

PART II

Chapter 9

Financing Disaster Risks in Developing and Emerging Economy Countries

by
Reinhard Mechler*
IIASA**

This chapter examines the experience, opportunities and drawbacks of risk financing, particularly through financial market instruments, for reducing the vulnerability of developing and emerging-economy countries to sudden-onset, natural disasters. Financial markets comprise a wide institutional spectrum from rural credit banks, international financial markets to multilateral finance institutions. This chapter shows that market-based financing instruments have potential for assisting households, businesses and governments in their recovery from catastrophes and for providing incentives for loss reduction. However, the cost of market instruments can substantially exceed that of traditional family-, state- and internationally-supported, non-market financing mechanisms. The chapter concludes that there is a case for national and international support to make these options affordable in developing and emerging-economy countries.

* Research Scholar, Risk, Modeling and Society (RMS) Program.

** International Institute for Applied Systems Analysis, Schlossplatz 1, A-3326 Laxenburg, Austria.

1. Introduction

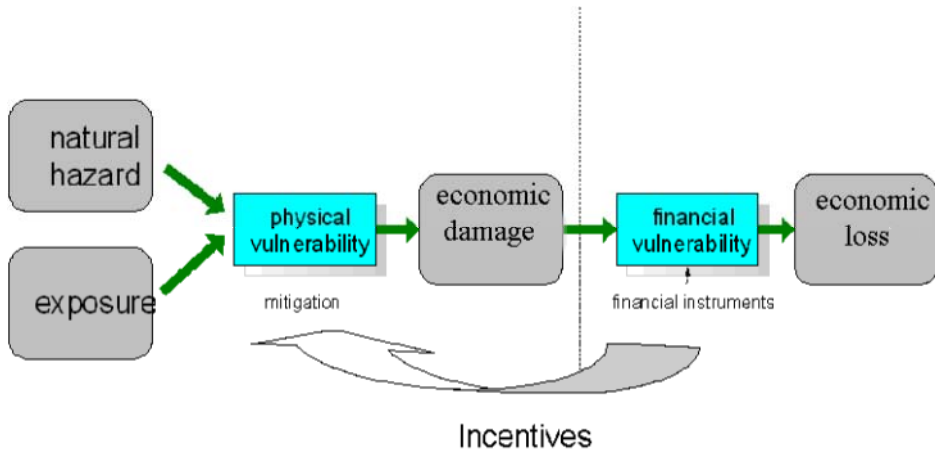
This chapter examines the experience, opportunities and drawbacks of relying on financial markets to finance risks arising from sudden-onset, natural disasters. Financial markets are defined to comprise a wide institutional spectrum from rural credit banks, international financial markets to multilateral finance institutions. The focus is on the application of these tools to developing and emerging-economy countries. We conclude that natural disaster risk financing instruments have a great deal of potential for assisting countries to adapt to their growing catastrophe risk exposures and for providing incentives for reducing risks; however, we point out that the cost of market instruments can substantially exceed that of traditional family- and state-supported, loss-sharing financing mechanisms. Traditional post-disaster financing, however, may not be sufficient for households and governments in developing and emerging-economy countries that face high catastrophe risks, in which case market risk-financing instruments that are put into place before the disaster, can be an important, but costly addition to the portfolio of measures available to households and government authorities.

The need to develop improved institutions, procedures and mechanisms for spreading and sharing disaster losses is motivated by their alarming increase. Economic losses from all natural disasters including earthquakes, windstorms, floods, droughts, landslides and tsunamis, to mention the most serious, have increased almost nine-fold from the decade of the 1960's to the 1990's, and insured losses more than 15-fold (Munich Re, 2003). The dominant factors behind rising losses are changes in land use and increasing concentration of people and capital in vulnerable areas, for example, in coastal regions exposed to windstorms, in fertile river basins exposed to floods, and in urban areas exposed to earthquakes (Mileti, 1999). Climate change may also be playing a role. The Intergovernmental Panel on Climate Change (IPCC) has concluded that at least part of the increase in economic losses is due to changes in climatic conditions (IPCC, 2001, Chapter 8). Most economic losses occur in wealthy countries, yet most of the human suffering (death toll, injuries, loss of income) occurs in developing countries (Müller, 2003). Not only developing countries, but the poor in those countries are the most vulnerable to disasters (POVCC 2003, UNDP 2001).

There are two options to reduce the net economic losses from disasters: mitigation and risk financing. The first, and usually highest priority in risk management, is to invest in preventing and mitigating economic damages from disasters. The residual risk can then be managed with risk financing strategies. What remains, is the actual or net loss. Mitigation, therefore, reduces physical vulnerability; risk financing reduces financial vulnerability.

As illustrated in figure 9.1, these options are interlinked, since the choice of financial instruments can have effects on physical vulnerability because of positive or adverse incentives.

Figure 9.1 Reducing physical and financing vulnerability



Financial arrangements that spread disaster losses among those most at risk, and including solidarity from those not at risk, can make a difference in the lives of vulnerable people in developing and emerging-economy countries. For example, many Mexican farmers face double exposure to fluctuations in crop prices and natural catastrophes that in a very bad year or consecutive years can force them to migrate to the slums of Mexico City, where they face even higher risks. Pre-disaster or ex ante financial arrangements that spread crop losses, temporally and spatially, have the potential to secure their livelihoods. Likewise, financial arrangements that transfer and spread catastrophe risks facing governments can make a huge difference in the economic development of vulnerable countries. If governments do not have the necessary infusion of capital after a disaster to rebuild critical infrastructure and assist households and businesses with their recovery, the indirect costs can greatly exceed the direct losses from the disaster. Such delays can also lead to secondary economic and social effects, such as deterioration in trade, budget imbalances and increased incidence of poverty (Benson, 1997; Freeman et al., 2002). For these reasons, international financial institutions and disaster management communities are placing great emphasis on pre-disaster, pro-active disaster planning to prevent losses and enable households and governments to recover in a timely manner (Gurenko, 2004, Kreimer and Arnold, 2000, World Bank, 2000).

While market instruments for financing risks have great potential for developing and emerging-economy countries, there are also associated costs. Keeping in mind that up to 95 percent of recent disaster deaths have occurred in poor countries (Mitchell and Ericksen, 1997), the return on preventive mitigation investments may outweigh the return on investing in market-based financial instruments. It is important thus to weigh the benefits and costs of financial instruments, particularly in comparison to the benefits and costs of preventing human and economic losses. This point cannot be overemphasized. In low-income countries, the opportunity costs of market based risk-financing instruments can be prohibitively high in terms of meeting other human needs. Moreover, it is important to examine the incentive effects that any financing approach has on preventing disaster losses. Gurenko (2004) and others argue that highly concessional post-disaster funding from large international donors and international development banks has reduced incentives of governments to engage in proactive risk management. Finally, market instruments often transfer liability from the state to individuals, which can mean increased burdens on already poor and vulnerable communities.

In addition to the well-known risk financing instruments of insurance and reinsurance, other types of market instruments have recently emerged making use of the rural, domestic and international financial markets. There are important examples of securitizing disaster risk in the financial markets by issuing catastrophe bonds, issuing weather derivatives for flood and drought exposure and using contingent credit arrangements for financing a government's post-disaster liabilities. This paper examines the benefits and costs, pros and cons, of market risk-transfer and other financial instruments in the social and economic context of developing and emerging-economy countries. We separately discuss financial risk management for households and businesses (private-sector risks) and governments (public-sector risks).

We begin by describing market and non-market financial instruments, both traditional and novel. In Section 3 we examine the range of private sector risk-financing instruments available for developing and emerging-economy countries, including traditional kinship arrangements and state-funded post-disaster assistance, weather derivatives and other hedging instruments. We emphasize the importance of national and international solidarity to assure the viability and social acceptance of these systems. In Section 4 we turn to financial risk management in the public sector. The underlying question is the amount of risk a government should retain and still avoid long-term negative implications on its citizens, growth and fiscal performance. This section presents a methodology and software for assessing the benefits and costs of pre-disaster instruments for the public sector, and suggests a role for the international community in providing

assistance to put these instruments into place. We conclude in Section 5 with a case for national and international support for financial risk management for developing and emerging-economy countries.

2. Risk Financing Background

Risk financing instruments can be categorized into risk transfer and intertemporal risk spreading. Risk transfer spreads and pools risks among victims and non-victims (individuals, households, businesses and governments) before a catastrophe occurs. An agent can choose to *retain* the risk to which it is exposed, or the agent can *transfer* the risk to another agent, which then *absorbs* the risk. There are both market and non-market instruments and institutional arrangements for transferring risks. Market risk-transfer instruments (for example, insurance) are pre-disaster arrangements in which the purchaser incurs a cost in return for the right to receive a much larger amount of money after a disaster occurs. Risks can be transferred to the government without the use of markets by legal or informal arrangement that obligate the government to fund the recovery of households or business after a disaster occurs. There are other pre-disaster arrangements that may not involve a transfer of risk from one agent to another, but spread risks over time. For example, persons or governments can spread risks inter-temporally through savings or catastrophe reserve funds, respectively (these instruments may transfer risk from one generation to the next).

The instruments for financing disaster risks are summarized in Table 9.1 and discussed in more detail below:

Table 9.1 - Risk management approaches and instruments

Approaches	Examples of Instruments
Non-market risk transfer* (<i>collective loss sharing, ex post</i>)	Government assistance (taxes) for private and public sector relief and reconstruction funding, Kinship arrangements, Some mutual insurance arrangements, Donor assistance
Market Risk transfer (<i>ex ante risk financing</i>)	Insurance and reinsurance, Microinsurance Financial market instruments: Catastrophe bond, Weather derivatives
Intertemporal risk spreading (<i>ex ante risk financing</i>)	Contingent credit (financial market instrument), Reserve fund, Microcredit and -savings (coupled with microinsurance)

*Mostly, these approaches have an ex post, ad hoc character. However, they can be considered *ex ante risk financing measures* if they are put into place, formally or informally, before the disaster.

Financial market instruments listed in table 9.1 and discussed in the following comprise catastrophe bonds, weather derivatives and contingent credit arrangements.

The ways in which catastrophe risks are transferred or losses shared are not value neutral, but they differentially transfer the risk and loss burden to family members, contributors to an insurance pool (e.g., property owners), taxpayers, future generations, and citizens/investors in other countries. Importantly, they also have differential incentives and implications for loss reduction.

2.1. Non-market risk transfer (collective loss sharing)

One of the most important non-market arrangements for transferring risks is post-disaster government assistance, which can be formally arranged before a disaster (e.g., the Italian government is statutorily required to assist earthquake victims) or arranged after a disaster in an *ad hoc* way. At the same time, acting as “insurers of last resort”, governments pool their own risks due to exposed infrastructure and other public assets across a wide geographical area. In case of an event, the reconstruction of these assets can be paid with taxpayer-money. Since governments often finance disaster losses with taxpayer funds, these collective loss-sharing practices are based on solidarity from persons not at risk. Alternatively, households or businesses facing similar risks can form a pool among themselves. Non-profit mutual insurance arrangements have a long tradition for providing crop, fire and other types of insurance. Informal kinship arrangements are another traditional coping mechanism characterized by financial or in-kind support of relatives (and neighbors) after a disaster. A family might collectively finance the migration of a child or relative to another region or country, and this relative is expected to support the family in times of crisis. Similarly, the family may diversify its livelihood, for example, by financing the education of one of its members.

While kinship is an important risk-transfer institution, governments play a key role throughout developing and emerging-economy countries, and even in high-income countries. For example, Colombia spent USD 800 million to rebuild Armenia and Perei after the 1999 earthquakes, and much of this funding went to private households and businesses. This was more than 50 percent of the direct damages (Freeman, et al., 2003). After the Sudanese floods in 1998, the state government transferred about 15 percent of the total direct costs to assisting households, businesses and local governments (Mantaye, 2000).

The picture changes little in middle- and high-income countries. Historically, the transition countries of Central and Eastern Europe have

provided substantial compensation and assistance to disaster victims. For example, after the 2001 flood on the Upper Tisza river in Hungary, the government fully financed the rebuilding of over 1000 homes that had been washed away. Moving to high-income countries, after the 1995 Great Hanshin earthquake, the Japanese government absorbed close to 50 percent of the direct losses, whereas private insurers absorbed only 2.5 percent. In the US, the average annual expenditure by the federal government for disaster assistance from 1977 to 1993 was significantly greater than the average annual loss borne by reinsurers on U.S. catastrophe coverage (Froot and O'Connell, 1999). The US federal government covered 30 percent of the losses from the 1993 Midwest floods, whereas insurance only absorbed 12 percent of these losses. In Europe, Italy stands out since the government is statutorily obligated to compensate earthquake victims 100 percent of their losses (Linnerooth-Bayer et al., 1999).

A major concern with any risk-financing system that depends on solidarity is "moral hazard", or the lack of incentives for reducing risk. It is feared that financial assistance to disaster victims, in whatever form, will encourage people to take less precaution against losses and to move into high-risk areas. Moreover, it will discourage people from purchasing insurance. If uninsured disaster victims are guaranteed post-disaster support that enables them to continue to locate their property in hazard-prone areas, and more people build in those areas, taxpayers will be subject to increasingly larger expenditures for bailing out victims of future disasters. For this reason, leading disaster experts in the United States argue for making private responsibility the guiding principle of catastrophic risk management (Kunreuther and Roth, 1998).

How relevant is moral hazard to emerging economy and developing countries? Two factors suggest that there may be a stronger case for avoiding moral hazard, which is inherent in government assistance or subsidized risk transfer, in wealthy countries than in developing countries. Rather than capital moving into high-risk areas, the main concern in poor countries or regions may be population migration out of rural disaster-prone areas to even riskier conditions, for example, rural farmers in Mexico resettling in the slums of Mexico City. Second, there are fewer risk-mitigation measures that poor households and businesses can afford, even with incentives. Alternatively, there are strong humanitarian arguments for providing pre- and post-disaster assistance to poor communities.

2.2. Market risk transfer (*ex ante* risk financing)

Risk can be bought and sold like merchandise. Instruments that make these trades possible must be put into place before a disaster occurs, and thus in this paper they are often referred to as *ex ante risk-financing*

instruments. Household, businesses and government authorities, who choose not to retain their catastrophe risk, can transfer or exchange risk for a fixed price or premium. The most common of these instruments is commercial insurance, but there is a great deal of recent interest in other alternative risk-transfer instruments, such as catastrophe bonds and risk swaps. Because of emerging interest in transferring risks with market instruments in developing and emerging-economy countries, we will describe the rationale, costs and benefits of insurance and other instruments in some detail.

According to Kunreuther (1998), a risk is insurable if it meets two conditions: (1) insurers must be able to identify and quantify the risk, that is, to estimate the chances of the event occurring and the extent of losses likely to be incurred, and (2) insurers must be unrestricted (unregulated) in setting premiums. Insurers do not offer coverage for all insurable risks, since it may not be possible to specify a rate for which there is sufficient demand and incoming revenue to cover the development, marketing, and claims costs of the insurance and still yield a net positive profit. This is especially the case in poor regions or countries, but even in developed countries full insurance cover is not available for many types of disasters.

Actuarial methods were long the preferred technique for estimating risks and setting premiums (Walker, 1997). In many areas of insurance coverage, such as car accidents, insurance policies are typically underwritten on the basis of historical loss data. In these areas, financial losses are inherently predictable due to a statistical concept known as the *Law of Large Numbers*¹, also known as the *insurance principle*. This means that the variance of insurance claims decreases as the number of policies increases (see Mechler, 2004). Because of the insurance principle, larger insurance companies have a comparative advantage over smaller ones; thus, in the insurance business there are economies of scale. Independence or low dependence of the risks plays a crucial role in risk transfer. If the independence condition is violated, it is important for the risk purchaser or insurance company to diversify its portfolio across regions or countries, and/or purchase reinsurance. Because of the expenses involved in diversification and reinsurance, and other difficulties, many insurers are reluctant to provide catastrophe cover.

In many respects, catastrophic risks are becoming more insurable as computer technologies provide improved methods for estimating risks and as better knowledge reduces the problem of adverse selection. Catastrophe models and other methodologies for estimating risks, however, can never yield unambiguous measures. Historical data on rare events is by definition sparse, and changing conditions require scenarios about an uncertain future world. As a case point, the IPCC concludes with a high degree of confidence that the risk of extreme weather events will increase as the climate changes.

