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Insurance against Losses from Natural Disasters in Developing Countries

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Abstract
This paper examines the recent experience with insurance and other risk-financing instruments in developing countries in order to gain insights into the effectiveness of these instruments in reducing economic insecurity. Insurance and other risk financing strategies are viewed as efforts to recover from negative income shocks through risk pooling and transfer. Specific examples of public-private insurance programs for households, business-firms, and governments are described, highlighting their limitations, especially in light of the post-Katrina experience in the United States. It examines arguments both in support of and in opposition to donor and public involvement in provision of subsidized insurance in developing countries.

JEL Codes: G11, G14, G22, Q1, Q14
Key words: Insurance, financing, risk, cost, benefit, developing country, natural disaster, climate change.

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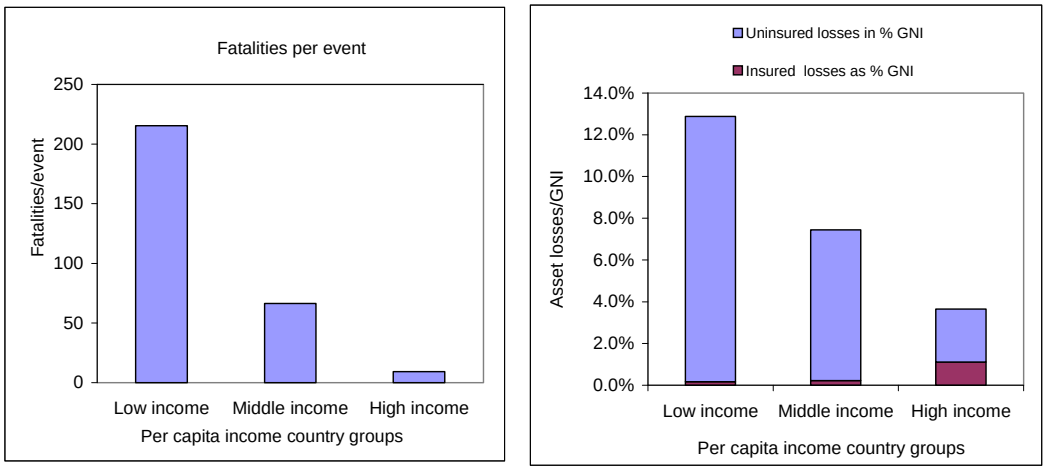
1 Introduction

The impact of natural hazards - weather variability, climate extremes, and geophysical events - on economic well-being and human sufferings has increased alarmingly. More than three-quarters of recent losses can be attributed to windstorms, floods, droughts and other climate-related hazards (UNISDR, 2007). This trend can be attributed largely to 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 also appears to be playing a role (Schönwiese *et. al*, 2003; IPCC, 2007; Emanuel, 2005). The Intergovernmental Panel on Climate Change (IPCC, 2007) has predicted that climate change will increase weather variability as well as the intensity and frequency of climate-related extremes.

Low- and middle-income countries, and especially the vulnerable within these countries, suffer the most. During the last quarter century (1980-2004), over 95% of natural disaster deaths occurred in developing countries and their direct economic losses averaged US$54 billion per annum (Munich Re, 2005). As illustrated in figure 1, a sample of large natural disasters over this period showed that fatalities per event were higher by orders of magnitude in low- and middle-income countries compared with those in high-income countries; and losses as a percentage of gross national income (GNI) were also highly negatively correlated with per capita income.

Fig. 1: Differential burden of natural disasters



Notes: Graphs depicting (i) fatalities per event, and (ii) insured and uninsured losses according to country income groups. Data source: Munich Re, 2005.[1]

Developed and developing countries differ not only in human and economic burden of natural disasters, but also in insurance cover. In rich countries about 30% of losses (totaling about 3.7% of GNP) in this period were insured; by contrast, in low-income

[1] Note: Country income groups according to World Bank classification using GNI per capita. Low income: less than 760 US$/year, middle income: 760-9360 US$/year, high income: larger than 9360 US$/year in 2005.

countries only about 1% of losses (amounting to 12.9% of GNP) were insured.[2] It should be kept in mind that these losses generally do not include long-term indirect losses, which can be very significant, particularly in countries with low capacity to cope. Due to lack of insurance, combined with exhausted tax bases, high levels of indebtedness and limited donor assistance, many highly exposed developing countries cannot raise sufficient capital to replace or repair damaged assets and restore livelihoods following major disasters, thus exacerbating the impacts of disaster shocks on poverty and development (Gurenko, 2004).

