson, 2010).

In Latin America, 17 per cent of the population – or about 100 million people – live in poverty (less than $2/day), while 8 per cent (45 million) are extremely poor (less than $1.25/day) (World Bank, 2008a). Poverty is not evenly distributed in the region. In Bolivia, Honduras and Nicaragua, between 30 and 50 per cent of the population live on less than $2 a day, while in Chile and Costa Rica less than 10 per cent of the population is considered poor (World Bank, 2008b). The number of poor people has decreased slightly since 1990 for the region as whole, but poverty has increased in some of the poorest countries in the region: El Salvador, Colombia and Honduras (World Bank, 2008b).

The concentration of poverty is a central determinant of disaster vulnerability. Owing to the densely congregated nature of the urban landscape, where 65 per cent of the region's poor live (Ravallion et al., 2007), residents are at increased risk of being trapped in a large-scale disaster zone when a natural hazard strikes (Hardoy and Pandiella, 2009). Poor housing conditions and lack of infrastructure pose great challenges for limiting the spread of disease and delivering emergency assistance. In rural areas, households are particularly vulnerable to the erosion of the natural resource base upon which their livelihoods are built. Their dependence on land, as a source of food and income, coupled with lack of physical and financial adaptive capacity means that poor farmers are also at increased risk of impact from slow-onset disasters.

The majority of low-income settlements in urban and rural areas in Latin America tend to be located in inhospitable areas prone to flooding, landslides or drought (Simms and Reid, 2006; IPCC, 2007b; Hardoy and Pandiella, 2009). Such low-income settlements at constant risk from hurricanes and flooding can be found in many of the Central American countries. The poor in urban settlements in the region's cities and mega cities have their livelihoods destroyed year after year because they reside in areas prone to mudslides and flooding during the rainy season.

The poor not only bear the brunt of weather shocks, but they also recover more slowly. When Hurricane Mitch swept through Honduras in 1998, the poor lost 15–20 per cent of their assets, while the richest only lost 3 per cent (World Bank, 2009: 42). Assets may be recovered quickly or not, depending on the severity and frequency of the disasters and the strategies used to cope. To cope with shocks, poor households who lack credit and insurance may be forced to dispose of their productive assets or adopt erosive coping mechanisms. In Honduras after Hurricane Mitch in 1998, the poorest households appeared to be forced into long-term poverty traps, as they had to dispose of valuable assets needed for recovery (De la Fuente, 2007). As a result of the loss of plantations, Dole and Chiquita laid off around 25,000 workers in Honduras following Mitch (Roberts and Parks, 2007: 86). These were vulnerable people living in very poor conditions in the most flood-prone areas. As a result, they struggled for two to three years, or longer, after the shocks to recover their previous asset levels (De la Fuente, 2007). Vicious circles might therefore develop in particularly hazard-prone areas affected by recurrent disasters, such as the coastal areas of Nicaragua, Peru, Ecuador or Northeast Brazil.

In summary, the poor are usually the most immediately and strongly affected by climate shocks because they lack the assets needed to cope. Communication and organisation networks are often last to be activated for the poor, leaving them without timely information about how to reduce their risk and protect their assets.

The Need for Social Asset-Based Adaptation in Latin America

The failure of the quantitative model to fully account for Latin America's high natural disaster mortality combined with the local nature of most natural disasters merits increased attention to local level vulnerability predictors and adaptation measures. From a policy perspective such a focus also appears warranted, as structural disadvantages and aggregate predictors of vulnerability (GDP per capita and inequality) can only be improved gradually, if at all. Hence, there is a need to focus on solutions on the ground and the benefits of community-based adaptation to climate-related disasters are increasingly recognised (Simms and Reid, 2006; Satterthwaite et al., 2007).

One of the most cost-effective ways to increase local resilience is to develop the social asset base (Rossing et al., 2010). Research shows that communities endowed with social networks are more likely to cope better with adverse situations (World Bank, 2009: 43). The way in which individuals and groups within a society interact with each other, through mechanisms such as risk sharing, mutual assistance and collective action, influences their vulnerability and resilience to natural disasters (Adger, 2003; Pelling, 2011). Social assets build on the concept of social capital: social assets are the end-product of social capital put to constructive use. Interactions through gender relations, intra-household relations, participation in associations and organisations, and inter-household relations including politics and markets, play a core role in the formation of social assets. As such, social assets express the communities' social memory, learning ability and degree of self-organisation – all essential skills in disaster adaptation and reconstruction. Self-organisation and social learning, according to Pelling (2011), are integral to all forms of adaptations. Satterthwaite et al. (2007) reach a similar conclusion in their study of climate change adaptation in urban areas: 'adaptation is all about the quality of local knowledge and of local capacity and willingness to act' (Satterthwaite et al., 2007: 51).

Thus far, attention to social assets in disaster management has been rare. Even when the World Bank in their 2010 Development Report (2009: 19) talks about the need for ingenuity and new tools and knowledge, the report's focus is limited to the role of natural, physical and human capital in adaptation. Poor households in Latin America, however, often lack precisely these types of capital. Social assets could therefore be an important tool in increasing their adaptive capacity and resilience, despite the covariate nature of disasters, if properly developed. Consider the importance placed on social assets by the most vulnerable communities in Chiapas. A study asked respondents to rate different possible sources of financing for disaster relief by scoring them between one (irrelevant) and five (very important) (Saldaña-Zorrilla, 2006). The study found that in times of stress community members relied heavily on social assets: relatives living within the community were scored to be the most important source of disaster finance, with neighbour solidarity coming in third.