Yet, the problem of uncertainty remains: climate scientists are currently unable to quantify the extent to which this risk is increasing, let alone provide more specific guidance as to when and how a disaster will strike. What seems clear though is that adaptation measures as envisaged in the UNFCCC and Kyoto Protocol might not be able to prevent substantial damage in developing countries (Verheyen, 2002).

Partly because of these ambiguities in the risk estimates, insurers have pulled out of some catastrophic risk markets. In the US, Hurricane Andrew in 1992, followed by the Mississippi floods in 1993 and the Northridge earthquake in 1994, and finally the events of Sept. 11, 2001, were unprecedented in the extent of insured losses. These mega-loss events threatened the solvency of a number of insurers and raised alarms that insurers may be over exposed in many regions and states. This has led to an increase in premiums on catastrophe insurance with a corresponding reduction in demand. This is not only a problem in the US, but insurance is unavailable for many types of disasters throughout emerging-economy and developing countries. In those countries, particularly low-income countries, NGOs and alternative financial institutions are exploring how to couple concepts of microfinance and microinsurance for independent risks, like illness and death, to provide microinsurance for dependent, disaster losses. Microinsurance schemes, as well as other mutual insurance arrangements, are ill suited, however, for co-variant risks that require a large capital reserve, reinsurance or wide geographical diversification. Thus, some backup scheme is necessary to guarantee the solvency of such schemes.

2.3. Alternative risk transfer (ex ante risk financing)

Recently, so-called alternative risk-transfer instrument utilizing the financial markets have become an important addition to the portfolio of financial risk management instruments as an alternative to traditional reinsurance (while households insure through primary insurers backed by reinsurance, governments generally insure through reinsurers). Prime examples are catastrophe bonds (cat bonds); these are instruments whereby the investor receives an above-market return when a specific catastrophe does not occur (e.g. an earthquake of magnitude 7.0 or greater in the vicinity of Tokyo, Japan), but shares the insurer's or government's losses by sacrificing interest or principal following the event. Cat bonds make use of different formulas to trigger compensation based on losses or on a physical phenomenon such as wind speed or precipitation. These bonds are purchased by investors and thus transfer the risk to the global capital markets.

Catastrophe bonds emerged as instruments primarily for insurers. In the early 1990s large losses from U.S. catastrophes strained the capacity of the

reinsurance markets and raised the price of reinsurance. This insurance crisis led to the development of new financial instruments to transfer catastrophe risk exposures, including cat bonds, but also to other types of index-based securities that are traded on the equity markets. For instance, the risk transfer characteristics of cat bonds can be replicated through a mechanism called catastrophe risk swaps, where the cedant (e.g., the government) makes fixed payments equal to the premiums paid in a cat bond structure against receipt of claims compensation in case losses occur. However, index-based bonds and securities have an associated “basis” risk since they may be poorly correlated with losses.

Furthermore, another interesting alternative to traditional insurance are so-called weather derivatives, which have been used by businesses and farmers to protect against harmful variations in temperature or rainfall. Contracts are written against physical indicators such as excess or shortage of rainfall measured at a certain location— a kind of lottery against the weather. As payments are triggered by these indicators, the complicated process of settling indemnity payments by insurance companies can be avoided and thus transaction costs are kept low. The downside of derivatives is usually the basis risk that is associated with linking indemnity payments to physical indicators, not to individually experienced losses.

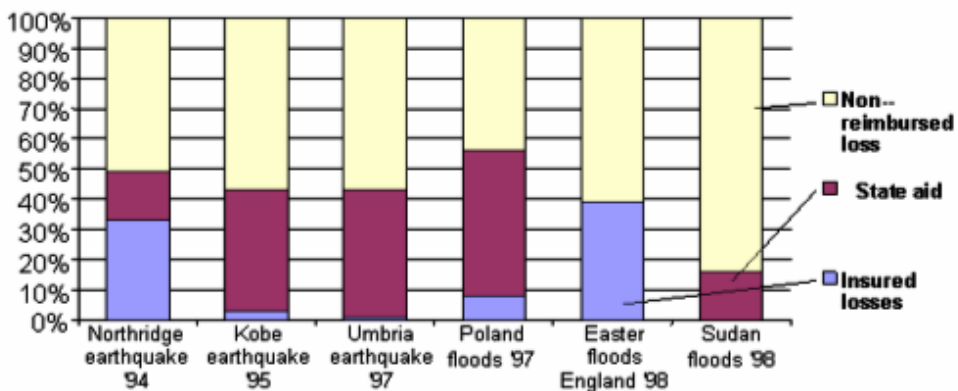
2.4. Inter-temporal risk spreading (*ex ante* risk financing)

Risk financing options can also be arranged inter-temporally to secure sufficient funding in case of need. Because these arrangements also must be put into place before a disaster occurs, they also belong to what we often refer to in this paper as *ex ante risk-financing* instruments. At the household level, inter-temporal risk spreading can be in the form of savings, and many microinsurance schemes are based on saving accounts that will be paid out if the event occurs (for example in the case of death) combined with pooling among those holding the saving accounts. Governments can also spread their risks temporally. Some regional and national governments (for example, Mexico) have catastrophe reserve funds financed by taxes, which will be used for disaster assistance and recovery. If these funds accumulate over time, this is a form of inter-temporal spreading combined with pooling among tax-payers. Borrowing after a disaster is also a form of inter-temporal spreading of the losses, since payments will be made in the future. In other words, arrangements for spreading losses over time can be made before a disaster occurs (saving) or after a disaster occurs (borrowing). The two can be combined, for example, contingent credit arrangements require a pre-event fee and a smaller post-event annuity in comparison to a regular credit.

2.5. Government assistance versus market-based arrangements

Most societies depend on both state and individual responsibility - on non-market and market arrangements - for distributing the losses from rare, unanticipated events, but the balance between the two varies considerably. Figure 9.2 shows six major disasters in the 1990's, which affected five OECD countries and one non-OECD. This figure illustrates the amount to which the victims retained the risks (or absorbed the losses) and the extent to which they were transferred to insurance companies and the state. In Poland, the government reimbursed around 48 percent of the estimated direct losses from the 1997 floods, which was mainly central government compensation to private victims. Notably, the US government also plays a large role in assisting victims; the losses from the 1994 Northridge earthquake were absorbed by insurance companies (about 30 percent) and governments (about 20 percent). In stark contrast, in the UK local and national governments gave practically no assistance to the victims of the 1998 Easter floods (nor did the central government give significant aid to repair local government infrastructure). The lack of government assistance resulted in only about 39 percent of the estimated losses being reimbursed, and almost fully by private insurers who claim close to 75 percent flood insurance penetration. As another contrast, and typical of low-income countries, the government of Sudan was only able to assist victims by about 15 percent of the direct losses from the 1998 floods, and there is no private flood insurance in this country.

Figure 9.2 Losses reimbursed from insurance and government assistance as a percentage of direct losses



Sources: Linnerooth-Bayer et al., 1999; Mantaye, 2000.

2.6. Potential, benefits and costs of market-based instruments

Only about 20 percent of global disaster losses are insured (Munich Re, 2000); the major share of catastrophe risk to households and businesses is retained or transferred to the government. Yet, the potential of insurance and alternative insurance instruments for transferring the risks of disasters to investors across the globe is high. The size of the US capital market alone is in the order of US\$ 26 trillion (Insurance Services Office, 1999), which could easily absorb the annual bill of global weather disaster losses averaging about US\$ 40 billion. In other words, the worldwide losses from extreme disasters are only a small percentage of the global capital markets, which deviate everyday by several billion dollars. This highlights the scope and potential of market risk transfer, especially for governments of poor countries that cannot form a viable insurance pool of taxpayers within their borders.

Market risk financing instruments can be extremely valuable to individuals and governments alike. In the case of severe disasters in poor countries, traditional coping strategies and government assistance for households and businesses may break down. This can have long-term consequences leading to a cycle of poverty. Likewise, if a government experiences a post-disaster financing gap, and additional funds are not available through pro-active financing strategies, its inability to continue social and economic programs, rebuild assets and assist the poor in the wake of the disaster can have severe effects to the public and the economy. These circumstances describe the case of risk aversion where purchasing market-based ex-ante risk financing instruments can be very beneficial in helping to avoid such eventualities and the longer-term adverse consequences they may cause.

The desirability of risk transfer instruments to developing and emerging-economy countries, however, cannot be determined solely by considering the benefits – it is essential to consider the costs. Most commercial risk financing arrangements incur an expected net financial loss to the purchaser (the annual costs over a longer time period are higher than retaining the risk and paying with own resources) since insurance and financial market companies are profit seeking and averse to risks that threaten their solvency. Several years ago Froot and O’Connell (1999) contended that the premium for catastrophe protection was considerably above its actuarially fair price or pure premium, mainly because insurers and reinsurers must have sufficient capital on hand to pay the bill if the rare disaster occurs. A capital reserve is costly. Additional factors that add to the costs of catastrophe cover include ambiguity or uncertainty aversion, adverse selection and moral hazard.

To conclude this section, there are many market and non-market mechanisms for transferring or spreading risks facing households, businesses and governments. First and foremost, risks can be pooled with those at risk and those who show solidarity, or they can be spread over time. These arrangements can be made by government, by communities pooling together, or through the market. Some of these financial strategies require planning before the disaster, and there has been a great deal of recent interest in pro-active *ex ante* financial tools for the private and public sectors.

In the following, we will discuss some recent experience with and comparative benefits of market mechanisms with a focus on financial market tools.

3. Financial Risk Management in the Private Sector

This section examines the experience and potential of risk-financing instruments, particularly those offered by financial markets, for spreading disaster risks and sharing losses accruing to the private sector in emerging-economy and developing countries. These instruments include market and non-market mechanisms for transferring risks across agents and spreading risks over time.

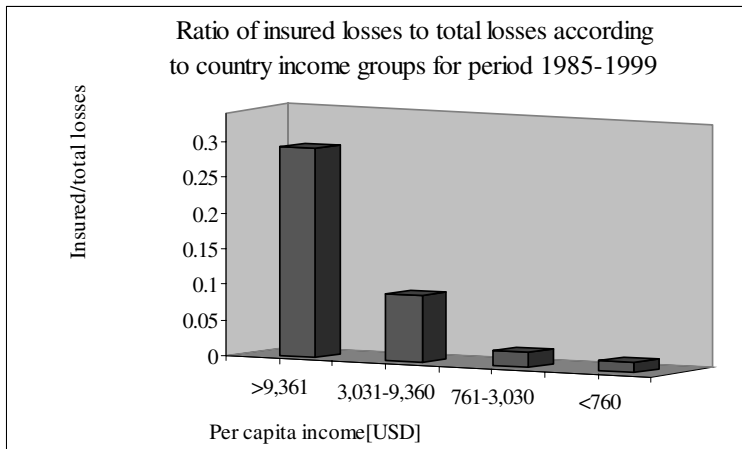
For this discussion, it is important to make a distinction between two different contexts of financial vulnerability. The first includes households or groups that can cope financially with the disaster risks to which they are exposed. This group can pay the costs of joining a pool, where each pays their expected annual losses plus administrative costs.

A second class of financial vulnerability includes persons or households who cannot pay the annual expected losses from disasters. In other words, they cannot afford the risks to which they are exposed, and they will require financial support to become members of a pool or to recover financially if a disaster occurs. The challenge for a risk-financing strategy for vulnerable countries is to combine social solidarity with affordable pooling arrangements, and at the same time promote loss prevention.

3.1. Risk transfer in emerging and developing countries

Insurance density for disaster risk is highly correlated with the state of economic development measured in terms of per capita GDP. Figure 9.3 shows the differences in insurance density for four main country income groups: high, upper middle, lower middle, and lower income.²

Figure 9.3 Catastrophe insurance density according to country income groups (per capita GDP in 2000)



Source: Munich Re 2000: 24-25.

As we see in Figure 9.3, most disaster insurance is held by citizens or residents of high-income countries, although even in the wealthy countries insurance density is far from its potential. Less than a third of disaster losses are insured. Not surprisingly, the picture is quite different for countries outside of the high-income bracket, where insurance density drops from around a third to less than a tenth in the emerging economy income countries, and it is almost negligible (1-2 percent) in developing lower middle income and lower income countries. Furthermore, the global reinsurance market covers mainly assets in developed countries and almost none in developing. As a consequence, the financing of recovery in developing countries has often to be done after a disaster by relying on family, government, multilateral donations and emergency loans (Andersen 2001: 1).

Low uptake of commercial catastrophe insurance in the developing world is neither surprising nor disturbing. There is great scope for and appeal of pooling and transferring risks; however, commercial insurance is for the most part unaffordable for low-income households. Even if insurance is affordable and available, there are high opportunity costs in terms of providing shelter, food and other basic needs in low- and medium-income households. Affordability is not the only limiting factor to insurance uptake. The literature on insurance in developing countries (see, e.g., Andersen 2001: 39; Kreimer et al. 1999: 26; and Litan 2000: 191) points to many factors limiting uptake, including:

- high premia including high transaction costs,

- lack of formal requirements and economic incentives to purchase insurance,
- lack of formal titles to property of many individuals and firms, without which no formal proof of holdings can be established,
- insufficient risk assessment and mitigation,
- lack of awareness and understanding of the concept of insurance,
- reliance on government or international donor relief spending.

Many low-income countries are highly exposed to disaster risk, which also holds true for many low-income communities in middle-income countries. Nicaragua and Haiti in the Caribbean are exposed to hurricane, flood and landslide risks; Bangladesh faces extreme risks from sea surge and floods; Nepal is at high risk to riverine and flash flooding along with landslides; India faces significant flood and earthquake risk; and Sudan and Mozambique face severe risks from flood and drought. For the most part, residents of these countries cannot pay the price of a fair pooling arrangement, and they will inevitably require support from the non-risk communities in their own countries or internationally.

Traditionally, low-income households have protected themselves from the economic impacts of natural disasters by diversification of crops and livelihoods and through kinship risk-transfer arrangements. For example, farmers may have a variety of crops that are differentially resistant to droughts, floods, hail storms and pests. In addition, many farmers in low-income countries have two and sometimes more different sources of income, and often they encourage their children to take on different jobs in and out of the region so as to hedge against family disasters. These family arrangements can be formalized, as in Nepal, where there are clear responsibilities among members of the extended family (Gyawali, 2004). At the extreme, families deliberately place their children or other kin in distant regions or countries that will not be affected by the disaster. Woo (2001) suggests that insurers consider offering disaster policies to family members living in wealthy countries to insure them against claims by relatives struck by disasters in their home countries.

Remittances from family members living abroad to low-income relatives, even in times of no disasters, are significant and growing. Orozco (2002) estimates that remittances to Mexico and selected Central American countries increased 20-fold from 1980 to 2000. Remittances can be a significant percentage of gross national income. For example, in 2000 remittances were estimated to be as much as 25 percent of the reported GNP of Honduras, which makes remittances in this country more important than

export income. Remittances to Honduras increased by approximately 15 percent after Hurricane Mitch devastated the country in 1998.

Informal kinship practices to hedge disaster risks are far more prevalent in low-income countries than insurance. Recently, however, there has been a great deal of interest in extending microinsurance and -financing arrangements to provide financing to low-income individuals and households. The idea is to provide very low cost financing to poor households by minimizing transaction costs, overhead and profits. Microinsurance has mainly covered funeral expenses, health and more recently, death. Most participants in the microfinance movement of recent decades see themselves as improving the availability and quality of financial services to poor and near-poor clients. It is generally thought that the main providers of microfinance, usually called Microfinance Institutions (MFIs), are NGOs and a few commercial companies. Recent evidence suggests that Alternative Financial Institutions (AFIs), which include state-owned banks and postal services, member-owned savings and loan institutions and low-capital local or rural banks, may be more important than NGOs in providing microfinance services.

The following examples from India and Bangladesh illustrate the types of risk financing provided by AFIs coupling microfinance and insurance schemes. Furthermore, the case of weather derivatives is discussed.

