

NATURAL DISASTER AND VULNERABILITY

by

Jeff Dayton-Johnson

- The frequency and the human and financial costs of natural disasters in developing countries are rising.
- *Hazards* like drought, earthquake, epidemics, floods, windstorms are naturally occurring, but *disasters* are not; unfavourable conditions such as irregular urban settlements and weak regulatory practices render a society much more vulnerable and less resilient to shocks.
- Taking action before shocks hit is more cost-effective than addressing social and economic consequences after the fact.
- The poor suffer most. To reduce vulnerability to shocks, governments should increase the human capital and diversify physical assets of poorer members of society, while monitoring and enforcing building codes and standards.
- International agencies and the private sector can explore ways to create innovative financial instruments to pool disaster risk and to provide insurance against it.

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Natural Disasters in their Economic Context

The tsunami disaster in the Indian Ocean on 26 December 2004, to which more than 225 000 deaths had been attributed by the United Nations' six-month review in June 2005, elicited a worldwide humanitarian relief effort unprecedented in its scale; individuals, firms, non-governmental organisations and governments rapidly marshalled billions of dollars of assistance. Even as reconstruction was barely underway, however, many observers could not escape concluding that many of the dead, the injured, the displaced, were victims primarily because they were poor, and that even a rudimentary early-warning system and relief-mobilisation infrastructure might have prevented thousands of deaths. The 2004 tsunami focused attention on global willingness to help those affected by natural disaster, but also on the enormous costs of failing to mitigate such disasters.

This *Policy Brief* focuses on the variety of country experiences with what John Stuart Mill called Nature's "injustice, ruin, and death" — droughts, earthquakes, epidemics, floods, wind storms — in the developing world. In particular, the *Policy Brief* seeks to distil lessons for mitigating people's vulnerability to ruin and death, thereby attacking the evident injustice of these events¹. The amount of aid channelled into disaster relief has increased by a factor of five in recent decades; given that overall aid flows were (until quite recently) stagnant, disaster relief as a component of aid thus looms larger than ever before. As a consequence donors are especially pressed to ensure the cost-effectiveness of disaster-relief efforts.

There is furthermore a growing concern that the magnitude of the human consequences of such disasters is growing over time. Global climate change, for example, might be increasing the frequency of El Niño events, which lead with regularity to drought, fires, flooding and famine. The warming of the surface of the Atlantic Ocean might be increasing the frequency and severity of hurricanes. Settlement of previously unpopulated forest environments may lie behind the proliferation of hitherto unknown diseases, including avian flus, sudden acute respiratory syndrome (SARS) and the human immunodeficiency virus (HIV), which were likely transmitted from animal carriers.

This *Policy Brief* poses, and seeks to answer, two questions. *First*, is the risk of natural disasters a *development* issue? The *second* question is whether there is a role for domestic and international development policy to address the risk of natural disasters. Demonstrating the link between disasters and development, as well as distilling policy-relevant lessons from a review of research requires a clearer understanding of just what is meant by the concept of *natural disaster*. For that reason, this brief proposes a conceptual framework for assessing the

development-related dimensions of natural disasters. In particular, the brief defines *adaptive capacity* as a combination of a society's *ex ante* (i.e. before the fact) vulnerability to damages from natural hazards and its *ex post* (i.e. after the fact) resilience or ability to cope with the damages that result.

Natural disaster is distinct from natural *hazards* (drought, earthquake, epidemics, floods, windstorms). Two different societies may be exposed to the same hazard risk, but differ in terms of their adaptive capacity. Thus policies that increase adaptive capacity — especially *ex ante* measures — stand a real chance of reducing the cost of disasters. These policies must mobilise national, regional and local governments, international agencies and the private sector.

Natural Disasters and Development: A Conceptual Framework

What can governments and international organisations learn from the varied experience of preparing for and recovering from natural disasters in the past century? Answering this question requires some understanding of what is meant by natural disasters, of social risk management, and of the link between disasters and poverty.

Natural Hazards and Natural Disasters

Natural disasters are not entirely natural, nor indeed the result of solely external factors. The enormous meteorite that is believed to have struck a remote and virtually unpopulated region of Siberia in 1908 was about as close to a truly external shock, and naturally-occurring to boot, as one can come, but it was not a disaster, since no one was affected. The leak of poisonous methyl isocyanate gas from the Union Carbide pesticide plant on the outskirts of Bhopal, India, in December 1984, which immediately killed more than 3 000 people, was, by contrast, a genuine disaster, but it was certainly not natural in origin. For our purposes, natural disasters lie somewhere in between the Siberian meteorite and the Bhopal tragedy, combining features of both. While the Bhopal disaster was clearly “man-made” in origin, many apparently natural disasters are arguably man-made as well, at least in part. For example, earthquakes have far more disastrous consequences where building codes are not rigorously enforced (as in Turkey in 1999 or Mexico City in 1985), thus producing a disaster, than they do in other circumstances, where they may not. In this example and many others, there are proximate or underlying causes that are socially produced.