Two brief cases are presented here to illustrate the importance and nature of social asset-based adaptation in Latin America. The cases are based on short field visits to the affected communities in March 2008 for Bolivia and in June 2008 for Belize in connection with commissioned work for the World Bank on Climate Change (see Verner, 2010). The field-sites were purposely selected based on the existence of recent flooding disasters. Additional examples of social asset-based adaptation in Latin America can be found in Simms and Reid (2006) and Bollin (2003).

Social Asset-based Adaptation in Two Poor Bolivian Communities

The importance of social assets in natural disaster management can be highlighted by a comparative study from a field visit to the subsistence communities of Mecapaca and Palca, both located in the La Paz Department in Bolivia. During the period December 2007 to January 2008, Bolivia was hit by torrential rains that resulted in severe flooding in large parts of the country. While the visited subsistence communities all suffered great losses, findings revealed how they dealt with them in different ways.

The Huayhuasi community consists of subsistence farmers, and is located in Mecapaca. As a result of the rain, severe flooding from the nearby river devastated the community, washing away the majority of their crops, damaging some houses beyond repair and sweeping away others altogether. Once the floods receded, a moonscape of debris, mud, rocks and stones remained, and it was estimated that it would take the community two years to clear the land before being able to cultivate it again, affecting food security and income in the intervening period. However, group interviews revealed that those hardest hit by the floods were to a large extent being helped by others who were less hard hit. During group interviews the participants were asked the hypothetical question: 'If you could ask for three things, what would they be?' Invariably a request for helping those hardest hit led the list, even when those people were not represented in the group being interviewed. Hence, even though some people essentially lost their livelihoods, strong social assets in the community enabled them to remain in the village, instead of being forced to migrate to La Paz for alternative income opportunities.

Another subsistence farmer community, Palca, was also severely affected by the floods, but appears to have reacted differently. Floods destroyed a century-old system of irrigation canals dug into the mountainside. As a result, the community was cut off from its crucial water supply, which is fed by glacial melt above them. To restore the water supply and return the farms to their former productive capacity, the infrastructure would need repairing, involving the instalment of new plastic pipes at a cost of US$ 10,000; something that could have been implemented quite quickly. Although the inhabitants were collectively dependent on the irrigation system, the majority thought and acted individualistically. This tendency for individualistic behaviour has also been observed by Wamsler (2007) in her study of fifteen disaster-prone slum communities in El Salvador. In Palca, many farmers appeared very despondent and did not think it would be possible to mobilise the needed assistance and funds for the repair of their water supply. Also, they did not have the level of self-organisation to jointly seek assistance or loans to finance the replacement of the pipes.

Social Asset-based Adaptation in the Stann Creek District in Belize

In May 2008 the tropical storms Arthur and Alma brought more than 25 cm of rain across Belize within 36 hours, which led to the worst flooding the country had ever experienced, affecting 80 per cent of its population of some 300,000.

In Stann Creek, a poor rural district of about 10,000 people, most of the villagers were caught by surprise. Though people in Belize are psychologically prepared for the storm/wind effects of hurricanes, few had perceived that the country is actually much more vulnerable to flooding, including flooding inland from heavy rainfall not necessarily related to coastal storms. The community's social memory was limited. Previous floods had risen gradually and only to about a meter, but on this occasion water levels rose as high as 2 or 3 meters within a few seconds, trapping some people in their houses and sweeping others away. The areas hardest hit were around the poorest part of Stann Creek. More than 20 homes were destroyed and 200–300 were severely damaged, displacing about 4,000 people. However, it appears that only five people died.

The low disaster mortality as well as the prompt post-disaster recovery process can at least be partly attributed to the community's social assets. Despite high poverty levels in the district, community members were able to self-organise in the immediate aftermath of the disaster. The least affected quickly and willingly reached out to people who had lost everything, providing them with temporary shelter or taking care of their children, while the clean-up process was initiated. Belongings and necessities such as food, water and clothes were proactively shared among the affected. The fact that fishermen from a nearby village came almost immediately to the rescue in their boats helped to save many lives. The local mayor was one of the first people on the spot. Possibly because of the considerable trust the community members already placed in him, he played a vital role in establishing shelters and organising the distribution of emergency supplies, in close collaboration with the army, which sent troops to the area almost immediately.

Part of the reason why the recovery process began so promptly was that members of the community, along with municipal officials and local branches of various non-governmental organisations (NGOs) had expanded their social assets through awareness raising and self-organising. The Red Cross was already present in the village when the disaster struck, and had implemented a pilot programme to train the community in emergency preparedness six months prior to the disaster. Even though the programme had not yet installed early warning systems, it had pioneered the creation of community networks (based on extensive female participation), which could be put in charge of key disaster management: carry out rescue missions, rehabilitate local infrastructure and distribute food.

The way in which the community, with negligible financial means, aided by local government officials and NGOs, was able to respond to this unprecedented flooding suggests that there is a clear role for social asset-based adaptation in poor communities.

Conclusion

Latin America has been hit hard by natural disasters during the last 40 years, and the trend is likely to continue as climate change increases the intensity and variability of natural hazards. Yet, the good news is that hotspots of natural hazards and natural disasters in Latin America are only partially overlapping. Socio-economic characteristics, most notably income per capita and inequality in Latin America, appear to have a substantial effect on national vulnerability to natural disasters. However, since most disasters have local impacts, and since adaptive capacity depends heavily on local dynamics, it seems appropriate to also focus attention to the livelihood strategies of poor communities. On a local level, vulnerability is closely related with community assets, most notably social memory and the capacity for self-organisation, which are not easily captured by national indicators. Experience from Belize and Bolivia suggests that climate change adaptation in Latin America could be enhanced through encouraging social asset-based formation at the local level.

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