3.2. Coupling microfinance and insurance schemes

The not-for-profit Gono Bima and Grameen Bima insurance programs for South-East Asia are operated by the Delta Life Insurance Company, which is fully licensed and regulated. The programs offer life insurance combined with microcredit, including protection against emergencies and disasters. Because they serve many clients with ensuing high transaction costs, premiums are actually higher than commercially-available insurance (which, however, is not available for poor persons). The sources of income are premium and service charges of micro-credit activities, which are invested to provide additional revenue. There are no profits or dividends accruing to Delta.

The Grameen Bank started as an experiment in Jobra village in Bangladesh with 42 of the poorest villagers. It has expanded to an institution covering 40,000 villages (out of 68,000 villages) and 2.4 million active micro entrepreneurs. Today, 494,044 groups comprise 67,691 centers under 1149 branches in 60 districts (out of 64 districts). The initial disbursement of Taka 856 (US\$26) has expanded to a cumulative disbursement of Taka 124,035 million (US\$3 billion). Among other types of insurance, the Grameen Bank offers two saving funds: the Group Fund and Emergency Fund. The

Emergency Fund covers the death of the member and has developed into a solid insurance plan for the poor. There is no explicit premium to be a member of the fund. Rather, payments to the fund are bundled with the interest paid on loans. As of November 1995, the fund is self supporting, and the Grameen Bank has discontinued collecting contributions from members for the Emergency Fund (Barual, 2004). Table 9.2 compares institutional arrangements of Grameen Bima and Gono Bima with those of commercial insurance companies and NGOs.

These programs, however, have not met the social-welfare objectives set out by their founders. Most current policyholders are middle class; only 5 percent of policyholders come from the poorest or have-nots. The reason is that without any subsidization, the poor are unable to afford the premium.

GHASHFUL, a small NGO MFI based in Chittagong City, Bangladesh, created a life insurance product for the people in slum dwellings. According to the NGO, their product is the least expensive form of life insurance protection available in the area. Coverage is limited to female members, who are clients of the GHASHFUL savings and credit program. The program operates with a small initial charge (5 Taka) and a monthly premium (10 Taka). The NGO reserves the right to increase or modify the premium rates, especially in exceptional cases, such as a large number of deaths due to disaster or epidemics. The organization maintains a cash reserve equivalent to 8 percent of the total loan outstanding for cash liquidity needs, including the payment of death claims, which range USD 100-200. The advantage of the program is its accessibility to low-income slum dwellers. In 2000, GHASHFUL had 1,955 policy holders. The program has been criticized for its lack of reinsurance exemplifying the considerable danger of small grassroots programs operating insurance schemes, which can be overwhelmed with claims in the case of a major disaster (Mamun, 2000).

3.3. Weather derivatives

Another interesting alternative to traditional insurance are so-called weather derivatives, which can protect farmers against droughts, storms and other extremes.³ Contracts are written against, say, severe rainfall shortages measured at a regional weather station. The contract is sold in standard units by banks, farm cooperatives or microfinance organizations, and the “premium” varies from crop to crop. The claim is a pre-fixed amount per unit of protection— a kind of lottery against the weather. By keeping it simple, the transaction costs are reduced.

Table 9.2 Comparing institutional arrangements for microcredit and microinsurance for Grameen Bima and Gono Bima with commercial insurance companies and NGOs.

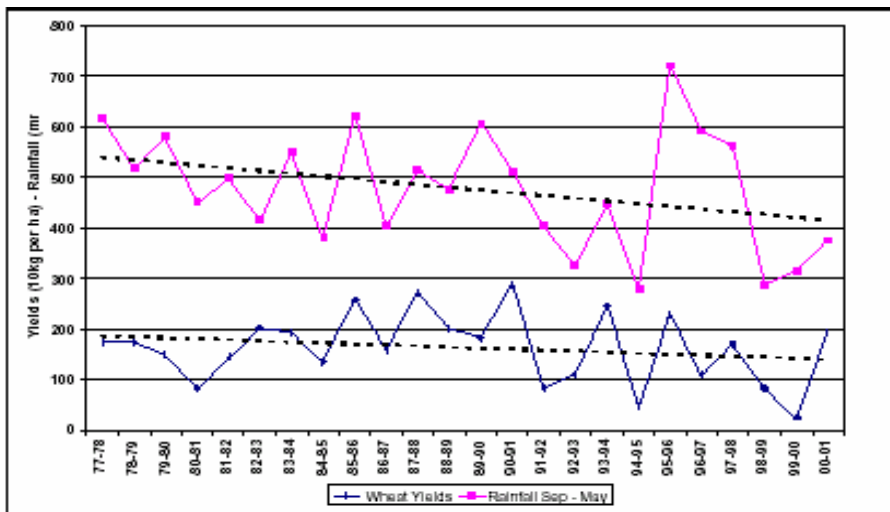
Commercial Insurance Companies	Not-for-profit Grameen Bima and Gono Bima
<p>The goal is profit Private owners take dividends Mainly dependent on commission based agent for collection of premiums Unspecified working area for agents. They are allowed to insure people and collect premium from any part of the country There is no limit to the sum assured. Clients are comparatively wealthier Policies are sold mainly to individuals and the relationship between policy holder and institution is purely commercial.</p>	<p>Profit is the means. The goal is socio-economic security for the have-nots and low income people Owners do not take dividends. All profits are invested in the improvement of the program and partially distributed among policy holders as a bonus Recruit officers and organizers who have a fixed salary Sum assured is limited (Taka 5000 to Taka 50,000). Clients must be low-income group or have-nots. Trying to organize the target group with an aim to build up self reliance and a welfare program</p>
NGO	Not-for-profit Grameen Bima/Gono Bima
<p>Well established institutions with reputations Mainly dependent on grants Employees are not local Insufficient levels of decentralization Lack of adequate transparency Have provisions for limited death security Avoid local leadership</p>	<p>Comparatively new and experimental products No international or domestic grant support Almost all workers are local Move towards a decentralized system that is simple with high levels of transparency Operated with participation of policy holders Insurance activities play a dominating role in the program Local leaders are welcome to participate in motivating anti-corruption measures</p>

Source: Adapted from Ahmed and Mosleuddin (2000)

In India, such a scheme has been recently implemented on a pilot basis by the government-owned Agriculture Insurance Company of India in collaboration with the rural credit banks (Agriculture Insurance Company of India, 2004). The main reason for initiating this program was that the existing public crop insurance program supplied by the National Agricultural Insurance Corporation of India for drought and flooding had been highly deficitary in recent years. Premium income had been only a sixth of total payouts, mainly due to the high costs associated with settling indemnity payments on a case-by-case basis. Another concern was the time lag associated with indemnity payments. Farmers place great emphasis on timely payouts. For example, if seedlings are lost at the beginning of the growing season, and capital is not available for replacement investment, the whole crop will be lost.

For these reasons, index-based weather derivatives with low transaction costs were introduced. Transaction costs are kept low by involving existing rural credit channels. Payouts are triggered by excess or lack of rainfall defined by a rainfall index, which eliminates the need to assess claims after the disaster. Generally, farmers are aware of the associated basis risk. On average, the costs of the derivatives amount to around 15 percent of the “insured property”. However, farmers value the proposed quick payout of claims, which is planned to take a maximum of two weeks after the triggering event. Furthermore, such a scheme provides incentives for prevention. As the payouts are not coupled with the individual loss experience, it will be beneficial to engage in loss-reduction measures (eg switching to a more robust crop variant). As the scheme has been only recently introduced, the number of contracts written is still low, and there is little experience to assess its viability. However, it is planned to expand the system to a large number of provinces in India affected by drought and flooding.

Figure 9.4 Correlation between physical and economic variables in Morocco



Source: Rainfall DMN, Yields DPAE

Source: Stoppa and Hess, 2003.

Similar schemes have been proposed or are currently being examined for Morocco and Ethiopia (see Stoppa and Hess 2003). The research experience in Morocco suggests the possibility of avoiding basis risk by constructing a hazard-index that is highly correlated with the agricultural

product. In the case of Morocco, the following time series for cumulated rainfall and wheat yields through September to May for the years 1978 to 2001 measured at one station were reported. As shown on figure 9.4, from 1977 to 2001, there clearly is correlation between wheat yield and rainfall during the growing season of November to May. However, when measured it amounted to 67 percent, a value for which basis risk would still be substantial. When focusing and establishing weights on certain growth phases, as well as limiting the measurement of precipitation to only water that can be stored and used, an improvement in the index correlation to 95 percent with wheat yields was achieved (Stoppa and Hess, 2003).

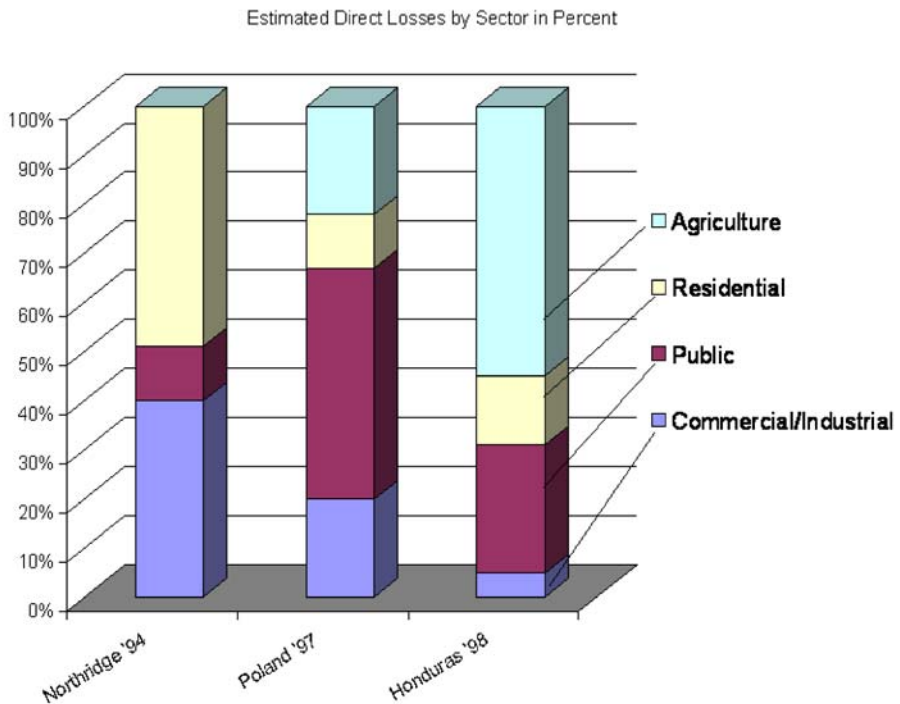
However, as discussed already, a major constraint to this and any micro scheme for providing disaster finance is the dependent nature of the insured risks within a single region. When an event occurs, the provider may not have the capital to cover the dependent claims. For this problem, micro scheme providers could make use of reinsurance, or of catastrophe bonds that spread the risks internationally. Many consider the use of alternative instruments an exciting new opportunity to pool large volumes of dependent risks at the global level, and they point out that these instruments have already been successful to spread insurers' risks. However, as pointed out above, there is a substantial cost associated with these instruments that may make these schemes unaffordable without assistance from international donors. In many vulnerable countries, there is increasing recognition that national programs must be developed that will effectively and fairly link private and public responsibility, insurance and loss mitigation (Kunreuther and Roth, 1998). The uneven distribution of income in these countries raises the issue of risk financing as a distributive mechanism, invoking social solidarity with low-income groups. At the same time, it raises the possibility of imposing greater personal responsibility on the wealthier members of society, encouraging more personal and local risk-reducing measures.

4. Financing Disaster Risk in the Public Sector

Throughout the world, the public sector retains a large proportion of catastrophe risk from naturally occurring disasters resulting from two main roles of government: the allocation of goods and services not provided by the market and the distribution of income (Peffekoven 1992: 487 ff.). Public economic infrastructure is a typical example of the allocative function of governments, and many governments carry a large portfolio of capital exposed to risk. Figure 9.5 compares infrastructure, agricultural, residential and commercial losses from three recent disasters. As shown in this figure, the share of public-sector losses was about 10, 45 and 20 percent in a developed country (1994 Northridge earthquake, U.S.), a transition country (1997 Polish floods) and a developing country (1998 Hurricane

Mitch, Honduras), respectively. In the case of Poland, losses to public infrastructure were significant, around 2 percent of GDP of that year. Since earthquakes generally cause more destruction to roads, schools, electric lines and other public infrastructure than floods and windstorms, these differences might be even more pronounced were we comparing over the same type of disaster. The important message is that, especially in developing and transition countries, the public sector can bear a large proportion of the direct economic losses from natural disasters, thus resulting in significant post-disaster government liabilities.

Figure 9.5 Direct losses borne by economic sectors for three natural disasters



Source: Adapted from Linnerooth-Bayer, et al, 1999

As discussed, governments also have a role in distributing burdens in society. Government's liabilities for redistributing losses, or assisting households and businesses, can be considerable. Around 29 percent of the USD 6.2 billion direct losses from the 1993 mid-west floods in the US were reimbursed by federal and state government assistance. In comparison, the

National Flood Insurance Program (NFIP) only paid out about half, or around USD 1.3 billion in claims, which amounted to about 14 percent of the direct losses to households, businesses and farms. As another case, after the catastrophic flooding on Hungary's Upper Tisza river in 2001, the government fully rebuilt nearly 1000 houses that had been washed away. This kind of taxpayer solidarity with flood victims is typical of all the formerly socialist countries of Central Europe. It is also typical of Latin American countries, many of which provide a great deal of state support to households and businesses following a disaster (Freeman et al, 2003).

Governments thus absorb and spread losses by acting as "insurers of last resort". Because of their ability to spread and diversify risks over a large population, Priest refers to governments as "the most effective insurance instrument of society" (Priest 1996: 225). This function allows governments to redistribute income to those members of society that are in need of post-disaster assistance. Government subsidies in the form of post-disaster assistance are criticized as promoting more development in high-risk areas, but in developing countries this assistance may be essential to the survival of poor households and businesses that cannot afford commercial insurance.

Many governments in developing and emerging-economy countries have difficulties raising the capital necessary for reconstruction of public assets and for their role as insurer of last resort. In this section we examine the arguments for and against *ex ante* market financing instruments to finance risks to the public-sector, or sovereign risk financing. We discuss the theory and practice, and conclude with the costs and benefits of *ex ante* financing instruments.

4.1. Reducing public sector catastrophe risk

A government has again two options for financing its post-disaster obligations. The first, and most common, is to rely on *ex post* disaster financing sources. For highly exposed countries, the strategy of raising necessary capital after the disaster has the risk that a disaster might overwhelm the government's available resources for financing recovery. The second option, sometimes referred to as sovereign risk transfer, is to arrange *ex ante* risk financing before an event occurs, usually through market risk-transfer instruments and inter-temporal risk spreading. Some combination of *ex ante* and *ex post* financing instruments is essential for aiding recovery. *Ex ante* instruments will help in guaranteeing a sufficient and timely financing of government's post disaster obligations, but they entail additional costs to reward investors for absorbing the risks. The question we turn to below is how to balance the portfolio of financing options. We begin by describing *ex post* and *ex ante* financing instruments in more detail.

4.1.1 *Ex post financing instruments*

Ex post financial instruments are arrangements whereby the government taps its funding sources after the event occurs. In the aftermath of a disaster, the government can divert funds from current budgets or internationally financed projects, borrow by issuing bonds or other debt instruments, raise taxes, or accept international bank loans. We discuss each in turn:

- *Diversions from other items in the public budget,*

Governments throughout the world resort to diverting funds from budgeted items to cover their post-disaster liabilities. This is a rational alternative if the return on the diverted funds is less than the interest on the debt, and some governments have even legislated this response as priority. For example, after the 2001 floods on the Tisza river, the Hungarian government discontinued construction on an extension of the Budapest subway system in order to divert funds to disaster relief and reconstruction (Linnerooth, et al., forthcoming);

- *Diversions from internationally financed project*

In the developing countries, these diversions are often from international loans for infrastructure projects. Whereas this response may be the least costly one for the government, it can be disruptive both economically and politically. The World Bank and other lending organizations are therefore interested in reducing the post-disaster liabilities of poor governments by encouraging sovereign risk transfer.