We can distinguish between *natural hazards*, which are geophysical events such as volcanic eruptions, floods, earthquakes or tsunamis, and *natural disasters*, which involve the interaction of natural hazards and social systems. Two societies might face a similar *exposure* to natural hazards, but they may have different vulnerabilities to the damages that ensue from the hazard. These hazards are thus essentially external shocks, but the resulting disasters are not. *Disasters* occur when societies are vulnerable to such hazards. If natural disasters are indeed increasing in frequency, this likely arises not only because of global-warming-induced increases in the frequency of hazards, but rather because of increased vulnerability to them when they occur.

Note two aspects of these hazards: they are difficult to predict, and they have negative effects ranging from mild to truly catastrophic. Indeed, research on disaster-prone Latin American and Caribbean economies over the period 1970-99 reveals that disasters are followed by a substantial decline in the growth rates of output and investment, a moderate decline in the rate of growth of consumption, and a worsening of the current account of the balance of payments².

Social Risk Management and Natural Disasters

The World Bank has developed a useful framework for policy analysis that they call *social risk management*³. They categorise risks as idiosyncratic (affecting a single household) or covariant (affecting several households at once, and thus limiting the extent to which neighbouring households can pool such risks). They consider the strengths and weaknesses of the various actors that can address these risks: households, communities, non-governmental organisations, governments, and international organisations. Finally, they propose a typology of the responses those actors can deploy to manage risk: *risk prevention*, actions intended to reduce the likelihood of adverse risks occurring at all; *risk mitigation*, actions intended to reduce the damages associated with risks should they occur; and *risk coping*, actions taken after the fact.

Natural disasters are covariant risks *par excellence*, striking entire regions or countries at once; consequently governments or indeed international organisations (or both) are the appropriate actors to undertake risk management. Here, the characteristics of the country matter in a purely physical sense. Flooding of the Yangtze River in China (as occurred to disastrous effect in 1998) might affect as many households as a hurricane that strikes St. Kitts and Nevis; the larger size of the Chinese economy, however, means that the national government might be able to respond (by pooling risk across regions, for example) in ways not available

to St. Kitts and Nevis, given that the whole of the Caribbean nation will be affected by the hurricane. Informal, community-based strategies will be limited in their capacity to manage disaster risks. (Nevertheless, national or international efforts might be more effective in communities with denser social networks.)

Natural Disasters, Poverty and Development

Natural disasters are decidedly a development issue, for at least five reasons. *First*, natural disasters disproportionately strike developing countries, as the lion's share of volcanic activity and El Niño-related events occur in developing countries, and the death toll is concentrated in developing countries to an even greater degree. Not all parts of the planet's surface are equally exposed to natural hazards. Four-fifths of the planet's volcanic activity occurs in the so-called Circum-Pacific Volcanic Belt, within which are located many Asian and Latin American countries. The droughts that regularly follow the onset of El Niño years are concentrated in Southern Africa and South Asia. The El Niño-related "malarial fringe" is located along coastal regions of South America and South Asia. Malaria epidemics tend to occur in regions where the illness had, until the time of the outbreak, been rare, so that people have poorly developed protective immunity. Even small year-to-year changes in temperature or rainfall, such as those caused by El Niño, can suddenly make conditions more favourable for the mosquitoes and other vectors that transmit the disease, leading to an epidemic.

Second, natural disasters are worse for the poor, whether one means poor countries, or poor households within a given country. Thus a recent United Nations Development Programme report notes that while only 11 per cent of people exposed to natural hazards live in countries classified as "low-human-development" countries, these same countries account for more than 53 per cent of disaster-related deaths⁴. Poor countries are therefore not only more exposed, but they are more vulnerable than rich ones; and the poorest people within them are the most vulnerable. Poor people live in housing of poorer quality, and often on marginal land (like the *favelas* surrounding Rio de Janeiro). Savings and insurance are not available to poor people if they are hit by a shock. The poor cannot as readily escape disaster zones (as was dramatically apparent in the wake of Hurricane Katrina in New Orleans in 2005). Poor people's levels of health and education are lower and more fragile, as when poor households decide to withdraw children from school so that they may earn labour income.

Third, natural disasters can dampen growth, by destroying capital and diverting resources towards relief and reconstruction. *Fourth*, natural disasters damage well-being more generally, as households' savings and possessions are

depleted or destroyed; in concrete terms, this means people lose their homes. *Fifth*, and finally, natural disasters are a development issue because development policy — both domestic and international — can credibly make a difference to lessen the impact on poverty, growth and welfare. This is the topic of the following section of this brief.