The seriousness of the post-disaster capital gap and the emergence of novel insurance instruments for pricing and transferring catastrophe risks to global financial markets have motivated many developing country governments, as well as development institutions, NGOs and other donor organizations, to consider pre-disaster financial instruments as a component of disaster risk management (Linnerooth-Bayer *et al*., 2005). Donor-supported pilot insurance programs are already demonstrating their potential to pool economic losses and smooth incomes of the poor facing weather variability, climate extremes, and geophysical disasters. These schemes provide insurance to farmers, property owners and small businesses, as well as transfer risks facing governments to global capital markets. A few examples serve to illustrate:

- In *Mongolia* herders can purchase an index-based insurance policy to protect them against livestock losses due to extreme winter weather (*dzud*). Small losses that do not affect their viability are retained by the herders, while larger losses are transferred to the private insurance industry, and the final layer of catastrophic losses is backed by the government (which is transferring part of this risk to global financial markets).
- In *Turkey*, apartment owners are required to purchase insurance that covers part of their losses from earthquakes. The policies are made affordable in part by the World Bank, which has absorbed layers of the risk through a contingent loan. This is the first time that the international development community has provided pro-active risk-financing support to a developing country.
- The *Caribbean Island States* have recently formed the world's first multi-country catastrophe insurance pool, reinsured in the capital markets, to provide governments with immediate liquidity in the aftermath of hurricanes or earthquakes.

Since many of these and other recent insurance programs are still in the pilot stage, and none have experienced a major and widespread catastrophic event, it is too early to fully assess their effectiveness in reducing economic insecurity. However, the need for careful examination of their effectiveness and sustainability, even if based on a short operating history, is underscored by the recent experience with disaster insurance systems in developed countries, especially the widespread inefficiencies of agricultural insurance systems and the insurance controversies following Hurricane Katrina's devastation to

[2] These losses are mostly *direct* losses of productive assets and property (*stocks*). Only to a minor extent are *indirect* losses of value added (*flows*), such as business interruption losses, accounted for and insured.

poor communities in New Orleans. The question arises whether developing countries should follow the path of the developed world in forming public-private partnerships to insure against catastrophic events, and which insurance instruments and modifications may be appropriate for better tackling the developmental dimensions of natural disasters.

The intent of this paper is to examine recent experience with insurance and other risk-financing instruments in developing countries, informed by that of developed countries, to provide insights into the effectiveness of insurance for reducing economic insecurity. Insurance and other risk-financing strategies should be viewed in the overall context of risk management, including prevention of losses as well as financing the recovery process through risk pooling and transfer strategies. The next section thus briefly reviews the respective cases for risk prevention and risk financing. We then turn to examining insurance and other risk-sharing mechanisms in developing countries: household/business insurance instruments in Section 3; agricultural insurance instruments in Section 4; and government risk pooling and transfer mechanisms in Section 5. Throughout these sections we discuss relevant experience in industrialized countries. In Section 6 we discuss the effectiveness of insurance for providing economic security to vulnerable communities by examining the costs, benefits and risks, and the appropriate role for donors. Finally, we conclude with general observations about the future role of insurance instruments in developing countries.

2 Disaster risk management

Insurance instruments are only one of many options in managing risks of natural hazards. The first, and arguably the highest priority in risk management, is to invest in preventing or mitigating human and economic losses. Disaster prevention can take many forms: reducing exposure to risks, (e.g., land-use planning); reducing vulnerability (e.g., retrofitting high-risk buildings); or creating institutions for better response (e.g., emergency planning). The residual risk can then be managed with insurance and other risk-financing strategies for the purpose of providing timely relief and assuring an effective recovery. Disaster risk management thus consists of risk reduction and risk coping.

2.1 Disaster risk reduction

While anecdotal evidence shows large benefits to disaster risk reduction in many contexts, there have been only a few systematic cost benefit analysis and other appraisal of prospective investments in disaster risk reduction (Benson and Twigg, 2004; Penning-Rowsell et al, 1992; Mechler, 2005; Benson et al. 2007; Moench, Mechler and Stapleton, 2007). According to Mechler (2005), available evidence suggests that in many contexts every Euro invested in risk prevention returns roughly 2 to 4 Euros in terms of avoided or reduced disaster impacts on life, property, economy and environment. In a retrospective analysis of 4,000 mitigation programs, the United States Federal Emergency Management Agency (FEMA) found an average benefit-cost ratio of four (MMC, 2005).