- *Internal borrowing*

Debt instruments, which partly pass the burden on to future generations, are a common post-disaster financing option, particularly for countries with a high credit standing or bond rating. The government can borrow either domestically or on the foreign market. For instance, after the 1997 floods Poland raised all its needed capital domestically; alternatively, Honduras relies on foreign borrowing. A government can also raise funds through a credit from the national bank if it has sufficient reserves, or, alternatively, it may use its foreign reserves, print money, or borrow by issuing bonds. International financial institutions warn indebted countries of the dangers of relying on debt instruments and especially foreign reserves and printed currency.

- *External borrowing*

Governments in developing countries often rely on loans from the World Bank and other multilateral finance institutions (MFIs). The World Bank estimates that it has provided grants and loans of more than US\$ 38 billion to developing countries over the last two decades for disaster relief and recovery (Gurenko, 2004; Gilbert and Kreimer, 1999), and the Asian Development Bank also reports large loans for this purpose (Arriens and Benson, 1999).

- *Taxes*

Governments can collect special catastrophe taxes or increase taxes. For example in Germany the tax reduction planned prior to the Elbe flooding in 2002 was postponed and the extra revenue was used for private sector compensation and public sector reconstruction. Alternatively, if a new tax year is approaching, government officials can raise the tax rate as was the case in Austria after the 2002 floods. A new tax has the disadvantage of large transaction costs for its implementation, and the funds will not be immediately available.

- *International assistance*

International donations, especially for highly publicized disasters, are an important source for bolstering the government's relief and reconstruction budget, yet donor aid is relatively small and declining (Linnerooth-Bayer and Amendola, 2000). Still, the donor community is concerned that international donations and loans for post-disaster reconstruction are taking an increasing portion of declining official development assistance (Mechler, 2004).

Most governments rely on *ex post* non-market instruments to finance their obligations from disasters. This reliance is not a problem in large, wealthy countries. For example, the US federal government with its vast base of well-to-do taxpayers absorb up to 90 percent of state and local government infrastructure losses from major disasters (Linnerooth-Bayer and Amendola, 2000). A problem in developing countries, and a major limitation of the current *ex post* approach to disaster funding, is the growing discrepancy between the extent of reconstruction funds available from taxes, the international community and other internal sources and the growing funding needs of disaster-prone countries. Government fiscal constraints often limit the capacity to raise capital from the budget or printing money. As a consequence, governments may resort to diverting funds from development projects or from other government programs, or to increased borrowing and national debt.

4.1.2 *Ex ante market-based financing instruments*

If the government chooses not to bear the full risks from disasters, it can spread its risk temporally by setting up a reserve fund or transfer its risk by paying a third party to absorb it. There are many forms of temporal spreading and risk transfer, some of the more common are listed below:

- A catastrophe reserve fund usually financed by tax revenues.

To reduce their dependency on debt financing, many countries have put into place a catastrophe or calamity fund. For example, the Mexican catastrophe reserve fund, FONDEN, was set up to smooth the volatility of economic activity after natural disasters (World Bank, 2000). Costa Rica, Nicaragua and Honduras also have or intend to create national funds (Charveriat, 2000). This financing option differs importantly from a post-disaster tax, which has the added disadvantage of high administrative costs. A catastrophe fund has a cost equal to the foregone return from maintaining liquid capital and an additional benefit in having the resources immediately available with less transaction costs. A major problem with a fund, however, is that it may not be able to supply sufficient capital, especially if the disaster occurs shortly after its creation. A second problem with a catastrophe fund is the political risk that it is diverted for other purposes in years with no disasters.

- Commercial insurance

As discussed, the most common forms of risk transfer are insurance or reinsurance, which provide indemnification against losses in exchange for a premium payment. For example, after the 1997 floods in Central Europe, the Czech Republic insured its infrastructure losses through a commercial reinsurer. Pricing of catastrophe insurance is very volatile, and this option may be significantly more costly than *ex post* financing instruments.

- Catastrophe bonds and other alternative insurance instruments

Catastrophe bonds pay high yields, but interest and/or principal may default if a specified catastrophe event happens during the lifetime of the bond. Funds from placing these bonds in the capital markets are usually invested in risk-free financial instruments. Catastrophe bonds are the most popular the group of alternative risk transfer instruments; this group also includes exchange traded catastrophe options, weather derivatives, catastrophe equity puts and catastrophe swaps. Catastrophe bonds are rather new and have until recently been issued only by insurance companies. Recently, the

Taiwan Residential Earthquake Insurance Pool, a publicly backed insurance scheme for private property, has placed a catastrophe bond on the market. Also Mexico is currently investigating whether to issue a cat bond for FONDEN liabilities.

- **Contingent credit**

In exchange for an annual fee, a contingent credit arrangement grants the purchaser the right to take out a specific loan amount post-event that has to be repaid at contractually fixed conditions. As mentioned in section 2, contingent credit options spread risk temporally.

Table 9.3 summarizes the most important *ex ante* and *ex post* financial instruments available to governments to assure sufficient funds for their post-disaster needs.

Table 9.3 Ex ante and Ex post financing sources for assistance and reconstruction

Ex ante	Ex post
Reserve fund	Diversion from budget and international loans
Commercial Insurance	Taxation
Catastrophe bonds and other alternative Risk transfer instruments	Central Bank credit
	Foreign reserves
	Domestic bonds and credit
Contingent Credit arrangements	Multilateral borrowing
	International borrowing
	Aid

Sources: Benson 1997, 1999; Fisher and Easterley 1990.

4.2. Should governments undertake risk financing for catastrophe risks?

The case for insurance instruments and other means of transferring or spreading public-sector risks is not a clear one. In fact, economic theory argues against public-sector risk transfer. However, we conclude that the theory may not hold for highly exposed developing and emerging-economy countries if the government faces constraints in raising sufficient capital after a disaster to meet its post-disaster obligations. In this case, it will be important to examine the costs and benefits of public-sector insurance and alternative insurance instruments.

4.2.1 *The theory and its implications*

The insurance premium or costs of risk-transfer instruments will generally be greater than the purchaser's statistical expected losses. This is due to transaction costs, cost of capital reserved by insurance companies for potential losses, as well as the financial return required for absorbing the risks. Still, people buy insurance, and justifiably so, because of their aversion to large losses, ie, their concern about the volatility of the possible outcomes. Insurance and other risk-transfer instruments are thus justified by the concept of risk aversion. It is because of aversion to large losses that people are willing to pay for insurance.

In contrast to many individuals, governments are not, in theory, risk averse, and, therefore, in most circumstances should not purchase insurance or other market risk-transfer instruments. This is the result of a well-know theorem by Arrow and Lind (1970), who give two reasons for the risk neutrality of governments: risk spreading and risk pooling through diversification.

Risk spreading: Arrow and Lind (1970) show that if the government spreads its risk over its citizens (most notably by means of taxation), the expected and actual losses to each individual taxpayer are minimal due to the sheer size of the population. They state, that

[...] when risks associated with a public investment are publicly borne, the total cost of risk-bearing is insignificant and, therefore, the government should ignore uncertainty in evaluating public investments" (Arrow and Lind 1970: 366).

A government can be compared to a wealthy individual engaging in small bets, who is not averse to the largest conceivable loss (Reutlinger 1970: 51). The Arrow-Lind theorem is largely accepted as the theoretical underpinning for governments dealing efficiently with risk (see Little and Mirrlees (1974: 316), and leads to the conclusion that governments should not purchase catastrophe insurance or other risk-transfer instruments.

Risk pooling through diversification: The government's relative losses from disasters in comparison with its assets may be small if the government possesses a large and diversified portfolio of independent assets. Depending on the size and diversification of its portfolio, public sector disaster losses may be independently distributed. This means losses will not deviate substantially from expectations, or statistically speaking, they will converge to the mean with little variance. The *Law of Large Numbers* states that for a series of independent and identically distributed variables the sample mean over the variables converges to the theoretical population mean of the probability distribution and thus the variance around the mean decreases for

large numbers (Kunreuther 1998: 24). It follows that by pooling independent or uncorrelated risks to government assets, a government is able to reduce the variance around the probability mean. If the government's portfolio of independent assets is very large, this is then another justification for risk neutrality.

Because of these conditions for risk neutrality, Arrow and Lind (1970:366) argue that "[...] the government should behave as an expected-value decision maker" and thus not purchase insurance or otherwise engage in risk transfer. Avoiding the extra costs involved in risk transfer, governments can be considered the entity best suited to deal with disaster risk (Arrow and Lind 1970: 364). In practice, most governments assume catastrophic risks themselves (Guy Carpenter 2001: 39-40), thus implicitly or explicitly they behave as risk-neutral agents.

Stated simply, local, state or national governments are not advised to incur the extra costs of transferring their disaster risks if they carry a large portfolio of independent assets and/or they can spread the losses of the disaster over a large population. We argue below that these conditions, and thus the Arrow-Lind theorem, are not fully relevant for many highly exposed developing countries. In the following section, we argue further that developing and emerging-economy governments should under very special circumstances consider pro-active risks transfer strategies. Because there are costs to these strategies, and because they violate the Arrow-Lind theorem, we will examine the two conditions underlying this theorem in more detail below.

4.2.2 Relevance of the theory to developing and emerging-economy countries

The conditions leading to government risk neutrality may not hold for highly exposed developing and emerging-economy countries, in which case government officials might consider pro-active risk-transfer strategies. We examine each of the two conditions in turn:

Risk spreading: in smaller developing countries the tax base is often too narrow to spread risk sufficiently. In other words, a small and poor population may not be able to collectively absorb the losses from a catastrophic disaster through additional tax payments. Of course, raising taxes is not the only way governments pay for disasters. As discussed in Section 3.3, the government can also rely on diverting funds, on domestic and international borrowing, and international assistance. What distinguishes a developing country from a developed country is that developing country officials may be severely constrained in raising capital in the aftermath of a disaster.

Risk pooling through diversification: This second condition will also not apply in a small, developing country, where the national or state government has a far smaller and less diversified portfolio of assets (Brent, 1998). Moreover, in a small country or region these assets will be in close proximity, and thus the risk is correlated (not independent, sometimes referred to as covariant risk).

In sum, developing and emerging-economy countries that meet these conditions may be justifiably risk averse to catastrophic events. This is the conclusion of the Organization of American States, which has many members from the developing world that are highly exposed to natural disasters. In the OAS primer on natural disasters, it is stated:

In view of the responsibility vested in the public sector for the administration of scarce resources, and considering issues such as fiscal debt, trade balances, income distribution, and a wide range of other economic and social, and political concerns, governments should not act risk-neutral (OAS 1991: 40).

The conditions that might lead countries to consider transferring their public sector risk through insurance and other instruments are (see Mechler 2004a):

- high natural hazard exposure;
- low tax revenue, low domestic savings and shallow financial markets, high indebtedness with little access to external finance;
- few large infrastructural assets and high geographical correlation between those assets; and
- concentrated economic activity (e.g. large urban agglomerations) exposed to natural hazards.

This does not necessarily mean that under these conditions state or national governments should purchase risk-transfer instruments. It is important to consider the government's ability to retain risks of different severity, as well as the opportunity costs of investing in pre-disaster mitigation and risk transfer. In other word, in developing a risk-financing strategy it is important to examine the government's financial vulnerability and the costs/benefits of reducing this vulnerability.

4.3. Developing a pro-active risk financing strategy

In the words of a leading World Bank expert, any *ex ante* risk financing strategy should be based on “an in-depth understanding of a country's risk exposure, a thorough analysis of the potential benefits of mitigation efforts,

and cost trade-offs between different types of risk-financing instruments, and last but not least, on assessing the country's internal financial capacity to retain the risk" (Gurenko, 2004:xxii). This advice for developing a proactive, country level risk-financing strategy underlies the approach described in this section, and which is embedded in IIASA software to assist policy makers in financial planning. Importantly, in our interpretation of this advice, the risk-financing instruments include traditional post-disaster measures for raising capital. We begin by assessing a country's internal financial capacity to retain risk, or its financial vulnerability. We then illustrate the IIASA software with reference to Honduras.

4.3.1 Financial vulnerability and the financing gap

Financial vulnerability can be defined as the risk that a local, state or national government will not have sufficient funds, either from domestic or foreign sources, to meet its post-disaster obligations for financing reconstruction investment and relief. We refer to this lack of sufficient funds as a financing gap.

A Financing gap is the difference between a government's loss potential and the amount of internal financing resources available to finance the recovery

Post-disaster financing gaps are frequently encountered in developing countries. For example, after the devastating earthquake of 2001 in Gujarat, India, there was a significant shortfall between the state government's planned expenditure, planned funding sources and the actual funding made available.

The Gujarat government estimated its post-disaster liabilities, or expenditure for reconstructing infrastructure and housing, at 2.4 billion USD, and planned funding from the state, from central reserve funds, and multilateral and bilateral financial sources was estimated at 3.6 billion USD. However, actual funding received by end 2002 amounted to only 0.7 billion USD. The state government faced a financing gap of 1.7 USD (World Bank 2003).

4.3.2 *Estimating financial vulnerability*

What is the risk that Honduras, or any exposed country or region, will experience a financing gap in the near future? This question has recently received a great deal of attention at the World Bank (see Pollner, et al, 2001), the InterAmerican Development Bank (see Keipi and Tyson, 2002) and other international financial institutions. The risk will depend on two factors: (1) the probability of public-sector disaster losses of different magnitudes (risk exposure), and (2) the ability of the government to meet its post-disaster liabilities. IIASA has developed a computer tool (CATSIM) to estimate these two factors, and, thus, to estimate a government's financial vulnerability (Hochrainer et al., 2004).

Assessing Honduras' Financial Vulnerability: The CATSIM Tool

Combining Honduras' loss probability with the government's ability to absorb the losses yields a picture of the government's financial vulnerability. IIASA's CATSIM model has illustrated the financial vulnerability of Honduras as shown in Figure 9.A.3 in the Annex following this chapter.

Governments of OECD countries can also experience financing gaps. In Poland, as a case in point, the infrastructure losses from the 1997 floods amounted to over 2 percent of GDP, and it was estimated that due to lack of funds it would be several years before all the roads and bridges were repaired (Kunreuther and Linnerooth, 2000).

4.3.3 *Importance of reducing financial vulnerability*

If a government experiences a financing gap after a disaster, its inability to continue social and economic programs, rebuild assets and assist the poor in the wake of the disaster can have severe effects on the public and the economy. The failure to repair public infrastructure, including roads, railways, electricity lines and water supplies, in a timely way can be economically devastating. First, there is a direct link between infrastructure and poverty since disasters can reduce access to sanitation, electricity and clean water, all indicators of poverty (Freeman, et al, 2002a). At the macroeconomic level, infrastructure is critical for economic growth and development. Moreover, if foreign investors anticipate long-term business disruptions from damaged infrastructure, they may not locate in disaster-

prone countries. All these factors underline the criticality of a timely repair of public infrastructure following a disaster.

International financial institutions are greatly concerned about the dependence of highly exposed, developing countries on post-disaster capital grants from large international donors and international development banks. This prevents them from seeking alternative market sources of risk financing because of their considerably higher cost. A major limitation of this *ex post* dependency, according to Gurenko (2004:xxiii) is the growing discrepancy between the amount of reconstruction funds available from the international community and the growing funding needs of disaster-prone countries:

As a consequence, governments tend to resort to diverted development loans, which often have onerous procurement rules, or additional external borrowing to fund reconstruction.... To reduce the funding/capability gap, the government fiscal exposures and the vulnerability of national economies to exogenous risks, the existing international system of post-disaster financing should be redesigned to provide stronger fiscal incentives for governments to adopt more proactive approaches to risk management and resort to market funding mechanisms.