Adaptive Capacity and Policy Responses

Adaptive Capacity

Hurricane Mitch struck most of the Central American countries in October 1998, ultimately killing nearly 19 000 people. Though loss of life, injury, and economic damages of the hurricane were widespread in the region, one of the disaster's most striking features was its uneven impact across the affected countries. Table I demonstrates that, leaving aside Belize, Costa Rica and Panama, which lay more or less in the periphery of the storm's impact, the effect of Mitch on the remaining four countries was quite varied. The reasons for this heterogeneity in the impact of an essentially identical shock are two: different countries were exposed to the hurricane in slightly different ways (essentially depending on its path) and different countries had differing underlying vulnerability to a hurricane. As a very crude indicator of such vulnerability, Table I includes income per capita for 1998, corrected for purchasing-power parity, for the seven countries in the path of Mitch. It is striking that a ranking of the countries in terms of the severity of the hurricane and a ranking in terms of the poverty of the country would be almost identical. The association is not perfect: Honduras is marginally less poor than Nicaragua, but suffered more, largely because the hurricane made landfall in the former. Nevertheless, there is a suggestive pattern: poorer countries fare worse when exposed to a similar shock.

One of the characteristics that separated Honduras and Nicaragua from their neighbours, in addition to their deeper poverty, is the extent of environmental degradation there, which predated the hurricane. Much of Mitch's impact in Honduras and Nicaragua was not attributable to wind damage, but to the large number of floods, flash floods, landslides and debris flows triggered by the hurricane. These derived, in turn, from the effects of environmental degradation that occurred over several decades. Environmental degradation was likely spurred on by the 1997 El Niño event, which caused drought and fires. This complex interaction of poverty, climate-induced environmental damage, and a hurricane shock, was further complicated by weaknesses in early warning and

Table 1. Hurricane Mitch: Summary of Damages

Country	People Killed	People Affected	Total population (thousands, 1998)	Damage (\$ 000)	GNP per capita (1998 PPP \$)
Belize	0	60 000	230	-	3 940
Costa Rica	8	16 700	3 747	-	6 620
El Salvador	475	84 000	6 031	-	2 850
Guatemala	384	105 700	10 713	-	4 070
Honduras	14 600	2 112 000	6 148	2 000 000	2 140
Nicaragua	3 332	868 228	4 763	1 000 000	1 790
Panama	0	7 500	2 836	-	6 940

Note: PPP = "purchasing-power parity".

Sources: EM-DAT (2004); World Bank (2000, Table 1) for GNP per capita; CELADE (2004, Cuadro 1b) for population.

disaster preparedness that led to large losses of life. Thus, roughly similar natural hazards might have vastly different social effects, depending at least in part on the capability of different societies to weather (literally) such shocks.

We can distinguish three characteristics of a society related to that capability to weather shocks: exposure, vulnerability, and resilience. *Exposure* is the probability that the shock will occur within a given time frame. Thus, geologists predicted that a major earthquake (with an intensity of 7 to 7.9 on the Richter scale) will strike the area of Turkey that comprises Izmir, Istanbul and Ankara in the next 30 years with probability equal to 62 per cent⁵. Similar judgements might be made regarding the exposure of Tokyo to an earthquake. *Vulnerability* is the expected value of the damage in the event the shock occurred. In this dimension, urban Turkey and Tokyo differ significantly. *Resilience* is the capacity of the economy to respond to the shock. This may embody notions of the cost of response and clean-up, or of social assistance; it might likewise embody a longer-term notion of "snap-back": how quickly does GDP per capita return to its pre-shock trend level? How quickly do child health indicators return to pre-shock levels?

Adaptive capacity, then, can be understood as a combination of vulnerability and resilience. It follows from this definition that a society's adaptive capacity is not a fixed and externally-given characteristic, but instead a function of that society's institutions and history. While all shocks may be costly and difficult to predict, historical episodes of shocks demonstrate that qualitatively similar shocks have different impacts in different environments, as in the varied country experiences with Hurricane Mitch in Central America. The differences in such cases can be traced to the adaptive capacities of the two economies hit by similar

shocks. For countries with a reasonably high exposure to natural disasters of some type, adaptive capacity can therefore range from low (high vulnerability and low resilience) to high (low vulnerability and high resilience).