Despite high returns, disasters are very much under-prevented. In the United States, several studies show that only about 10% of earthquake- and flood-prone households have adopted loss-reduction measures (Kunreuther, 2006). Kunreuther attributes this

shortfall mainly to social myopia, which appears hard to influence through public policies. Even with extensive public awareness campaigns in earthquake-prone California, there has been little change in risk perception. Policy makers, faced with myopic voters, also appear reluctant to allocate public resources to reducing disaster risks.[3] This may be especially the case for development and donor organizations. According to some estimates, bilateral and multilateral donors currently allocate 98% of their disaster management funds for relief and reconstruction and only 2% for pro-active disaster risk management (Mechler, 2005).[4]

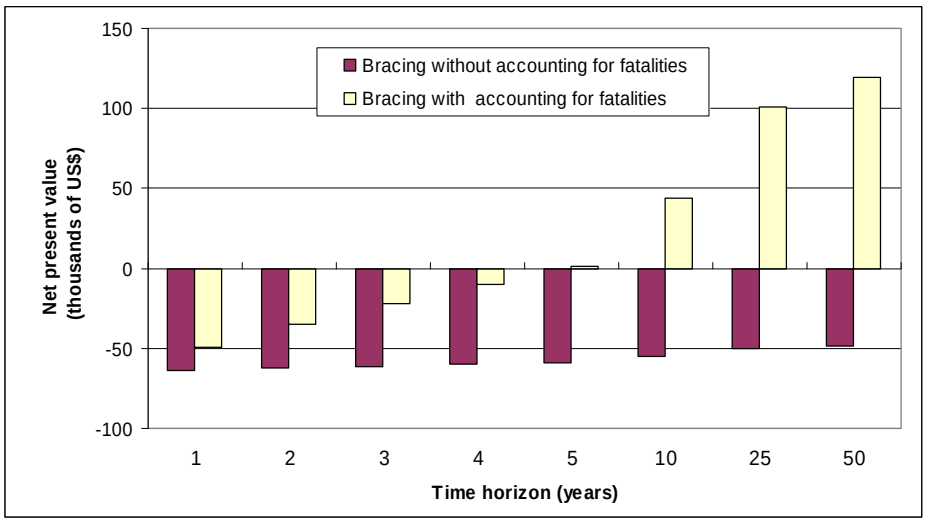
Annex 1 shows a sample of 7 pre-investment and 21 post-investment studies of projects meant for disaster risk reduction. With few exceptions, the projects examined demonstrated high benefit-cost ratios. However, assessing costs and benefits of disaster risk reduction is complicated especially because of two difficult tasks: (i) evaluating and expressing risk and (ii) monetizing benefits. Since it is misleading to assess benefits of prevention by deterministic means or by average expected gains (avoid loss), cost-benefit analyses (CBAs) have to express avoided losses in probabilistic terms. Similarly, monetizing key relevant impacts, such as indirect economic consequences on income and livelihoods, health effects, loss of life and ecological effects, etc. is also quite challenging.

Despite the above methodological difficulties, transparent cost-benefit analyses of disaster risk reduction can be useful in guiding public policies. An example is provided by Smyth *et al*. (2004) who estimated (in probabilistic terms) the economic efficiency of different seismic retrofitting measures for a representative apartment building in Istanbul. Based on estimates of the expected direct damages and the costs of selected retrofitting measures, the authors estimated the expected net present value of such measures. The analysis was conducted for different time horizons, with and without including the monetary value of saving lives. Interestingly, as shown in figure 2, the net present value of bracing apartment buildings and other retrofitting measures *without considering the value of saving lives* was negative for all time horizons considered. Only when including fatalities and a value of US$1 million for the life of a person did the projects become cost-effective for time horizons longer than 10 years. Such findings are of huge policy interest since most retrofitting decisions are made by absentee landlords, who may consider only the economic value of the retrofitting investment without considering the human losses. The analysis shows the large difference between private and social benefits of retrofitting programs, justifying public intervention and funding for such programs.

[3] ``In the absence of concrete information on net economic and social benefits and faced with limited budgetary resources, many policy makers have been reluctant to commit significant funds for risk reduction, although happy to continue pumping considerable funds into high profile, post-disaster response (Benson and Twigg, 2004: 4).''

[4] This is the topic of an on-going study sponsored by World Bank and UN-ISDR on "The economics of disaster risk reduction."

Fig. 2: Net present value for bracing an apartment house in Istanbul over time



Source: Smyth et al., 2004.

Increasing evidence of high returns on investments in prevention throughout highly exposed developing countries makes a clear case for giving priority to disaster risk reduction. The major hurdle in this regard appears to lie in the absence of requisite political will, as was eloquently expressed by Kofi Annan (1999):

> Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible; they are the disasters that did NOT happen.