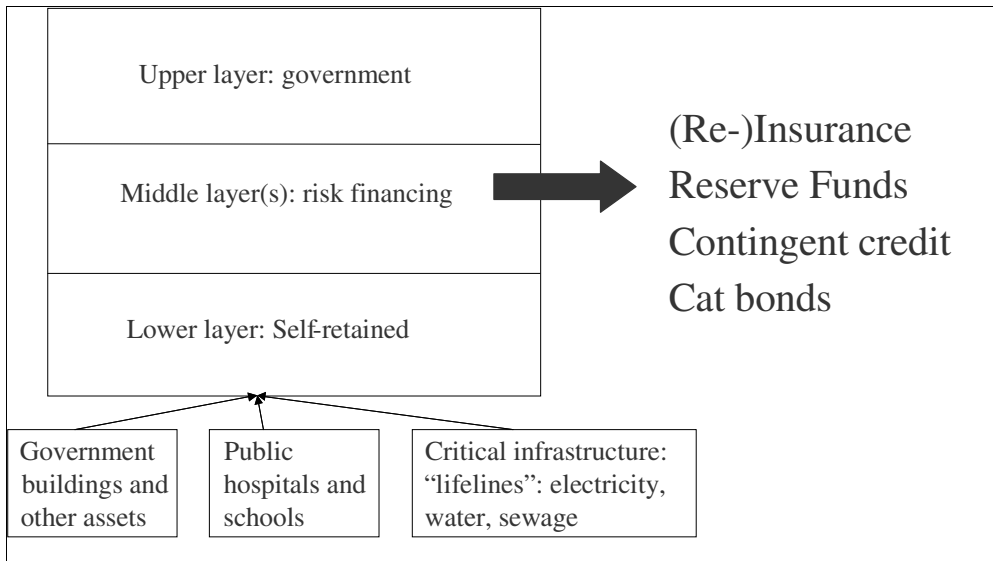
It is important to add that not only can poor governments not afford post-disaster reconstruction costs, but they also cannot afford the costs of market funding mechanisms. This may call for shifting disaster assistance from the current post-disaster approach to supporting pre-disaster mitigation and financing strategies.

4.4 Reducing financial vulnerability with ex ante risk financing instruments

The risk of a financial gap, or financial vulnerability, can be reduced by the purchase of *ex ante* risk financing instruments. Typically these instruments are put into place to finance a layer of the government's risk. Schematically, such arrangements could look as proposed for the Caribbean as shown in Figure 9.6. The proposed regional structure shown in this figure is a government risk pool for infrastructure and other public assets. A unique feature of this system is that public assets of neighbouring governments are included, increasing the size of the pool (increase in bargaining power) and rendering it more diversified. Under this arrangement, the lowest risk layer (with events occurring more frequently - up to 10 years) would be self-

retained by the government(s), whereas risk financing would cover the middle layer. Since it is generally very expensive or difficult to purchase risk financing for the very extreme losses, the uppermost layer often remains uncovered. Whatever form the risk-transfer contract takes, it is important to examine its pros and cons – costs and benefits - to the government.

Figure 9.6 Proposed risk transfer structure for public assets

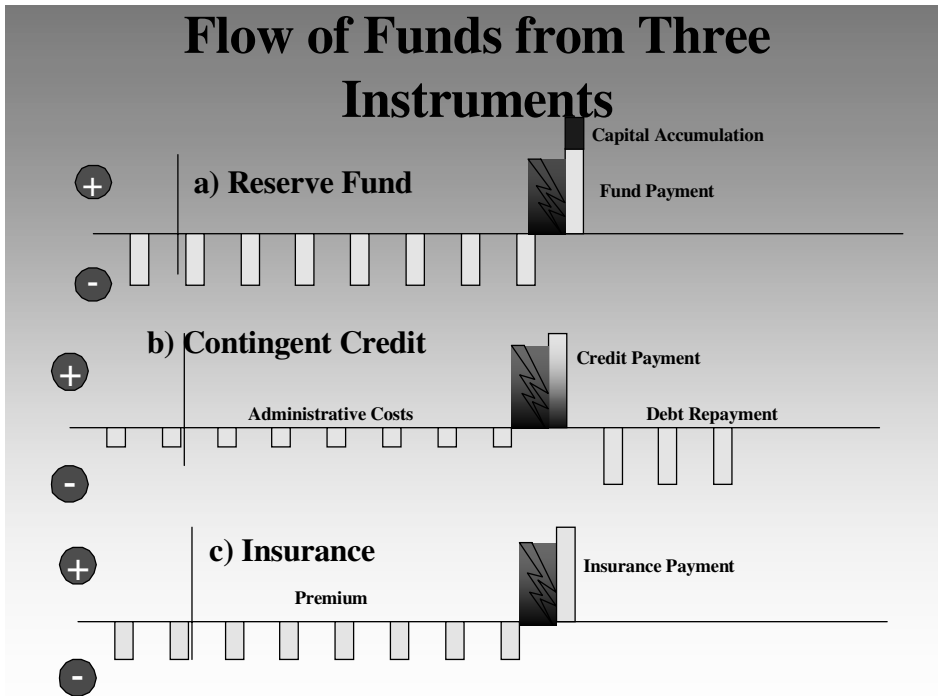


Source: Based on Pollner, 2000.

4.4.1 Pros and cons of ex ante financial instruments

Ex ante, risk-financing instruments - reserve funds, contingent credit arrangements, commercial insurance and catastrophe bonds - can be compared on several criteria, including their costs, their respective benefits after a disaster occurs, and the types of incentives they create for loss mitigation. These comparisons are summarized in Table 9.4.

Figure 9.7 Financial streams of three ex-ante financing options



Costs of instruments: The costs of these instruments are distributed over time in different ways. Figure 9.7 illustrates the different flows of capital before and after disasters with each of three *ex ante* instruments (the figure does not show cat bonds, which has the same profile as insurance). As we see from this figure, a reserve fund requires moderate public outlays before the disaster, which is used to meet the government's obligations after a disaster occurs. There is a misnomer that reserve funds have no cost. Indeed, the opportunity costs of keeping large amounts of capital liquid can be significant. Contingent credit arrangements require smaller expenses on the part of the government before an event; however, large debt service payments will be necessary in the case of a disaster (in this example for an assumed maturity of 20 years, after the grace period 56 million USD (in constant terms) will have to be paid annually in debt service installments). Insurance has the highest annual costs, but provides guaranteed loss indemnification for the risks insured and has no consecutive costs in terms of debt service payments. However, unlike the reserve fund, if no disaster occurs, the government will have no claim on the residual capital. If there is no disaster, the opportunity cost of reserve funds is only the interest

foregone on the resources invested in the fund, whereas for insurance and contingent credit these costs comprise the full premium or fee payment.

Post-disaster benefits: A reserve fund has the advantage that it is not automatically depleted after a disaster, but any residual capital accumulation remains in the fund. It relies on domestic financing and, therefore, does not transfer the losses into the international capital markets (of course, the latter comes with a cost). Insurance has the advantage of predictable loss indemnification, but in comparison with the other instruments insurance claims may be delayed due to the time needed for assessment.

Incentives for mitigation: A disadvantage of all *ex ante* instruments is moral hazard since governments may be less disposed to invest in mitigation if funds are available after a disaster. This is most serious with respect to insurance, but can be mitigated with the inclusion of a deductible. Catastrophe bonds may have several advantages: First, they avoid the “load” of insurers (which can be over and above the transaction costs and return on risk absorption), and, second, if there is a physical trigger (for example, payment on the bond is triggered by the intensity of the earthquake and not the losses), there is an incentive for the government to reduce the losses.

Political and other risks: Reserve funds are frequently diverted for other uses if a disaster has not occurred over many years. The risk of depleting the reserves can be high, particularly in capital-scarce economies where the accumulated capital in the fund stands in competition with other social projects. In addition, after many years without major disasters politicians become reluctant to continue contributions to the fund. (Freeman et al. 2003). A similar risk faces purchasers of insurance and contingent credit arrangements, which are subject to re-insurer or financial agent insolvency. Finally, the payments from catastrophe bonds with a physical trigger, if a disaster occurs, may be uncorrelated with the losses. If, for example, precipitation is the trigger, this may or may not lead to flooding in the designated area.

The IIASA CATSIM tool has the capability of calculating the cost efficiency of *ex ante* instruments for reducing the risk of a financial gap. Of course, these calculations depend critically on the current prices of the instruments, including insurance premium and interest rates, as well as the assumptions underlying calculation of the risks. For this reason, the CATSIM tool is interactive, allowing the user to change parameters and assumptions. Based on one set of parameters and assumptions, Figure 9.8 illustrates the efficacy of three measures – insurance, a reserve fund and mitigation – for reducing Honduras’ risk of a financing gap (Mechler and Pflug 2002)⁴.

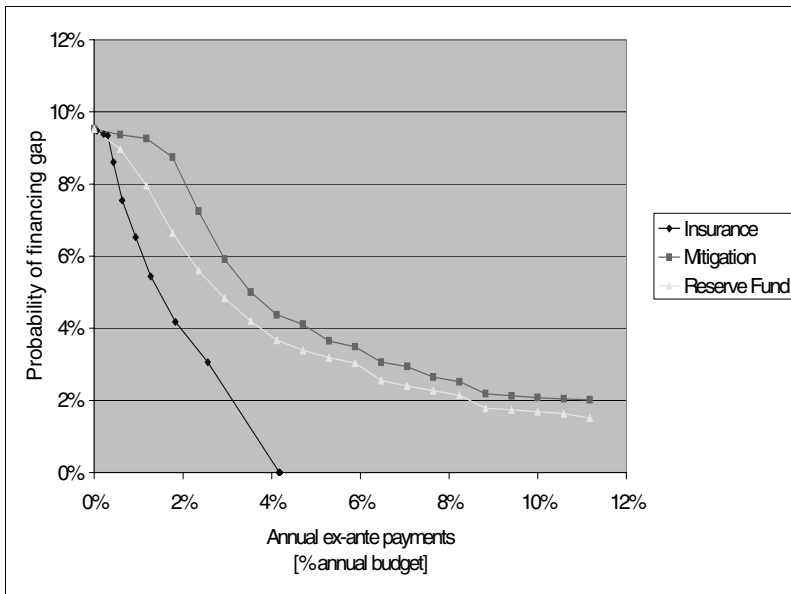
Table 9.4 Pros and Cons of Ex-Ante Financing Tools

	Reserve fund	Insurance	Contingent credit	Catastrophe bond
Cost before and after event	Usually annual payment into fund; Opportunity cost of liquid capital.	Annual premium includes transaction costs plus return to investors for absorbing risk; Volatile international reinsurance prices	Holding fee includes transaction costs and return to investors; Post-event, additional debt service	Interest payments to investors
Benefit after event	Capital immediately available; Funds will not be lost in case of no event	Loss indemnification for elements insured; Increased capital inflows from abroad to affected economy	Capital immediately available; Increased capital inflows from abroad to affected economy	Capital immediately available; Increased capital inflows from abroad to affected economy
Incentive for mitigation?	More incentive than insurance w/o deductible since government retains unspent funds	Only if insurer rewards loss-reducing behavior or high deductible; otherwise moral hazard	No Also risk of moral hazard	Yes, if physical trigger.
Political and other risks	Reserve funds can be raided for other purposes; Risk of insufficient funds	Risk of (re)insurer insolvency;	Risk of insufficient funds Risk of financial entity insolvency	Basis risk (losses uncorrelated with bond)

Source: Mechler 2004a, extended on basis of Freeman et al. 2000b

Note that Figure 9.8 includes mitigation in the portfolio of *ex ante* tools available to the government. Indeed, a question on the minds of policy makers facing constrained budgets is: Should the government invest in risk-transfer instruments, or should it rather invest in reducing risk? CATSIM includes mitigation as an option, and the policy maker has a choice of the effectiveness of mitigation measures for reducing the financing gap. In this illustrative example, mitigation is less effective in reducing the gap than insurance. However, it must be kept in mind that risk-reductions measures have benefits to the society far greater than reducing financial vulnerability. The mitigation-financing tradeoff, thus, requires an integrated analysis of the full costs and benefits.

Figure 9.8 Comparison of different risk financing instruments and mitigation for Honduras

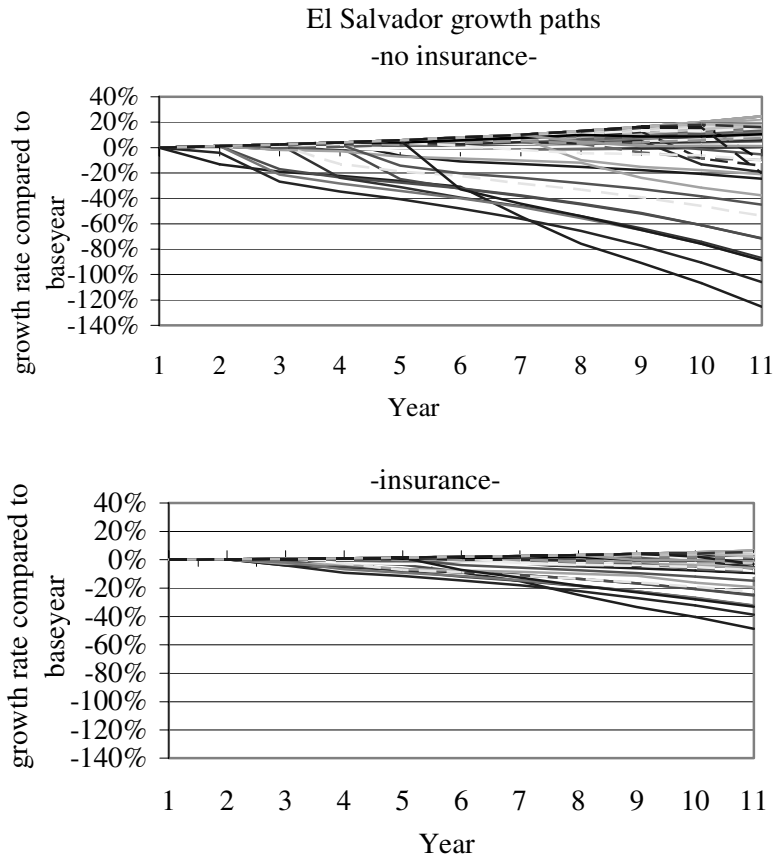


Source: Mechler and Pflug 2002: 24.

4.4.2 The tradeoff between growth and stability

Ex-ante mitigation and financing can be analyzed in terms of a trade-off between economic growth and economic stability. If a government purchases a risk-financing instrument, there are fewer public resources for investments in capital and socioeconomic development. Alternatively, without this purchase, there is no indemnity for infrastructure losses, which will delay economic and social recovery and thus add to economic instability.

Example El Salvador IASA has modeled this tradeoff for El Salvador and insurance (Freeman, et al. 2003). However, the same relationship holds true for other ex ante risk financing instruments. Figure 9.9 illustrates model simulations of El Salvador's growth path for public assets without risk-financing and with risk-financing. The upper figure illustrates simulated growth paths without risk-financing, which shows high average growth but with large volatility. The lower figure illustrates simulated growth paths with risk financing (insurance), which shows lower average growth but a more stable economy.

Figure 9.9 Growth-stability trade-off in El Salvador as modeled by IIASA

Ideally, El Salvador would have both high growth and economic stability. This suggests a role for the international community in providing pre-disaster assistance for governments investing in risk-transfer instruments and mitigation to complement post-disaster humanitarian assistance. International assistance could have high payoffs, especially if this assistance is tied to requirements for mitigation (for example, in the same way as the US flood insurance program). The advantages of international pre-disaster assistance might be considerable, including a more secure economy for internal planning purposes and for attracting outside investment.

There are also compelling reasons for the international community of wealthy nations to assist developing and transition countries in preparing their economies for disasters. Besides contributing to reaching the UN's

millennium goals, wealthy countries may have an increasing responsibility for weather-related disasters in the developing world because of their historical emissions of greenhouse gases. In a background paper to a UNFCCC (United Nations Framework Convention on Climate Change), the authors (Linnerooth-Bayer, et al, 2003) identified several specific ways in which the international community can assist developing countries to transfer their disaster risks, including the following (by no means exhaustive) possibilities:

- *Supporting public private partnerships:* The international community could absorb (or arrange for the transfer of) a layer of the risks of national or regional public-private insurance systems.
- *Supporting relief and reconstruction:* The international community could assist governments in transferring their risks of public infrastructure damage either through private insurers or directly to the capital markets through alternative risk-transfer instruments.
- *Supporting microinsurers:* The international community could also play a role in supporting and transferring the risks of microinsurers, for example those offering weather hedges, possibly by acting as reinsurer or assuming the interest payments of catastrophe bonds.
- *Supporting data collection and analytical capacity building:* Since any insurance or insurance-related system requires knowledge of the risks, the international community could provide support to developing countries in collecting the requisite data and in building analytical capacity.
- *Supporting alternative instruments:* There may also be options to create national-level market incentives, for example tax reductions to individuals or institutions for purchasing developing country catastrophe bonds at lower interest. There might be possibilities for enhancing the participation of voluntary contributions and NGOs in these schemes. One imaginative idea could be to link investments in developing country disaster hedges to emerging sustainable-development investment portfolios.