Amartya Sen suggests that India suffered fewer famines than China in the latter half of the twentieth century because the former country had a democratic government and a free press, while the latter did not⁶. These concerns were echoed more recently in international criticism of the Chinese response to the SARS epidemic. Surely, adaptive capacity in the face of natural disasters is in part a function of such institutional features of a society as press freedoms or democratic government. In principle, adaptive capacity is a function of two classes of variables: policy-determined variables including the social assistance infrastructure, disaster policy, levels of aid inflows, access to capital markets and other such institutional variables; and structural factors such as the size of the economy, average income, poverty, inequality and geography.

Classifying Disaster Policies

The social risk management approach distinguishes three kinds of policies: *prevention*, *mitigation*, and *coping*. Of course, natural hazards, at least the major geophysical ones, cannot reasonably be *prevented* given the technological and scientific constraints of our age; we simply cannot stop tectonic plates from moving around. Therefore, unlike other forms of damaging fluctuations (e.g. harvest failures, commodity prices, violence), policy has not and will not in the foreseeable future be aimed at risk prevention.

Nevertheless, policies can and do seek to reduce vulnerability and raise resilience; that is, to strengthen adaptive capacity. A striking feature of the catalogue of common disaster-relief measures is that it includes most of the classic poverty-alleviation policies: cash transfers, public works, unemployment assistance, wage and commodity-price subsidies, targeted human-development transfers such as those conditional on school attendance, service fee waivers, food and nutrition supplements, microfinance, and social funds. There is nothing especially disaster-specific about any of these measures⁷.

Mitigating Vulnerability to Natural Hazards

While risk-prevention strategies seek to reduce the probability of a risk occurring, risk-mitigation strategies attempt to reduce the damages associated with the risk should it occur. In the natural-disaster context, this corresponds to

reducing *vulnerability* to natural hazards. Vulnerability can be mitigated in two ways. *Diversification* of risk is a mitigation strategy meant to reduce the variability of income by using a greater variety of assets to generate that income. *Insurance* is a mitigation strategy that pools risk across agents, by means of formal insurance contracts or informal arrangements among households.

Diversification of Hazard Risk

Conceptually, “diversification of assets” means earning income from a variety of sources, and furthermore that those sources do not necessarily rise and fall together. Poor agricultural households might “scatter plots”, hold parcels of land in two or more different places; they might rely on income from family members who have migrated elsewhere; they might undertake non-agricultural pursuits in addition to their farming. When faced with a shock, assets can be drawn upon to tide over the household; *diversified* assets are especially valuable because it is possible that not all of them have been damaged at the same time.

Arguably, policies that help people improve their skills and health will diversify disaster risk, because households with higher levels of education and better health status are better able to weather shocks. They are better prepared to heed warnings from governments, to seek alternative means of generating income. If they are in better health, they are better able to withstand reduced food or housing availability — in the short term.

These aims are also served by so-called “social funds,” community-based investment and anti-poverty programmes. If such programmes are in place before a disaster strikes, it dramatically reduces the start-up cost of disaster relief, given that the pre-existing programmes can be used to channel aid. What is more immediately relevant to the current discussion is that the targeted transfers that are a cornerstone of social funds effectively diversify poor households’ livelihoods away from a dependence on the returns from unskilled labour. A study of the impact of the Philippine drought of 1997 suggests that households with diverse sources of labour income were better able to protect their living standards⁸.

Policies that redistribute wealth (of which targeted health and education transfers are a subset) can be thought of as diversifying risk in a more global sense. Suppose that a hurricane strikes two communities, each with ten households. In one community, seven houses are built of concrete block, and three are built of straw; in the second, the proportions are reversed. If all concrete houses can withstand a hurricane and no straw houses can, then after the hurricane, there are seven houses standing in the first community and three standing in the

second: that is, if more households in the latter community had the means to construct more durable housing, their losses from the hurricane would have been less significant. Indeed, households with more and better assets fared better during Hurricane Mitch in Honduras⁹. Certainly, the prominence of disaster damages in middle-income countries like Brazil and the Philippines is at least in part a function of the inequality with which resources are distributed there, and not solely the average level of resources per household. A concrete example of a policy that diversifies the risk of natural hazards in this sense is neighbourhood improvement. Thus, a local NGO in Peru facilitated rebuilding of houses destroyed by an earthquake with more earthquake-proof materials (called *quincha*); these houses resisted a subsequent earthquake¹⁰. This is like raising the proportion of disaster-proof housing in the example given above. In this context, then, establishing, monitoring and enforcing building standards is in fact a policy that diversifies risk and genuinely redistributes wealth.