2.2 Disaster risk coping

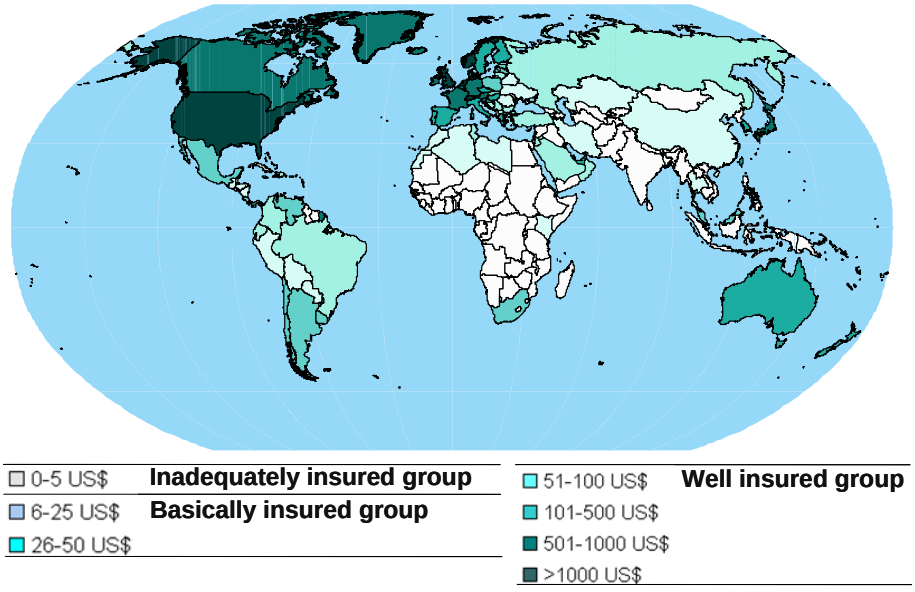
Risk coping through insurance and other hedging instruments spreads and pools risks, thus lessening the *variability* of losses, but not directly reducing them. By providing indemnification in exchange for a premium payment, insured victims benefit from the contributions of the many others who are not affected, and thus in the case of a disaster they receive a contribution greater than their premium payment. However, over the long run, insured persons or governments can expect to pay significantly more than their losses. This is due to the costs of insurance transactions and the capital reserved by insurance companies for potential losses (or reinsurance), as well as the financial return required for absorbing the risks. The "load" can be significant, as much as 500% of the pure risk (expected losses). Still, people buy insurance, and justifiably so, because of their aversion to large losses. Insurance and other risk-transfer instruments are thus justified by the concept of risk aversion.

While insurance does not directly prevent losses, well-structured contracts can provide incentives for loss reduction. For example, in Istanbul apartment owners pay less for their insurance if they retrofit their buildings. By providing timely post-disaster liquidity, insurance also reduces the long-term indirect losses, which can be as devastating to lives and livelihoods as the direct damages. In addition to reducing direct and indirect losses, insurance provides economic security. For businesses, insurance removes risks from

balance sheets, meaning that higher-profit and higher-risk activities can be pursued. For governments, insurance assures timely assistance and recovery, which can attract more investment to the country.

Globally, insurance penetration for disaster risks is varied. As shown on figure 3, in the United States, parts of Europe and Australia, the average person pays over US$500 annually in premium for non-life disaster coverage as compared to Africa and parts of Asia where the analogous figure is less than US$5. The averages, however, hide large differences within the regions. In Africa, for instance, there is virtually no coverage at all in a number of countries, whereas the above described per capita premium in South Africa is US$160 (Munich Re, 2003; Swiss Re, 2007).

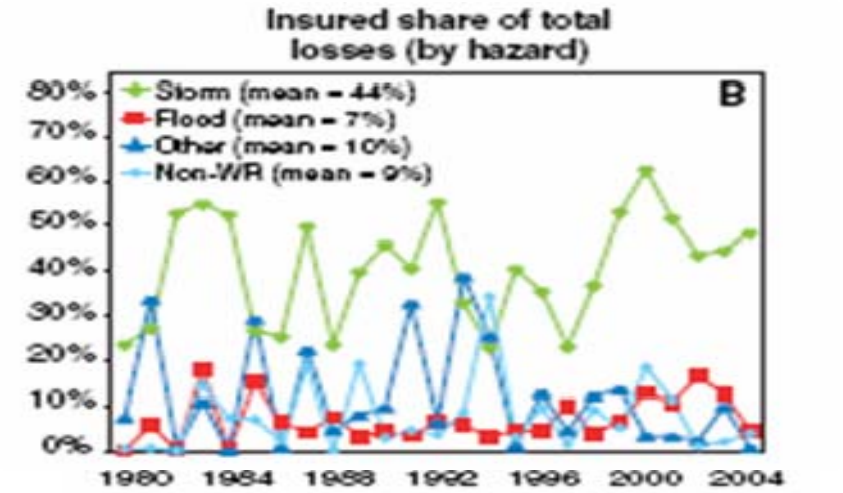
Fig. 3: Global distribution of non-life insurance premiums per capita