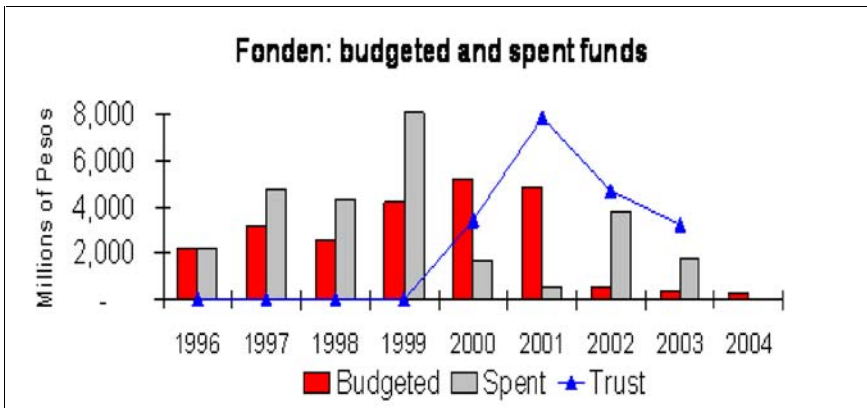
4.5. Recent developments in Latin America

A number of governments in developing and emerging economy countries are currently considering ex ante risk financing instruments for public-sector liabilities.

Mexico

In 1996, Mexico, an upper-middle income OECD country, installed a government-sponsored fund (FONDEN) for financing reconstruction of federally or state-owned infrastructure as well as relief to the public. This fund is financed by annual contributions from the central government's budget.⁵ Fig. 11 demonstrates, that as long as requests for assistance under FONDEN and funds spent had been high, funds budgeted were of similar magnitude. However, after years with relatively little disaster funding needs, resources proposed for funding have tended to be stripped by Congress. FONDEN resources have been reducing since 2001 and spending for natural disasters has become highly unpredictable. Furthermore, the trust fund, fed by residual FONDEN amounts in respective years has been decreasing strongly.

Figure 9.10 Budgeted and spend funds of FONDEN



Sources: Hurtado, 2004.

Within this context, in order to improve financial security, Mexican authorities are considering whether to engage in risk financing to cover a layer of losses accruing to the government in case of a major earthquake event. Specifically, a cat bond is being examined. A benefit of a cat bond is the avoidance of reinsurance cycles arising from reinsurers' practice of intertemporal premium adjustment between peak years and years with reduced catastrophe activity. A related benefit is the avoidance of global cross-subsidization of reinsurance premium. As reinsurers are only active in a very limited number of markets in the Western Hemisphere, severe losses in one region will have a bearing on unaffected areas and may increase premia there.

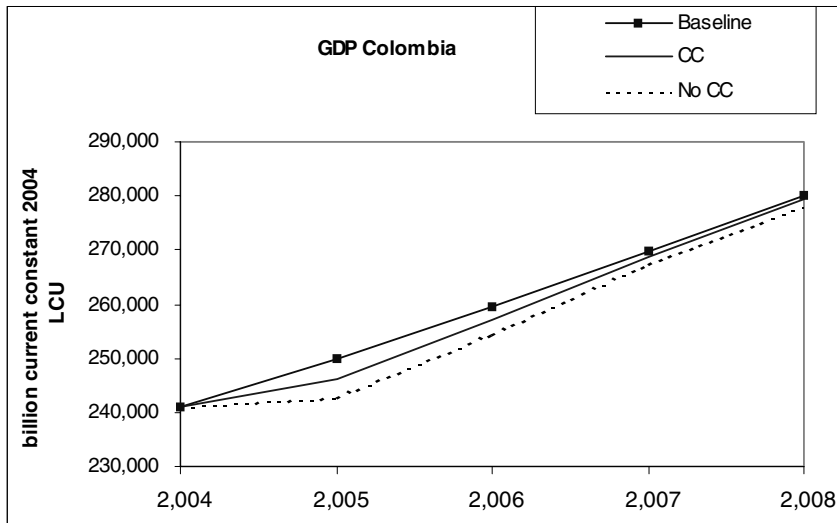
Colombia

A second Latin American country, Colombia, faces a difficult situation regarding the financing of public infrastructure losses. Natural disaster risks in this country are high - on average Colombians face more than one severe flood every year and a strong earthquake every two years. Past disasters, such as in the 1999 Armenia earthquake, have caused losses up to 3 billion USD. At the same time, fiscal operations are heavily constrained by high external debt and debt service payments, which severely limits the ability of the central government to respond to disasters. One option currently under discussion in Colombia is a contingent credit facility of a total amount of 150 million USD through a multilateral financial institution. Generally, such a contingent credit scheme has the following costs and benefits associated:

- **Cost:** there is a cost associated with paying for the commitment fees of the contingent credit in terms of government funds spent on it on a regular basis; this results in less financing available for government spending and investment, which adversely affects overall economic output. As with debt instruments, the debt has to be paid back ultimately.
- **Benefit:** necessary financing after a disaster is available quickly in case of need for reconstruction and relief, whereas regular lending and increasing taxation have a time lag of at least one year. This means that relief and reconstruction activities can be funded more fully and more quickly. The economy can rebound more quickly.

In a model-based analysis including deterministic and probabilistic scenarios, the benefits of such an arrangement were analyzed (see Mechler 2004b). In the deterministic case, it was assumed an event with a recurrence period of 100 years would occur in 2005 and destroy 6.2 percent of capital stock causing total damages of ca. 45,500 billion Pesos of which a substantial part would have to be financed by the government. As Figure 9.11 shows, a contingent credit arrangement, according to this analysis, would be effective in rebuilding capital stock in a timely manner. More productive capital results in more GDP produced with the contingent credit. As a consequence, the GDP recovery process is quicker given the contingent credit arrangement.

Figure 9.11 Baseline GDP and effects of deterministic 100 year earthquake shock on GDP with and without contingent credit for government liabilities in Colombia



Source: Mechler 2004b.

In this analysis, and for the case of Colombia, the credit was provided by a MFI at rates substantially below market interest. When arranging such a credit in the financial markets at higher interest, the viability and economic implications for Colombia may change considerably.

Honduras

Honduras is another country that is currently examining whether to engage in a sovereign risk financing scheme, traditional or alternative. In Honduras, some quasi-private public infrastructure is already insured, for example, airports, telecommunications and energy facilities. Yet, Honduras lacks a risk financing scheme for roads, other transport and water infrastructure. With assistance from a multilateral finance agency, workshops and deliberations are ongoing with government officials from the Finance Ministry and the Central Bank. To date, however, no decision has been taken on a specific public risk-financing strategy.

5. Outlook: Financing Catastrophe Risk in Developing and Emerging-Economy Countries

Risk-financing instruments can potentially assist individuals and countries cope with the economic hardships of disasters. Financial planning

can make a difference in the lives of vulnerable people in developing and emerging-economy countries, and can mean the difference between post-disaster economic stagnation and recovery. However, the cost of these instruments can substantially exceed that of traditional post-disaster financing mechanisms.

We have emphasized in this paper that market risk-financing instruments, because of their high costs, are not appropriate for poor households or governments unless they are highly financially vulnerable to disaster losses, meaning that they cannot muster sufficient capital to finance their recovery from traditional post-disaster sources. Even with high financial vulnerability, households and governments must carefully consider the costs and benefits of pre-disaster financing instruments.

This paper specifically focused on the experience, opportunities and drawbacks of risk financing mechanisms offered by the financial markets for sudden-onset, natural disasters in developing and emerging-economy countries such as weather derivatives, catastrophe bonds and contingent credit arrangements. The paper distinguishes between market and non-market risk-transfer and intertemporal risk-spreading instruments for both the private and public sectors. For both the private and the public sector there are important initiatives and precedents for using the financial markets for financing risk. In the private sector, initiatives are underway to render these instruments affordable to households and farms in developing and emerging-economy countries. Schemes in the form of coupled microcredit and microinsurance arrangements are offered by alternative financial institutions including state-owned banks, member-owned savings and loan institutions and low-capital local or rural banks. Weather hedges, which combine low transaction costs with public subsidies, already exist or are on the horizon in Asia and Latin America. There are also important initiatives and exciting prospects for transferring sovereign risks, especially the risks of vulnerable countries. Government policy makers in Colombia and Honduras are considering risk financing arrangements with assistance from multilateral finance institutions. In Mexico, the government is designing a catastrophe bond in order to secure financing for its catastrophe reserve fund in case of a severe earthquake.

Market-based financial mechanisms can have important benefits compared to traditional insurance and reinsurance: These generally consist of a reduction of transaction costs, increased speed of payouts and increased incentives for mitigation. Another benefit is that existing financial market channels can be utilized, as is the case for weather derivatives and rural credit banks. On the other hand, the main drawback with financial market instruments is the problem of basis risk, i.e. correlating the individual loss experience with indemnity payments triggered by pre-defined indexes such

as rainfall. As shown, improvements in the specification of the index may mitigate this problem.

As experience shows, the success of these instruments depends on the affordability for developing and emerging-economy countries, and may necessitate subsidies from national or international bodies. Since micro schemes for disaster cover can only operate with a costly capital backup, they inevitably require outside support to assure their affordability to the poor. Recent schemes developed or devised in Honduras and Colombia will likely rely on support from international financial institutions in transferring their high public-sector risks.

The advantage of these financial market instruments is that they share responsibility between individuals, the state and international bodies, and by providing needed capital after the destruction of a disaster, they will avoid reliance on debt financing and international donations. The international community – especially as wealthy countries recognize their contribution to climate warming and weather-related disasters affecting the developing world - can assist developing and emerging-economy countries finance their risks in many ways, including: supporting microinsurers by absorbing a layer of risk; absorbing risks of national or regional public-private insurance systems in the capacity of re-insurer and subsidizing the costs of alternative insurance instruments; creating national-level market incentives, for example tax reductions to individuals or institutions for purchasing developing country catastrophe bonds; or linking investments in developing country disaster hedges to emerging sustainable-development investment portfolios. These measures could be important additions to international post-disaster donor assistance, especially if they are contingent on households and governments adhering to a pro-active plan for preventing losses. In an assessment of disaster insurance options for the Caribbean region, a World Bank study came to the following conclusion:

[...] based on the evidence, market arrangements (both domestic and international) can better channel and fund these (disaster) risks, with governments and multilateral institutions supporting the development of self-sustaining structures (Pollner 2000:5).

The focus on supporting *ex ante* risk financing can be seen as a third phase of assistance by the donor community: The first phase was (and remains) characterized by *ex post* disaster assistance and relief by the international donor community. The second phase, at least rhetorically, has emphasized pro-active disaster risk prevention. The third phase of disaster risk management complements prevention with a focus on financial planning to spread disaster burdens so that developing and emerging-economy communities and countries can recover from disasters in a timely, efficient and fair way.

Notes

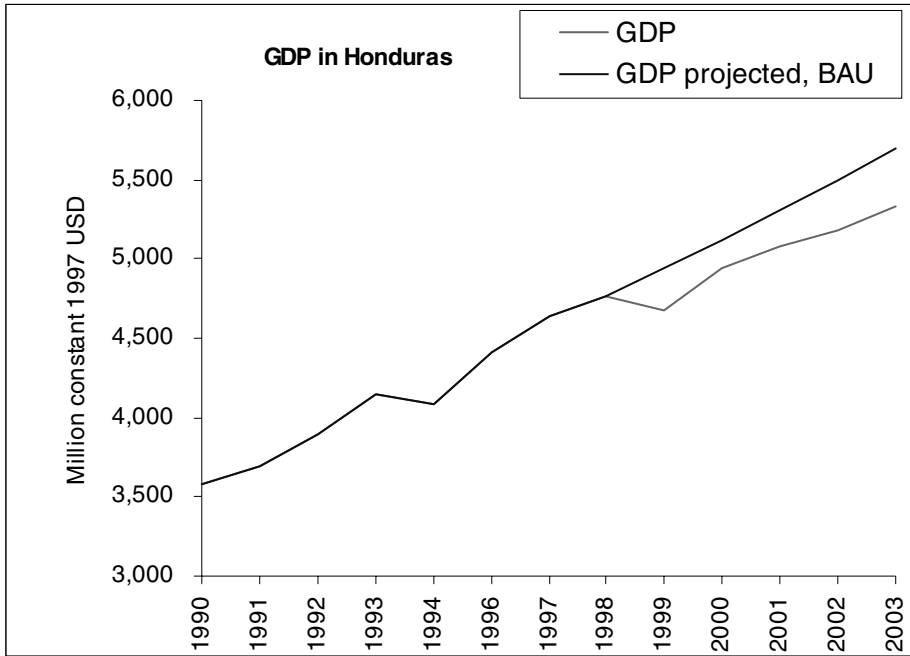
- 1 The *law of large numbers* states that for a series of independent and identically distributed variables the sample mean over the variables converges to the theoretical population mean of the probability distribution and thus the variance around the mean decreases for large numbers.
- 2 This discussion is based on the World Bank classification of economies according to GNI per capita in 2000, calculated using the World Bank Atlas method. High income countries had incomes greater than USD 9,385, upper middle income USD 3,036-9,385, lower middle income USD 765-3,035, and lower income less than USD 765.
- 3 Weather contracts can be issued as weather derivatives or weather insurance, the main differences being in regulatory and legal issues. For this discussion, the main point was the involvement of the (rural) financial market in such a scheme.
- 4 In this study, insurance was modeled as XL-insurance with a fixed attachment point at 5 percent capital stock lost (equal to the 50-year storm and flood event in Honduras). The exhaustion point was the decision variable in this stochastic simulation exercise and determined by the amounts spent on insurance (Mechler and Plug 2002).
- 5 In case of an event, states have to contribute own matching funds in order to qualify for reconstruction and relief funding by FONDEN.

Annex 9.A

Estimating Financial Vulnerability: Case Study Honduras

The economic consequences of a government ill prepared to respond to a major disaster can be illustrated by considering the case of Honduras, in which following the devastation of Hurricane Mitch in October 1998, development was set back significantly. With over half of its 6.5 million people living in poverty, Honduras is socially and economically vulnerable to extremes in weather. Since the 1980s, the economy has been subject to a combination of adverse internal and external influences causing stagnation, inflation and a large increase of external debt. In addition to killing 5,700 people, and affecting another 620,000, Hurricane Mitch, an event with an expected return period of less than one in 100 years, destroyed or damaged about a third of the country's public infrastructure. Total direct losses amounted to approximately 2 billion USD. Indirect damages were calculated at 1.8 billion USD (ECLAC and IDB 2000: A 1-4-8; CRED 2004). Total losses approximated 80 percent of the country's GDP and overwhelmed the government's capacity to provide relief and repair critical infrastructure. In other words, Honduras experienced a serious financing gap.

Before Mitch, the economy had performed well, and GDP was projected to increase substantially in future years, as shown on the upper line in Figure 9.A.1 Post-Mitch, GDP continued to grow in the remainder of 1998, mainly because of the reconstruction efforts. In 1999, there was a recession with a decline in GDP by 1.9 percent, followed by a recovery. Comparing growth projections (in a business-as-usual scenario) with actual development of GDP, it can be seen that the development path in Honduras after Mitch fell short of pre-Mitch expectations.

Figure 9.A.1 GDP over the last 20 years (1980-2002) and as projected

Data source: World Bank 2004, own projection.