Bangladesh employed two major diversification strategies that helped it stave off a starvation crisis in the wake of flooding in 1998. The first was long-term agricultural and investment policies that had fostered expansion of winter rice, reducing dependence on flood-susceptible monsoon rice. Thus, though the monsoon harvest was devastated, the impact on consumption was less drastic than would have been the case in the absence of the winter-rice policy. Second, and perhaps more startling in its impact, substantial liberalisation of trade in the years preceding the flooding allowed massive rice imports, which prevented a surge in the rice price. This is contrasted with the 1974 famine in Bangladesh in which speculative behaviour by rice traders and the shortage of foreign exchange with which to purchase foreign rice led to 50 per cent increases in rice prices; as many as 100 000 starved to death during the earlier episode. Trade liberalisation can legitimately be seen in this case as diversifying the risk of a natural hazard to food supplies¹¹.

Insuring against Hazard Risk

Despite their ingenuity, many community-level risk-pooling schemes are ill-suited to insure their participants against covariant risks like natural hazards: when people need the help of their neighbours, their neighbours are unable to provide it. For similar reasons, private insurance companies are unlikely to provide risk-pooling services, given that they may not be able to pool risks with consumers not subject to the risk of natural hazard. Given the thinness of formal insurance markets in many developing countries, it is unlikely that purely private insurance would be a viable means of insuring against disaster risk in any case,

even if such risks were geographically limited, relative to the size of the market. As with other covariant risks (such as the risk of macroeconomic recession), it is natural to think of the state — or international aid — as the risk manager.

In the late 1990s, the Mexican disaster-relief authority (FONDEN) underwent major changes, some of which look very much like an insurance scheme in which state governments contribute to the scheme during good years and receive benefits in bad years. Institutional reforms to increase the transparency and accountability of FONDEN decision making could well increase the authority's ability to behave as a provider of social insurance. Similarly, reforms to disaster relief in Turkey following the 1999 earthquakes (and financed by international donors) include earthquake insurance for property owners. A key emerging theme in discussions of disaster insurance is that hybrid public-private schemes might be most attractive; this will be discussed below.

Resilience: Coping with Disasters

Two lessons emerge from the reasonably successful post-Hurricane Mitch relief effort in Honduras. *First*, relief aid can potentially avoid targeting people who suffered no loss (in Honduras, there was strong evidence that aid was channelled to households who did suffer housing damage); but aid easily fails to reach many victims. *Second*, in-kind aid is not well-scaled, by its nature, to the *magnitude* of an individual household's losses. Thus poorer victims were, if anything, "overcompensated", and wealthier victims were drastically under-compensated. Such imbalance between losses and compensation would not be a feature of well-functioning insurance contracts, for instance.

In the wake of massive flooding in Bangladesh in 1998, two government programmes channelled food aid to affected households. The programmes exhibited somewhat larger leakage than in Honduras to poor-but-not-flooded households. Like the Honduran case, the volume of food aid was small relative to the needs of households (only one-sixth to one-eighth of the size of household borrowing following the floods). Analysis of government response to the drought in Zimbabwe in 1994-95 finds even weaker precision in targeting of victims¹².

The distinction between mitigation policies and coping policies is that the former must be conceived before disaster strikes. Superficially, both policies may look similar: delivering food or medicine to households affected by the disaster, for example. Where poverty-alleviation or social safety-net policies exist before a disaster, however, they can be called upon to provide post-disaster relief without first incurring prohibitive start-up costs. In the context of a different

kind of shock, the Nicaraguan social safety net provided surprisingly effective relief for coffee farmers and others hit by the precipitous decline in world coffee prices, even though the policy was not intended to mitigate terms-of-trade shocks¹³. In the case of natural disasters, mitigation policies might include the formation of medical networks that could be rapidly mobilised, or the establishment of food-storage facilities.

Key Themes for Public Action

Three dimensions of public action need to be emphasised: domestic versus international policies; *ex ante* (before the fact) versus *ex post* (after the fact) measures; and public versus private actions. These are not just trade-offs, but balances that must be found in disaster-related policies. This section concludes with a consideration of how innovative financial instruments for disaster relief might balance these tensions¹⁴.

Domestic and International Policies

The first balance is that between domestic and international policy makers, especially aid donors. In this connection, Paul K. Freeman calculates “resource gaps” for disaster-prone countries, as a function of per-capita income, geographic variation in risk, and frequency of hazard events¹⁵. For some countries considered, like El Salvador and the Dominican Republic, there is a genuine risk that a disaster will occur that will outstrip the ability to raise post-disaster reconstruction funds. Similarly, the Inter-American Development Bank estimates that additional resources of approximately \$2 billion will be needed in each Central American country to safeguard against another hurricane of Mitch-like proportions. In such cases, additional international aid will be necessary. As a general rule, for a given degree of exposure to natural hazards, more international assistance will be required the lower is per-capita income and the greater the country-wide exposure to disaster risk (as in the case of small island states).