Source: Munich Re, 2003

The insured share of economic losses has risen from approximately 10% in the 70s to about 25% in 2004; yet the overall insurance penetration for many hazards remains relatively low (see figure 4). Globally, storm risk (since it is often bundled with property insurance) has the greatest penetration with about 50% of losses currently absorbed by insurance, followed distantly by flood, at less than 10%. Other hazards, such as earthquake, wildfire, lighting etc., have even less penetration.

Fig. 4: Global disaster insurance density for different hazards

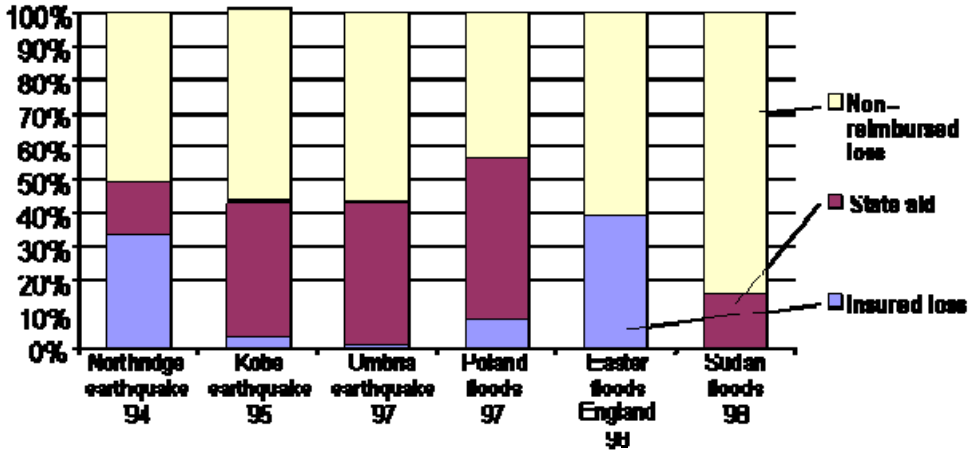


Source: Mills, 2005

As recent major disasters show, even in high-income countries, households and businesses rely extensively on public assistance (see figure 5). After the 1995 Kobe earthquake, where only about 4% of damaged or destroyed homes were insured despite a national public-private seismic insurance system, the government provided extensive assistance. Taking another example, in the United States, about 30% of total direct private and public losses from the 1994 Northridge earthquake were absorbed by private insurance companies, and the federal government provided extensive assistance to private victims, as well as to state governments for repairing public infrastructure. In stark contrast, in the UK, which claims 75% flood insurance penetration, the government gave practically no assistance to the private victims after the 1998 Easter floods.

Insurance is practically non-existent in least developed countries, like Sudan, where the victims absorbed over 80% of the losses from the severe flooding in 1998, and the state covered the rest with outside assistance (Linnerooth-Bayer and Mechler, 2007). Outside donor aid and financial assistance are volatile, and with the exception of highly publicized disasters (e.g., the 2004 Indian Ocean Tsunami), aid is usually only a small fraction of what is needed. Humanitarian assistance reported by the Organization for Economic Cooperation and Development (OECD) Development Aid Committee in the 1990's was less than 10% of disaster losses in recipient countries (Freeman et al. 2002). Post-disaster arrangements are not only often insufficient for meeting needs for relief and reconstruction, but they tend to be ad hoc and inefficient (Cardenas et al, 2007).

Fig. 5: Insurance and government assistance for selected disasters as a percentage of direct losses



Source: Linnerooth-Bayer and Mechler, 2007

In the absence of government assistance and international aid, poor victims rely on an array of (often innovative) pre- and post- disaster arrangements for financing their recovery. As shown in Table 1, insurance is only one of many different modalities for this purpose. The most usual financial course is to raise needed capital after a disaster strikes: Individuals take out emergency loans from family, micro-credit institutions or money lenders; sell or mortgage assets and land; or rely on public and international aid. Likewise, governments raise post-disaster capital by diverting funds from other budgeted programs, borrowing money domestically, or taking loans from international financial institutions.