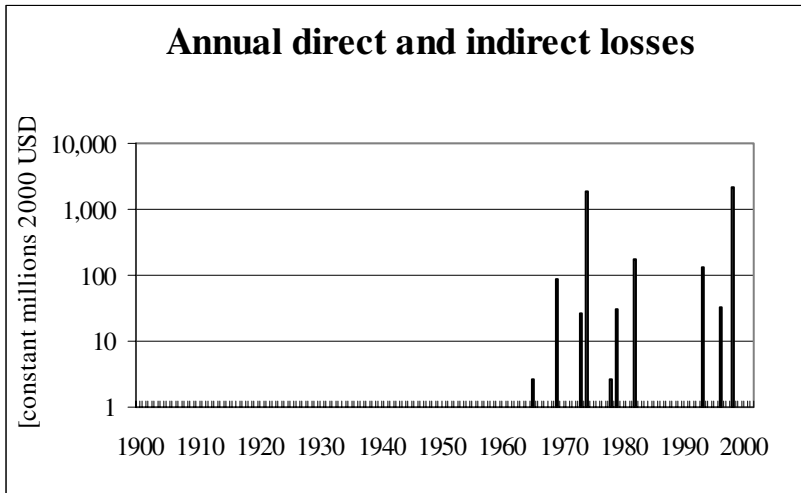
What is the risk that Honduras, or any exposed country or region, will experience a financing gap in the near future? This question has recently received a great deal of attention at the World Bank (see Pollner, et al, 2001), the InterAmerican Development Bank (see Keipi and Tyson, 2002) and other international financial institutions. The risk will depend on two factors: (1) the probability of public-sector disaster losses of different magnitudes (risk exposure), and (2) the ability of the government to meet its post-disaster liabilities. IIASA has developed a computer tool (CATSIM) to estimate these two factors, and, thus, to estimate a government's financial vulnerability (Hochrainer et al. 2004). In what follows, we illustrate the estimation of financial vulnerability for Honduras.

1. Honduras' probability of losses and associated government liabilities

Given Honduras' exposure to weather extremes, the IIASA CATSIM model has illustrated the conditions under which the government can expect to experience a financing gap. Figure 9.A.2 shows the historical losses from all types of natural disasters in Honduras 1900-2001. The destruction from

natural disasters has worsened since 1960, from which time there have been losses nearly every second year. In some years, there have been multiple catastrophes. Very significant economic damages have been rarer, but in three recent years losses have reached or exceeded 1 billion USD in constant 2000 prices.

Figure 9.A.2 Total direct and indirect disaster losses in Honduras: 1900-2001



(Source: CRED 2004)

The IIASA model assessed the direct loss potential for Honduras based on historical losses and hazard simulation modeling. Based on loss exposure information provided by Swiss Re in Freeman et al. (2002b) the expected annual losses due to storm/flood and hurricane risk are 0.43 percent and 0.06 percent of Honduras' total capital stock, respectively, which results in a combined expected loss (due to independence of these events) of 0.49 percent of capital stock. Thus, IIASA estimated Honduras' expected losses for the coming year as 62.3 million USD total capital stock and 12.7 million USD infrastructure losses.

Financial vulnerability cannot, however, be based on expected loss since disasters may be considerably more or less costly than the average. Therefore, we must look at probabilistic occurrence of disasters of different magnitudes, which we will turn to in a later section.

2. Honduras' financial options

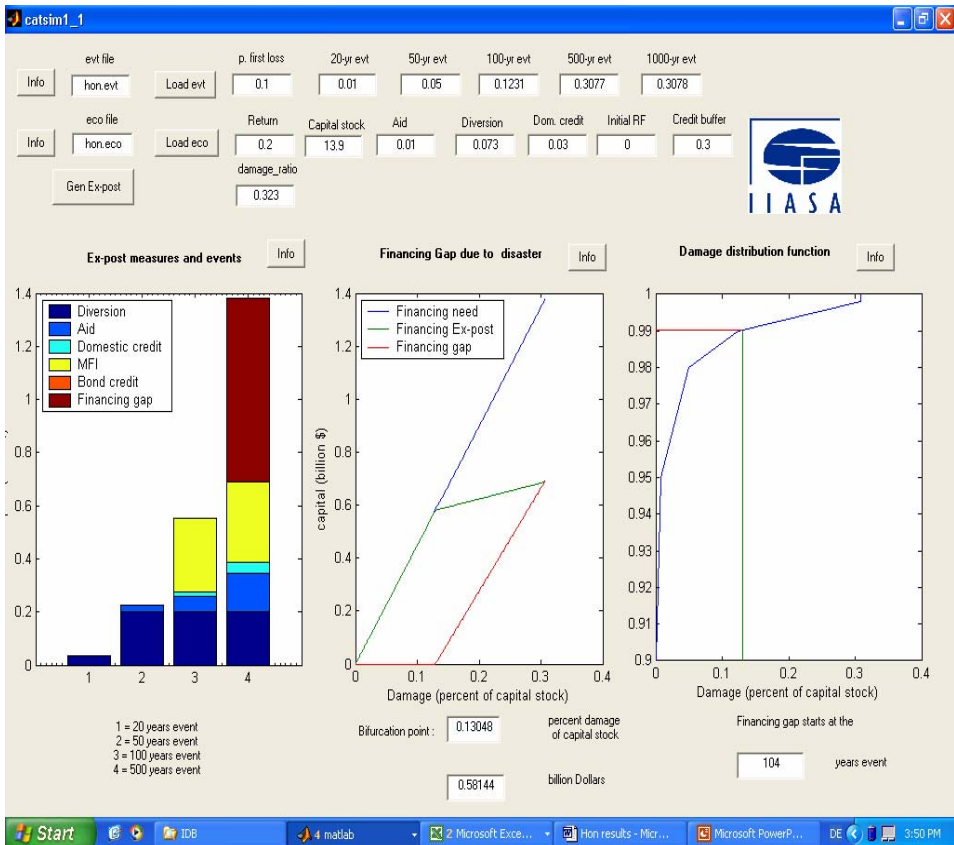
If a disaster of a particular magnitude occurs in Honduras in the current year, can the central government finance its obligations for reconstruction and assistance? To answer this question it is necessary to examine the capacity of the government to raise funds. Honduras, like most developing countries, has neither a catastrophe reserve fund nor other *ex ante* financing instruments in place. Therefore, it relies fully on *ex post* financing, including particularly external aid and assistance. Concerning the latter, because of its low per-capita income, Honduras is eligible for most favorable borrowing or very low percent interest loans from World Bank through the International Development Association (IDA). After disasters, such as Hurricane Mitch, Honduras is heavily dependent on outside assistance. Already before Hurricane Mitch, foreign aid amounted to 6.3 percent of GDP in 1997 (6.1 percent in 1998), and rose to 15.2 percent in 1999, when disaster aid flows materialized. This reliance reflects the high cost of disasters in Honduras in relation to GDP and the inability to spread risk internally.

3. Honduras' financial vulnerability

Combining Honduras' loss probability with the government's ability to absorb the losses yields a picture of the government's financial vulnerability. IIASA's CATSIM model has illustrated the financial vulnerability of Honduras as shown in Figure 9.A.3.

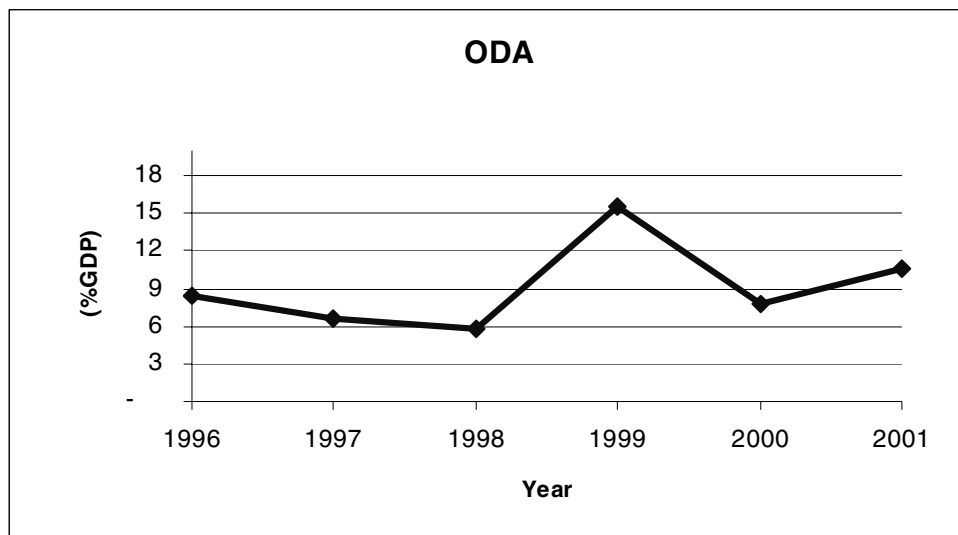
The left chart in Figure 9.A.3 illustrates the government's projected financial needs and available funds to recover from disasters occurring at four different frequencies: the 20-, 50-, 100- and 500-year events. A financing gap occurs only between the 100- and 500-year events, in this figure shown as the 500 year event (precisely, as shown in the lower right window, Honduras experiences a financing gap at ant below the 104-year event). The middle chart shows financing needs and financing availability given the destruction to the country's capital stock. The right chart illustrates the cumulative loss-frequency distribution and outlines the threshold event (104) that would trigger a financing gap. The period of recurrence of this threshold event, the associated damage to capital stock and absolute losses are also calculated in the lower area of the screen.

Figure 9.A.3 The Financing Gap for Honduras



The IIASA model shows that if the event occurred in 2004, the government could “withstand” the losses from moderate flood and storm disasters up to approximately the 100-year event. For rarer catastrophes, according to this analysis there would be a financing gap. The model calculated the gap to commence with the 104-year event estimated to destroy 13.1 percent of Honduras’ capital stock and cause economic losses of approximately 581 million current USD to the public sector. Of course, these estimates rely on the different parameters and assumptions, all of which can be changed by the user of this software (the parameters are shown on top of the screen).

Historical data corroborate this assessment of financial vulnerability. As shown in Figure 9.A.4 Honduras has had a limited ability to finance losses by its own means and has traditionally relied on external assistance to help with economic development in the event of natural disasters.

Figure 9.A.4 Actual financial vulnerability in Honduras after 1998 Hurricane Mitch

As illustrated in Figure 9.A.4, official development assistance (ODA), comprising of grants or loans with a grant element of at least 25 percent given to developing countries, comprised about 6 percent of GDP in 1998. With this amount of international aid, it is not surprising that Honduras was in need of outside help after Hurricane Mitch. Post-disaster, ODA rose sharply to about 16 percent of GDP in 1999, or in absolute terms from 303 to 842 million USD. This large inflow of free or concessional financing contributed considerably to the recovery process. However, even with this international flow, it was estimated that Honduras would take many years to fully replace its public infrastructure. This reliance on outside assistance reflects the high cost of disasters in Honduras in relation to GDP and the inability of the government to spread risk internally.

References

- Agriculture Insurance Company of India, 2004 Varsha Bima, New Delhi.
- Ahmed, Sadi, Mosleuddin, A. 2000. Delta Life Insurance Company - Gono Bima and Grameen Bima, Proceedings of the International Discussion Forum on Micro-Insurance, Dhaka, Bangladesh, 29 Feb. 2000.
- Andersen, T. J. , 2001 Managing Economic Exposures of Natural Disasters. Exploring Alternative Financial Risk Management Opportunities and Instruments. Washington DC, IDB.
- Arriens, W.T.L., Benson, C., 1999 Post disaster rehabilitation: The experience of the Asian Development Bank, Paper presented at the IDNR-ESCAP regional meeting for Asia: Risk reduction and society in the 21st century, Bangkok, Feb. 23 1999.
- Arrow, K. J., Lind, R. C., 1970 "Uncertainty and the Evaluation of Public Investment Decisions." *The American Economic Review* 60: 364-378.
- Barual, D., 2004 Grameen Bank Insurance Schemes, Proceedings of the International Discussion Forum on Micro-Insurance, Dhaka, Bangladesh, 29 Feb. 2000.
- Benson, C., 1997 *The Economic Impact of Natural Disasters in Fiji*. London, UK, Overseas Development Institute.
- Benson, C., 1999 *The Economic Impact of Natural Disasters in the Philippines*. London, UK, Overseas Development Institute.
- Brent, R.J., 1998 *Cost-Benefit Analysis for Developing Countries*. Cheltenham, Edward Elgar.
- Charveriat, C., 2000 *Natural Disasters in Latin America and the Caribbean: An Overview of Risk*. Working Paper 434. Washington DC, Inter-American Development Bank.
- CRED, 2004 EM-DAT: International Disaster Database. Brussels, Belgium, Centre for Research on the Epidemiology of Disasters, Universite Catholique de Louvain.

- ECLAC and IDB, 2000 “A matter of development: how to reduce vulnerability in the face of natural disasters”. Seminar “Confronting Natural Disasters: A Matter of Development”, New Orleans, 25-26.3.2000.
- Fischer, S., Easterly, W., 1990 “The economics of the government budget constraint.” *The World Bank Research Observer* 5(2):127-42.
- Freeman, P.K., Martin, L.A., Mechler, R., Warner, K., Hausmann, P., 2002a *Catastrophes and Development. Integrating Natural Catastrophes into Development Planning*. Washington, DC, World Bank.
- Freeman, P.K., Leslie, K. Martin, L.A., Linnerooth-Bayer, J. Mechler, R., Saldana, S. Warner, K., Plug, G., 2002b *Financing Reconstruction. Phase II Background study for the Inter-American Development Bank Regional Policy Dialogue on National Systems for Comprehensive Disaster Management*, Washington DC, Inter-American Development Bank.
- Freeman, P. K., Martin, L.A., Linnerooth-Bayer, J., Mechler, R., Warner, K., Pflug, G., 2003 *Disaster Risk Management: National Systems for the Comprehensive Management of Disaster Risk and Financial Strategies for Natural Disaster Reconstruction*, Inter-American Development Bank, Washington, D.C.
- Froot, K. A., O’Connell, P. G. J. 1999 *The Pricing of U.S. Catastrophe Reinsurance*. In K. Froot (ed.). *The Financing of Catastrophe Risk*. Chicago, The University of Chicago Press: 195-232.
- Gilbert, R., Kreimer, A., 1999 *Learning from the World Bank's Experience of Natural Disaster Related Assistance*. Washington DC, World Bank.
- Gurenko, E., 2004 Introduction, In *Catastrophe Risk and Reinsurance: A Country Risk Management Perspective* (ed. E. Gurenko), Risk Books, Haymarket.
- Guy Carpenter, 2001 *The World Catastrophe Reinsurance Market 2000*. New York, Guy Carpenter.
- Gyawali, D., 2004 Personal Communication, May 20, 2004.
- Hochrainer, S., Mechler, R., Pflug, G., 2004 *Financial natural disaster risk management for developing countries*.
- Proceedings of XIII. Annual Conference of European Association of Environmental and Resource Economics, Budapest.

- Hurtado, C., 2004 Financing Disaster Risk Management in Mexico. Presentation at ProVention/World Bank/ IIASA workshop “Financial Management of Disaster Risk.”
- Insurance Services Office, 1999 Financing Catastrophic Risk: Capital Market Solutions. New York, NY: Insurance Services Office.
- IPCC, 2001 Mc Carthy et.al. (Eds.) Climate Change 2001, Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the IPCC Third Assessment Report, Cambridge University Press.
- Keipi, K., Tyson, A., 2002 Planning and Financial Protection to Survive Disasters, Sustainable Development Department, Technical Papers Series, Inter-American Development Bank, Washington, D.C.
- Kreimer, A., Arnold, M., Freeman, P., et. al., 1999 “Managing Disaster Risk in Mexico – Market Incentives for Mitigation Investment.” Disaster Risk Management Series. Washington, D.C.: World Bank.
- Kreimer, A., Arnold, M., 2000 “World Bank's role in reducing impacts of disasters.” *Natural Hazards Review* 1(1): 37-42.
- Kunreuther, H., 1998 Introduction, Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States, (Kunreuther /Roth, Sr., Editors), Joseph Henry Press, Washington, DC.
- Kunreuther, H., Linnerooth-Bayer, J., 2000 The Financial Mangement of Catastrophic Flood Risks in Emerging Economy Countries (with Howard Kunreuther). In Linnerooth-Bayer J. and A. Amendola, Special Edition on Flood Risks in Europe, *Risk Analysis*, 23:627-639.
- Kunreuther, H., Roth, R. J. (Eds.), 1998 Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States. Washington DC, Joseph Henry Press.
- Lester, R. , 1999 The World Bank and natural catastrophe funding. The Changing Risk Landscape: Implications for Insurance Risk Management. Proceedings of a Conference sponsored by Aon Group Australia Ltd., Sydney, Australia.
- Linnerooth-Bayer, J., Quijano, S., Löfstedt, R., Elahi, S. , 1999 The Uninsured Elements of Natural Catastrophic Losses: Seven Case Studies of Earthquake and Flood Disasters, Paper prepared for the TSUNAMI project on “The Uninsured Elements of Natural Catastrophic Losses”, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria.