The gross magnitude of foreign and domestic resources required to address disaster risk, however, is only one dimension; another is the qualitative differences between foreign and domestic resources. In many settings, these will not be perfect substitutes. Local knowledge and capabilities might be highly valuable for emergency preparedness and coping efforts after disaster has struck: concretely, local community networks might be able to provide these services at a lower average cost than international agents. Conversely, some kinds of

technical expertise [like those involved in establishing early-warning systems or internet-based information-sharing networks like the Regional Centre for Disaster Information in Costa Rica (www.crid.or.cr)] might be more ably provided, at least initially, by international donors.

What are some examples of domestic policies that can reduce vulnerability and increase resilience? Regulations that govern urban development should seek to avoid construction of homes and industrial sites in areas subject to risk of earthquake or flooding; failing that, such regulations should encourage (with subsidies and other incentives, if necessary) buildings and settlements more likely to withstand such hazards. Rural-development policies should provide incentives for households to engage in farming and settlement behaviour that does not increase the rural sector's vulnerability to hazards (e.g. flooding following a windstorm). Furthermore, these policies should encourage urban and rural development that will permit the timely delivery of post-disaster aid (by avoiding entirely unregulated and chaotic "irregular" urban settlement, for example). Finally, such regulations must be effectively monitored and enforced. Whether the resources necessitated by such policies are generated domestically or are financed by foreign aid, their effective implementation will require location-specific knowledge that can only be provided by domestic policy makers in concert with their constituents.

Finally, recent research on foreign aid cautions that the same aid flows might differ widely in their effectiveness depending on the policy environment in the country into which they are channelled (Burnside and Dollar, 2000). Certainly, disaster-prone countries differ in quality of governance, and this will have an effect on the efficacy of international disaster-related aid.

Ex ante versus Ex post Policies

It is arguably the case that most developing-country disaster policy takes the form of coping after the fact. Indeed, *ex ante* policies, to the extent that they exist, are not specifically targeted to disasters — although this is a feature of some *ex post* measures as well. In any case, many authors argue that a greater emphasis on *ex ante* measures is called for. The US Federal Emergency Management Agency (FEMA), it is reported, calculates that a dollar spent on mitigation saves two in coping¹⁶. In the cities struck by earthquakes (as in Turkey in 1999), it seems reasonable to assume that fewer resources would be required to build once to code rather than building and then rebuilding earthquake-damaged structures. In the case of the Caribbean, the UN estimates that it is less costly to design and

build a structure to standards that would withstand maximum expected wind or seismic forces in a given location, rather than build to lower standards and suffer the damages¹⁷. Naturally, the balance struck between *ex ante* and *ex post* policies will have implications for the quantity of domestic and foreign resources that will be needed.

A useful study of the post-drought impact of relief aid in Zimbabwe (1994/95) uses unusually good survey data to ask the following question: What would be the difference if Z\$100 of drought relief post-disaster had instead been disbursed to farmers *before* the disaster in the form of agricultural equipment? The results indicate that under all scenarios, income would substantially higher in non-drought years, allowing households to accumulate buffer stocks that can be drawn down during drought years. As a consequence, income poverty is significantly reduced¹⁸.

It would be premature to claim decisive scientific evidence in favour of the cost-effective superiority of *ex ante* measures relative to *ex post* ones, but given the preponderance of *ex post* measures in practice, and the suggestive evidence cited here, an increased focus on *ex ante* measures seems appropriate.

Public versus Private Initiatives

Individual households and local communities are ill-suited on their own to insure against the risk of natural disaster, given that natural hazards will tend to strike all members of a household or community. Furthermore, few households, certainly few poor households, can access the formal financial system to tide over their consumption in the face of natural hazards; markets for insurance or credit are thin or non-existent for many people. From this it usually follows that the appropriate agent to manage such risks is the public sector, either in the form of developing-country governments, or international donors, or both. But is this the appropriate conclusion?

Certainly the important role of international rice markets in maintaining consumption levels in the wake of flooding in Bangladesh in 1998 illustrates that markets can be harnessed to manage risks. [This is so even if others have pointed out that international food markets can, under different circumstances, allow foreign consumers to out-bid disaster-struck, and sometimes starving, local consumers (Sen, 1981).] In the context of epidemics, the appropriate analogy is liberalisation of international trade in generic medications. To the extent that market forces can reduce the costs of disaster risk-management policies, decision makers will have a lively interest in such market-oriented alternatives.

As is so often the case in debates about the appropriate roles of the market and the state, it is not helpful to pose the question in terms of a dichotomy. Instead, intelligent public action will seek to complement rather than supplant market forces.

Innovative Aid Instruments

In the spirit of seeking innovative ways to finance ambitious development objectives such as the Millennium Development Goals, can aid donors distil these lessons into novel strategies to manage the risk of natural disasters?