While many locally based funding sources, for example, borrowing from neighbors or family, appear to work reasonably well for small localized events (Cohen and Sebstad, 2003), they are problematic for catastrophes that affect large regions or many persons at the same time (so-called co-variant or systemic risks). To hedge against co-variant risks, households may purposely locate family members outside of harms way or diversify their livelihoods. They may also arrange contingent savings or food supplies, activities that spread risks temporally. Alternatively, households/businesses and farms can purchase property or crop insurance, which spreads risk both temporally and spatially. Insurance can be provided by micro-insurance programs, which are distinguished from other types of insurance by their provision of affordable coverage to low-income clients. Like individuals, governments can also spread risks temporarily and spatially by setting up reserve funds or regional pools and by purchasing insurance or hedging instruments (e.g. catastrophe bonds or contingent credit), respectively.

Table 1: Examples of pre- and post-disaster risk financing arrangements

	Security for loss of assets (households/businesses)	**Food security for crops/livestock loss (farms)**	**Security for relief and reconstruction (governments)**
Post-disaster (ex post)			
	emergency loans; money lenders; public assistance	sale of productive assets, food aid	diversions; loans from World Bank and other IFIs
Pre-disaster (ex ante)			
Non-market	kinship arrangements	voluntary mutual arrangements	international aid
Inter-temporal	micro-savings	food storage	catastrophe reserve funds, regional pools, contingent credit
Market-based risk transfer	property and life insurance	crop and livestock insurance (also index based)	Insurance or catastrophe bonds (also index based)

Many of these risk financing modalities are conventional; yet, some, most notably index insurance and catastrophe bonds, are rather novel and have been made possible by new developments in modeling risks and financial transactions. Whereas conventional insurance is written against actual losses, index-based (parametric) insurance is written against physical or economic triggers. Index-based insurance is against *events* that cause loss, not against the *loss* itself. For example, crop insurance may be based on measures of insufficient rainfall at key points in the growing season or a loss index determined by the correlation between historical weather events and crop yields in a region. The insurer will pay out if rainfall measured by a rain gauge falls below a specified level regardless of crop damage. The major advantage, of index-based insurance is the substantial decrease in transaction costs, which, particularly for developing countries, have impeded the development of insurance mechanisms. The major disadvantage is *basis risk*, which is the lack of correlation of the trigger with the loss incurred. If the rainfall measured at the weather station is sufficient, but for isolated farmers insufficient, they will not receive compensation for crop losses.

As another novel insurance mechanism, a catastrophe bond is an instrument whereby disaster risks are packaged (*securitized)* in the financial markets (they can be parametric or indemnity-based). The investor receives an above-market return when a specific catastrophe does not occur in a specified time but sacrifices interest or part of the principal following the event. Disaster risk is thus transferred to international financial markets that have many times the capacity of the reinsurance market. Another advantage accrues to investors. By adding catastrophic risk to their investment portfolios, needed diversification is increased since natural catastrophes are not correlated with stocks and other investments tied to economic performance. There are also risks to this and other novel financial instruments, especially if they are not subject to national or international

regulation and oversight (the benefits and risks of insurance instruments are discussed in greater length in Section 6).

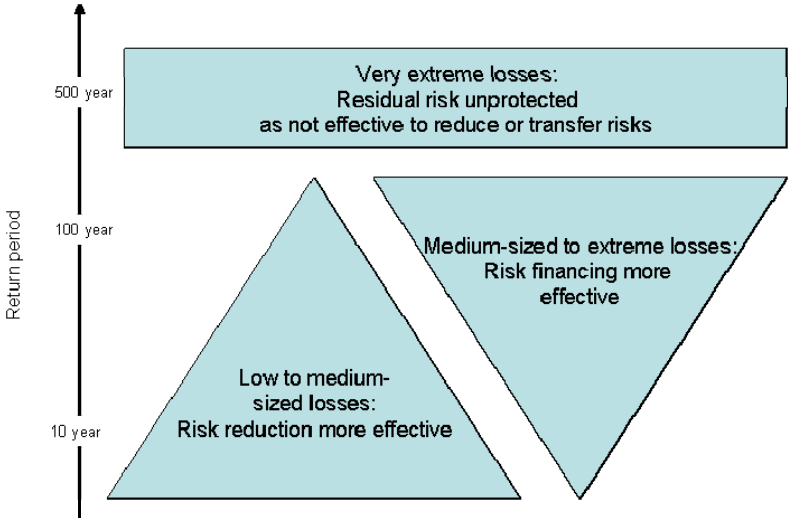
2.3 Prevention and coping

How much should be invested in the prevention of disaster losses, and how much in insurance? This is a complex question, which ultimately depends on the costs and benefits of both types of activities, as well as on their interaction (e.g. through incentives, financial instruments influence prevention activities). Cost and benefits, in turn, depend on the nature of the hazard and losses (e.g. the occurrence probability and exposure).