- Linnerooth-Bayer, J., Amendola, A., 2000 Global change, natural disasters and loss sharing: Issues of efficiency and equity. *The Geneva Papers on Risk and Insurance*, 25, 203-219
- Linnerooth-Bayer, J., Mace, M.J., Verheyen, R., 2003. Insurance-Related Actions and Risk Assessment in the Context of the UN FCCC, Background paper for UNFCCC workshop on Insurance-related Actions and Risk Assessment in the Framework of the UNFCCC, May 11-15, 2003, Bonn.
<http://unfccc.int/sessions/workshop/120503/documents/background.pdf>
- Linnerooth-Bayer, J., Vari., A., Brouwers, L., forthcoming. "Flood Risk Management in the Upper Tisza Region: A Model-Based Stakeholder Approach." *Special Edition of the Journal of Risk Research*.
- Litan, R. E., 2000 Catastrophe Insurance and Mitigating Disaster Losses: A Possible Happy Marriage. In A. Kreimer and M. Arnold (eds.). *Managing Disaster Risk in Emerging Countries*. Washington DC, World Bank: 187-193.
- Little, I.M.D., Mirrlees, J.A., 1974 Project appraisal and planning for developing countries. London, Heinemann.
- Mamun, R., 2000. GHASHFUL – Experiences of a small urban NGO MFI in Chittagong City, Proceedings of the International Discussion Forum on Micro-Insurance, Dhaka, Bangladesh, 29 Feb. 2000.
- Mantaye, A. 2002 Natural Catastrophes and Loss Sharing: The Case of the Nile Basin, Proceedings of the Second Annual IIASA-DPRI Meeting on Integrated Disaster Risk Management, 29-31 July, 2002.
- Mechler, R., 2004a Natural Disaster Risk Management and Financing Disaster Losses in Developing Countries. Verlag für Versicherungswissenschaft, Karlsruhe.
- Mechler, R. 2004b Financing disaster risk by means of contingent credit in Colombia: Costs and Benefits.
- Mechler, R., Pflug, G., 2002 The IIASA Model for Evaluating Ex-ante Risk Management: Case Study Honduras. Report to Inter-American Development Bank, Washington DC.
- Mileti, D., 1999 Disasters by design. Washington, D.C: Joseph Henry Press.
- Mitchell, J. K., Ericksen, N.J. 1997. Effects of Climate Change on Weather-Related Disasters, in Irving M. Minitzer (ed.), *Confronting Climate Change: Risks, Implications and Responses*, Springer: Berlin.

- Müller, B. , 2003 Equity in climate change: The Great Divide, Oxford Institute for Energy Studies.
- Munich Re, 2000 Topics. Jahresüberblick Naturkatastrophen 1999. Munich, Munich Re.
- Munich Re, 2003 Topics Vol. 10 – Natural Catastrophes in 2002, Munich Re Group.
- OAS, 1991 Primer on Natural Hazard Management in Integrated Regional Development Planning. Washington DC, Organization of American States.
- Orozco, M., 2002 Globalization and Migration; The Impacts of Family Remittances in Latin America, *Latin American Politics and Society*, http://www.iadialog.org/publications/country_studies/remittances/orozco_laps.pdf
- Peffekoven, R., 1992 J. Oeffentliche Finanzen. In D. Bender et al. (eds.). Vahlens Kompendium der Wirtschaftstheorie und Wirtschaftspolitik. Band 1, 5, Auflage. München, Verlag Franz Vahlen: 479-560.
- Pollner, J., 2000 Managing catastrophic risks using alternative risk financing & insurance pooling mechanisms. Washington DC, World Bank.
- Pollner, J., Camara, M. et al., 2001 Honduras. Catastrophe risk exposure of public assets. An analysis of financing instruments for smoothing fiscal volatility. Washington DC, World Bank.
- Priest, G.L., 1996 “The Government, the Market, and the Problem of Catastrophic Loss.” *Journal of Risk and Uncertainty* 12(2/3): 219-237.
- POVCC, 2003 Climate Change and Poverty, Joint Agency Paper, World Bank/BMZ/DFID etc. (<http://www.worldbank.org>).
- Reutlinger, S., 1970 Techniques for Project Appraisal under Uncertainty. Washington DC, World Bank.
- Stoppa, A, U. Hess, 2003 Design and Use of Weather Derivatives in Agricultural Policies: the Case of Rainfall Index Insurance in Morocco. Conference “Agricultural policy reform and the WTO: where are we heading?,” Capri, June 23-26, 2003.
- UNDP, 2001 Disaster Profiles of the Least Developed Countries. Report for Third United Nations Conference on Least Developed Countries, Brussels, 14-20 May 2001. Geneva.
- Verheyen, R., 2002 Adaptation to the Impacts of Anthropogenic Climate Change – The International Legal Framework, 11 (2) Review of

European Community and International Environmental Law (2002) 15-28.

Woo, G., 2001 Risk acceptance as a charitable donation, Proceedings of the First Annual IIASA-DPRI Meeting on Integrated Disaster Risk Management: Reducing Socio-economic Vulnerability, 1-4 August, 2001.

World Bank, 2000 Managing the Financial Impacts of Natural Disaster Losses in Mexico. Government Options for Risk Financing & Risk Transfer. Washington DC, World Bank.

World Bank, 2003 Financing Rapid onset natural disaster losses in India: a risk management approach. Washington, DC.

World Bank, 2004 World Development Indicators. Washington, DC.

Annex 1

List of Speakers and Presentations at the Conference*

Session 1 - Insurability of catastrophic risks

- Economics of catastrophe risk insurance, *Christian Gollier (University of Toulouse)*.
- Insurability of terrorism risk: challenges and perspectives, *Howard Kunreuther and Erwann Michel-Kerjan (Wharton School, University of Pennsylvania)*.
- Industrial, technological and other catastrophes, *Christian Lahnstein (Munich Re)*.
- Recent trends in the catastrophe risk insurance/reinsurance market, *Patrick Murphy O'Connor (Benfield)*.
- Role of the reinsurance industry in the management of weather related risks, *Peter Zimmerli (Swiss Re)*.
- Issues and options in the management of terrorism risk through insurance, *Robert Reville (Rand Corporation)*.
- Current state of the coverage for war and terrorism risks - including NBC - in the aviation sector, *Eugene Hoeven (IATA)*
- Free market solutions for terrorism risks coverage, *Ben Garston (MAP Underwriting and Lloyd's Terrorism Panel)*.

* Power point presentations summarising papers included in this publication as well as other presentations made at the conference are available on the OECD Insurance homepage: <http://www.oecd.org/daf/insurance>.

- Improving insurability and affordability: the role of insurance in hazard identification, risk assessment, risk prevention and mitigation for industrial/chemical accidents, *Satyananda Mishra, IAS, Disaster Management Institute, Bhopal - Government of Madhya Pradesh, India*).

Session 2 - Financial market solutions to manage catastrophic risks

- International financing solutions to catastrophic risk exposures, *Torben Juul Andersen (Copenhagen Business School)*.
- The use of risk linked securities to manage catastrophic risks, including terrorism, *Christian Mumenthaler (Swiss Re)*.
- Current challenges in terrorism risk securitization, *Gordon Woo (RMS)*.
- Financing catastrophic risks in non-OECD countries: challenges and perspectives, *Reinhard Mechler (IIASA)*.
- Current market trends for catastrophe bonds and risk linked securities, *Christopher McGhee (MMC Securities, Guy Carpenter)*.
- The potential for new risk transfer instruments to cover terrorism risks, *Michele David (The Bond Market Association)*.
- Rating agency's perspective on catastrophe bonds and risk linked securities, *Rodrigo Araya (Moody's)*.

Session 3 - Role of governments and development of public-private partnerships for catastrophe risk management

- Role of governments in natural catastrophe risk management and financing in OECD countries, *Paul K. Freeman (University of Denver)*.
- Catastrophe insurance programs in emerging countries: field experience, *Eugene Gurenko (World Bank, Financial Sector Operations and Policy Department)*.
- Potential role for governments in terrorism coverage, *Dwight Jaffee (Haas School of Business, UC Berkeley)*.
- Public-private partnerships to cover terrorism risks in OECD countries, *John Cooke (International Economic Relations Consultant, London)*.

- Role of the US government in the prevention and mitigation of terrorism risks, *Robert Liscouski (Infrastructure Protection Office, Department of Homeland Security, USA)*.
- Disaster risk management policy in Japan, *Kazuhiro Kawachimaru (NIPPONKOA Insurance Company Ltd)*.
- The Spanish experience in the management of extraordinary risks, including terrorism, *Ignacio Machetti (Consorcio de Compensación de Seguros)*.
- A stakeholder approach for developing a public-private partnership: the Hungarian case, *Reinhard Mechler (IIASA)*.
- Disaster risk management policy in China, *Yuanchang Zheng and Jianguo Mu (Department of Disaster and Social Relief, Ministry of Civil Affairs)*.
- The French experience in natural catastrophe risk management, *Suzanne Vallet (Caisse Centrale de Réassurance)*.
- Earthquake risk management policy in Indonesia, *Werner Bugl (PT Asuransi, MAIPARK Indonesia)*.
- Disaster risk management policy in Mexico, *Carlos Bayo Martinez (FONDEN)*.
- Disaster risk management policy in the Philippines, *Ronald I. Flores (Department of National Defense, Office of Civil Defense, National Disasters Coordinating Council)*.
- Disaster management in India, *D. Madan (Under Secretary, National Disaster Management Division, Ministry of Home Affairs, Government of India)*.
- Management of extraordinary risks, including terrorism, in India: achievements and perspectives, *C. S. Rao (Indian Insurance Regulatory and Development Authority)*.

Table of Contents

Part I

Insurability of Catastrophic Risks

<i>Chapter 1</i>	Some Aspects of the Economics of Catastrophe Risk Insurance <i>by Christian Gollier, University of Toulouse</i>	13
<i>Chapter 2</i>	Industrial, Technological and Other Catastrophes <i>by Christian Lahnstein, Munich Re</i>	31
<i>Chapter 3</i>	Recent Trends in the Catastrophic Risk Insurance / Reinsurance Market <i>by Patrick Murphy O'Connor, Benfield</i>	41
<i>Chapter 4</i>	Insurance of Atmospheric Perils – Challenges Ahead <i>by Peter Zimmerli, Swiss Re</i>	51
<i>Chapter 5</i>	National Security and Compensation Policy for Terrorism Losses <i>by Lloyd Dixon and Robert Reville, RAND Center for Terrorism Risk Management Policy</i>	59
<i>Chapter 6</i>	Current State of the Coverage for War and Terrorism Risks in the Aviation Sector <i>by Eugene Hoenen, International Air Transport Association (IATA)</i>	73
<i>Chapter 7</i>	Terrorism Insurance : An Overview of the Private Market <i>by Ben Garston, MAP Underwriting at Lloyd's</i>	81

Part II

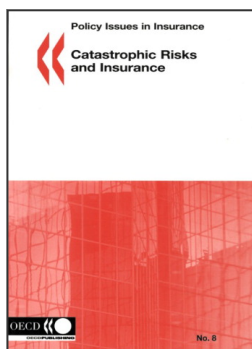
Financial Markets Solutions to Manage Catastrophic Risks

<i>Chapter 8</i>	Current Challenges in the Securitization of Terrorism Risk <i>by Gordon Woo, Risk Management Solutions Ltd</i>	91
------------------	--	----

<i>Chapter 9</i>	Financing Disaster Risks in Developing and Emerging Economy Countries by Reinhard Mechler, IIASA	105
<i>Chapter 10</i>	The Potential for New Derivatives Instruments to Cover Terrorism Risks by Michele David, the Bond Market Association	163
<i>Chapter 11</i>	Catastrophic Risk Securitization: Moody's Perspective by Rodrigo Araya, Moody's	171
<i>Part III</i>		
Role of Government and Public-Private Partnerships for Catastrophic Risks Management		
<i>Part III.A.</i>	Analytical and Comparative Reports.....	185
<i>Chapter 12</i>	Comparative Analysis of Large Scale Catastrophe Compensation Schemes by Paul K. Freeman and Kathryn Scott, University of Denver	187
<i>Chapter 13</i>	Rapid Onset Natural Disasters: the Role of Risk Financing in Effective Catastrophe Risk Management by Eugene Gurenko and Rodney Lester, World Bank	235
<i>Chapter 14</i>	Designing a Disaster Insurance Pool Participatory and Expert Approaches in Hungary and Turkey by Joanne Linnerooth-Bayer, IIASA, Anna Vári, Hungarian Academy of Sciences and Reinhard Mechler, IIASA.....	267
<i>Part III.B.</i>	Country Surveys – OECD Countries	291
<i>Chapter 15</i>	The French Experience in the Management and Compensation of Large Scale Disasters by Suzanne Vallet, Caisse Centrale de Réassurance.....	293

<i>Chapter 16</i>	Disaster Risk Management in Japan by Non-Life Insurance Rating Organization of Japan and K. Kawachimaru, NIPPONKOA Insurance Company Ltd*	303
<i>Chapter 17</i>	Natural Disasters Fund (FONDEN) by Carlos Bayo Martinez, FONDEN, Mexico	321
<i>Chapter 18</i>	The Spanish Experience in the Management of Extraordinary Risks, Including Terrorism by Ignacio Machetti, Consorcio de Compensación de Seguros	337
<i>Chapter 19</i>	The Turkish Catastrophe Insurance Pool (TCIP) and Compulsory Earthquake Insurance Scheme by S. Yazici, Permanent Delegation of Turkey to the OECD	349
<i>Part III.C.</i>	Country Surveys – Emerging Economies	365
<i>Chapter 20</i>	Natural Disasters and Disaster Relief Policy in China by Y. Zheng, Department of Disaster and Social Relief, J. Mu, National Disaster Reduction Center of China, Ministry of Civil Affairs	367
<i>Chapter 21</i>	Disaster Management in India by D. Madan, National Disaster Management Division, Ministry of Home Affairs, India	381
<i>Chapter 22</i>	Management of Extraordinary Risks, Including Terrorism, in India Achievements and Perspectives by C.S. Rao, Indian Insurance Regulatory and Development Authority	393
<i>Chapter 23</i>	Earthquake Risk Management Policy in Indonesia by Werner G. Bugl, Asuransi Maipark Indonesia	399
<i>Chapter 24</i>	Disaster Risk Management Policy in the Philippines by Ronald I. Flores, Department of National Defense, Office of Civil Defense, National Disasters Coordinating Council	411
<i>Annex 1</i>	List of Speakers and Presentations at the Conference	419

* Background Note of Mr Kawachimaru's presentation (NIPPONKOA Insurance Company Ltd), based on *Governmental Earthquake Insurance System in Japan*, from *Earthquake Insurance in Japan*, written and published in March 2003 by Non-Life Insurance Rating Organization of Japan.



From:
Catastrophic Risks and Insurance

Access the complete publication at:
<https://doi.org/10.1787/9789264009950-en>

Please cite this chapter as:

Mechler, Reinhard (2006), "Financing Disaster Risks in Developing and Emerging Economy Countries", in OECD, *Catastrophic Risks and Insurance*, OECD Publishing, Paris.

DOI: <https://doi.org/10.1787/9789264009950-10-en>

This work is published under the responsibility of the Secretary-General of the OECD. The opinions expressed and arguments employed herein do not necessarily reflect the official views of OECD member countries.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for public or commercial use and translation rights should be submitted to rights@oecd.org. Requests for permission to photocopy portions of this material for public or commercial use shall be addressed directly to the Copyright Clearance Center (CCC) at info@copyright.com or the Centre français d'exploitation du droit de copie (CFC) at contact@cfcopies.com.