First, if new strategies are to focus on mitigation rather than coping, they will do so by providing diversification of natural hazard risk, or insurance against such risks. As argued above, the establishment and (perhaps more important) enforcement of standards is akin to diversification. Donors can provide technical guidance regarding building standards, but the harder task may prove to be the monitoring and enforcement of such standards.

Insurance against disaster risk raises different issues. Such schemes might, at one extreme, be social-insurance systems that are entirely publicly-provided; alternatively, firms and households could purchase private insurance contracts. There exist proposals that seek a third way: using public resources to foster and promote private insurance markets for natural disaster risk.

A study of the failure of private insurance markets in the disaster-prone Caribbean region makes it clear that there are formidable obstacles to be overcome in the provision of insurance¹⁹. First, there is little to no local forecasting capacity (for predicting location, frequency, duration and magnitude of catastrophes) on which premiums could be based; in their absence, international reinsurers have set premiums at levels observed in the United States. Second, there are furthermore the usual problems that beset insurance contracts everywhere: households and firms who live in high-risk areas are likely to buy more insurance than those in low-risk areas (this the problem of “adverse selection”), and those who *do* buy insurance are subsequently less likely to undertake actions that will reduce the negative effects of potential natural disasters (this is the problem of “moral hazard”). As economists have argued for decades, such problems reduce the willingness of private insurers to offer contracts in the first place. Third, catastrophic events, though frequently recurring, are sufficiently irregular that people do not adequately prepare for them even when they can. Fourth, domestic insurers may face restrictions on investing in international financial markets: this prevents them from buffering their assets against a possible fallout from catastrophic occurrences. This in turn

leads insurance companies to set premiums above those that would prevail if they could diversify their investments; and high premiums drive relatively less risky consumers out of the pool of subscribers. Fifth and finally, the availability of international assistance after disaster strikes is itself a disincentive for risk-reduction policies: why undertake costly measures before the fact when foreign aid is certain to come after the fact?

Several of these problems — notably, the tendency of high-risk buyers to be overrepresented among consumers and firms' lack of access to international financial markets — lead to the so-called “prohibitive pricing” problem that besets catastrophic or disaster-related insurance. To these might be added the tendency of reinsurers to simply drop out of developing-country markets following a disaster, or the problem of insufficient capitalisation of firms. While economists have long advocated prudent government intervention to address such market failures, experts remind us that government intervention, at least in the sphere of crop-insurance schemes, has not always been prudent. Government-sponsored schemes have tended to founder on high administrative costs and poorly-designed payout arrangements (farmers often withdrew far more than they put in).

Nevertheless, the public sector (supported by international aid) can in principle address many of these obstacles. Governments can provide the necessary infrastructure for the emergence of private insurance markets, incurring the fixed cost of scientific research to enable local forecasting. Moral hazard could be reduced through enforcement of building standards and other measures; these measures would reduce the supply of “uninsurable properties”. Governments can provide tax credits and other incentives to firms and households that make risk-reduction investments or purchase disaster insurance. Removal of restrictions on domestic firms' foreign investments (and on foreign insurance firms' participation in the domestic market) would allow insurers to spread more adequately the risk of disasters they insure. International donors could counter the disincentive effects of relief by switching their role from providers of disaster-related assistance to initiators of the implementation of risk-reduction measures, or provide disaster-related lines of credit contingent upon the implementation of some preliminary risk-reduction measures.

This is a long list of policies, not all of which will be everywhere politically feasible. Opening up the domestic market to foreign insurance companies is likely to be politically sensitive, for example. It will be difficult for foreign donors to signal credibly that they are “switching roles”, providing less *ex post* assistance in favour of contingent *ex ante* aid. It is furthermore hard to envision how it is that governments that have failed to enforce building standards will suddenly begin to

do so. Nevertheless, there is a fruitful role for governments to enhance and foster the emergence of markets. This involves a quite traditional rationale for public action, as the provider of infrastructure that lowers the costs of private agents in a host of markets.

A concrete example of this kind of promotion of insurance markets is provided by J. Skees and his co-authors in a series of studies of the feasibility of crop insurance in some Latin American contexts. The simplest and lowest-cost variant is a rainfall-index insurance scheme that pays farmers when rainfall in their region is below some kind of average. This kind of arrangement addresses some of the incentive problems mentioned above, given that farmers cannot manipulate the level of rainfall (and therefore the payments they receive from the scheme). How could policy makers instate such a scheme? A multilateral agency like the World Bank makes a contingency loan to a developing-country government. The government offers option contracts payable if rainfall in a region is extremely low by historical standards. Insurance firms and reinsurers can buy whatever quantity and mix of such contracts they like, and use them to hedge their payout risk to farmers themselves, who buy crop insurance from the firms. Reinsurance may be attractive for financial firms, as the risks involved (linked to local rainfall patterns) may be uncorrelated with other global financial returns. In the case of massive rainfall failure, the government draws upon its international contingency loan. (In another variant, international aid could capitalise domestic insurance firms in order to cushion against the probability of a major rain shortfall early in the emergence of the market, the risk of which would otherwise tend to push up premiums and force a return of the prohibitive pricing problem.)