One way to think about prevention and insurance is illustrated by the layering approach shown in figure 6. Generally, costs of prevention increase disproportionately with the severity of the consequences. Therefore, for low- to medium loss events that happen relatively frequently, prevention is likely to be more cost effective in reducing burdens than insurance. Moreover, individuals and governments are generally better able to finance lower consequence events (disasters) using their own means, such as savings or calamity reserve funds; including international assistance.

The opposite is generally the case for costly risk-coping instruments, including insurance, catastrophe bonds and contingent credit arrangements Catastrophe insurance premiums fluctuate widely and are often substantially higher than the pure risk premium (average expected loss), mainly because the insurer's cost of back-up capital is reflected in the premium. For this reason, it may be advisable to use those instruments mainly for lower probability hazards that have debilitating consequences (catastrophes). Finally, as shown in the uppermost layer of figure 6, most individuals and governments find it too costly to insure against very extreme risks occurring less frequently than, say, every 500 years.

Fig. 6: The layering approach for risk reduction and risk coping



In what follows we discuss the effectiveness of insurance and other *ex ante* risk-coping schemes that offer security to low-income

- households and businesses,
- farms, and
- governments.

3 Insurance for households and businesses

3.1 Microinsurance schemes

Households and businesses in poor countries cannot easily afford commercial insurance to cover their risks, even in the unlikely case that providers exist. Without an insurance culture, or support from family or the government, disasters can lead to a worsening of poverty as victims take out high-interest loans (or default on existing loans), sell assets and livestock, or engage in low-risk, low-yield farming to lessen exposure to extreme events (Varangis *et al*., 2002).

The intent of microinsurance is to service low-income markets by offering limited coverage and greatly reducing transaction costs (Mechler *et.al*., 2006). Until recently natural hazards have not been explicitly considered as a niche for microinsurance because they impact large regions with multiple and simultaneous losses, and thus are both more uncertain and have higher potential losses than other types of insurance. The co-variant or systemic nature of the risks – and the large capital reserves necessary to avoid insolvency - distinguishes catastrophe coverage from health, accident and other forms of microinsurance. Given the challenges of providing microinsurance-type coverage for natural disasters, various innovative programs are emerging with the support of governments, NGOs, and international donors.

As identified by Cohen and McCord (2003), there are four institutional models for providing microinsurance-type coverage for catastrophic, co-variant risks:

- *Community-based model*: Local communities, MFIs, NGOs and/or cooperatives develop and distribute the product, manage the risk pool and absorb the risk, with no involvement on the part of commercial insurers.
- *Full service model:* Commercial or public insurers provide the full range of insurance services.
- *Provider model:* Banks and other providers of microfinance can directly offer or require insurance contracts. These are usually coupled with credit, for example, to insure against default risk.
- *Partner-agent model*: Commercial or public insurers together with microfinance institutions (MFIs) or non-governmental organizations (NGOs) collaboratively develop the product. The insurer absorbs the risk, and the MFI/NGO markets the product through its established distribution network. This lowers the cost of distribution and thus promotes affordability.

The microinsurance program offered by *Proshika* in Bangladesh illustrates the community based model, although on a large geographic scale (see box below).

If insurers with limited capital reserves choose to indemnify large covariant and recurring risks, they must guard against insolvency by diversifying their portfolios geographically, limiting exposure and/or transferring their risks to the global reinsurance and financial markets. Lacking geographic diversification, it is not clear if the *Proshika* scheme can survive another massive flood or other catastrophic loss. Large areas of the country can be affected by disasters: normal flooding can affect about 25% of the land area whereas extreme events can submerge more than 50% of Bangladesh (FAO, 2005). Since the scheme operates without reinsurance or donor support, and without stringent Bangladesh regulations for insurer reserves, its financial viability is questionable The *Proshika* scheme is not alone in this respect. A recent review of micro-insurance throughout Asia and Latin America showed little transparency or commonalities in the financial backup arrangements of private market providers (Mechler *et al*., 2006).