The rainfall-index insurance scheme is targeted not at disasters *per se*, but rather at one of the consequences (crop failure) of a type of disaster (drought). Different disaster types (e.g. urban earthquakes) may be insurable along these lines, but will require suitably-modified schemes. Insurance schemes for disasters whose principal consequences are health-related would not be targeted at households, like the crop-insurance scheme, but at health authorities themselves.

The point to emphasise is that such proposals promise to provide substantially more cost-effective disaster relief than many current practices. The choice here for international donors is between financing the World Bank contingency loan and providing *ex post* food, housing and other forms of relief. More important, improving *ex ante* security raises the well-being of risk-averse farmers. An added benefit is that this kind of promotion of private insurance will bolster domestic financial markets more generally; this in turn provides greater opportunities to more households and firms to mitigate risks of all kinds.

Conclusion

Natural disasters (drought, earthquake, epidemics, floods, windstorms) pose a growing threat to developing economies, both in terms of their frequency and of the damages associated with them. These shocks, in addition to causing death and injury, also give rise to long-lasting damage, as buildings, homes and infrastructure are destroyed and scarce resources are diverted to coping with reconstruction. Effective risk management is therefore a pressing concern for development agencies and developing-country governments. Indeed, the extent to which resources are effectively applied to mitigating and coping with disasters has immediate consequences for growth and development.

The adaptive capacity of a society faced with the risk of natural disaster can be defined as the vulnerability of a society before disaster strikes and its resilience after the fact. This brief reminds us that the adaptive capacity of a country is not in fact externally determined, but related to its level of development. Unfavourable economic and social conditions such as irregular urban settlements and weak regulatory practices including poor enforcement of building standards can render a society much more vulnerable and less resilient to any given shock.

Given the limited scope for diversifying against such risks at the household or community level, there is an *a priori* case for public action. For this to be effective, a partnership of multiple stakeholders needs to be forged. To reduce vulnerability to shocks, it is important for governments to increase the skills, health and physical assets of poorer members of society and to monitor and enforce building codes and standards. Enhanced resilience can be achieved by implementing a series of precautionary measures that would lower the cost of relief (e.g. social safety nets, improved communications), and preparing adequate contingency plans for rapid medical and humanitarian responses.

International agencies and the private sector can play their part by exploring ways to create innovative financial instruments to pool disaster risk and to provide insurance against it. Examples include rainfall-based crop-insurance programmes that rely on international public funding for their seed capital. Such joint actions accelerate a return to a sustainable growth path.

Notes

1. The issues discussed here are treated in greater analytical detail in Dayton-Johnson (2004), which also provides more complete references to the research literature
2. Auffret (2003b).
3. See Holzmann and Jørgensen (2000, 2001); World Bank, 2001, ch. 9.
4. UNDP, 2004, 1. Low-human-development countries are those whose human-development index — a score based on health, education and per-capita income achievements of the country — is less than 0.5; for 2003, this means countries with human development equal to or lower than that of Cameroon, Nepal and Pakistan (UNDP, 2003, Table 1, 237 ff.). This is a conservative threshold, as it leaves out many medium- and high-human-development countries also prone to disasters, such as Indonesia, the Philippines or Mexico.
5. Brauch (2003).
6. See, for example, Drèze and Sen (1989, ch. 11).
7. The list referred to in this paragraph was tallied by Skoufias (2003).
8. Datt and Hoogeveen (2003). It should be noted nevertheless that greater education did not seem to matter to how households fared and that the adverse impact of the shock *increased* with land ownership (this last result is not inconsistent with the beneficial effects of diversification; holding all else constant, raising a household's land ownership is tantamount to reducing its diversification).
9. Morris and Wodon (2003).
10. World Bank (2001, 173-174).
11. Del Ninno *et al.* (2003).
12. Del Ninno *et al.* (2003); Owens *et al.* (2003).
13. Maluccio (2003).
14. A quite useful set of guidelines for aid agencies confronted with natural disaster risk is provided in OECD (1994); in a similar vein, policy lessons are distilled from a range of recent disasters in OECD (2004).
15. Freeman (2003, 41).
16. World Bank (2001, 173).
17. UNISDR (2002).
18. Owens *et al.* (2003).
19. Auffret (2003a).

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