Proshika

One of the largest NGOs and MFIs in the world with more than 2 million clients, *Proshika* offers the Participatory Livestock Compensation Fund (PLCF). The PLCF was introduced in 1990 and covers the loss caused by sudden death of farm animals and poultry, specifically cattle, goats and chickens. Each group of borrowers contributes 3 percent of the purchase value of the animals to this fund and in case of death the whole purchase value is compensated. This scheme experienced wide-scale defaults during the 1988 massive floods that affected 73 million people, more than half the population of Bangladesh (CRED, 2007). As a response to the disaster, in 1991 a natural disaster management program was established (Nagarajan, 1998), and since 1997 compulsory group based insurance is included. Under this program 2% of the savings balance is annually transferred to a fund, which will pay twice the amount of the savings deposit in the case of property damages due to disasters, while savings stay intact. In the life policy component a minimum of twice the savings balance will be paid out depending on the years of membership in the savings scheme -- the outstanding loan will be recovered (ILO, 2005). With more than two million clients in 20,000 villages and 2000 slums in 57 districts of the country, this insurance fund has wide geographic diversification.

The experience of the Proshika scheme and similar other programmes have led many observers to recommend the partner-agent model, where commercial insurers play an important role (Linnerooth-Bayer and Mechler, 2007). The *Afat Vimo* all-hazard insurance program sponsored by the All India Disaster Mitigation Institute (AIDMI) illustrates this model (see box below). This partner-agent scheme appears to be both affordable to poor clients and, with backup capital from public insurers and donors, resilient to large catastrophes. Important features contributing to its expanding client base, according to its sponsors, are the long-standing relationship that AIDMI has with the communities it serves and the trust established through the administration of the Livelihood Relief Fund (LRF) (Linnerooth-Bayer and Mechler, 2007). Effectively utilizing such relationships has, however, proven administratively costly. The enlisting of new clients apparently costs about the same as the premium, and the cost of processing claims about three times this amount.

Afat Vimo
Since 2004 the NGO, All India Disaster Mitigation Institute (AIDMI), has been offering a disaster insurance program, *Afat Vimo*, covering households and small businesses for 19 different types of disasters, including floods, earthquakes, cyclones, fires and riots. Currently covering 6,000 clients - mostly men and women running small enterprises - it is planned to upscale the scheme to cover an additional 10,000 people in the next few years. The scheme is backed by two public insurance companies which collaborated closely with AIDMI in designing the product, setting premiums, determining cover and underwriting the risk.

On average, premiums are approximately 0.5% of the clients' annual income. They are kept affordable by relying on voluntary help from the NGO administering the Livelihood Relief Fund (LRF) and support from donors in the form of post-disaster and post-conflict interest-free loans to assure solvency. Because of the pro-poor regulatory requirements in India, the public insurers also subsidize premiums of their low-income clients from insurance in more lucrative markets. Finally, premiums are kept affordable by limiting cover, leading some observers to claim that the main benefit of *Afat Vimo* has been to limit the debt that can quickly arise out of a disaster, but not necessarily to provide the poor with needed capital to fully restore their livelihoods (Vaux 2007).

Diversification and reinsurance can add significantly to the costs of providing micro-insurance, which raises the challenge of assuring the financial sustainability of micro-insurance providers and at the same time providing affordable premiums to poor and high-risk communities. Many support subsidies (in the broadest sense) to meet this challenge and caution against shifting full responsibility to the poor, while others warn against the negative incentives promoted by subsidies and favor limiting support. It is notable that the *Afat Vimo* program does not adjust premiums to award risk-reducing behavior, which introduces moral hazard in the sense that clients may not take cost-effective preventive measures. Despite the advantages of donor-supported public private partnerships in providing sustainable and affordable insurance, there are thus concerns that excessive public and international support will distort market prices and greatly jeopardize the incentive effects of insurance.

3.2 National insurance programs

Microinsurance programs like *Afat Vimo* usually serve only very few clients. Scaling up across regions with uncorrelated risks adds valuable diversification to these schemes (the scaled-up Proshika scheme appears to include co-variant risks), but at the same time diminishes the institutional familiarity and trust that contributes both to their success and reduces expense. This raises the question of how insurance can effectively serve large regions or countries exposed to high systemic risks.

Even in industrialized countries, private insurers have been reluctant to offer region- or nation- wide policies covering flood and other hazards because of the systemic nature of the risks, as well as problems of moral hazard and adverse selection (Kunreuther, 1998). Moral hazard occurs when the insured change behavior after the purchase of the insurance, making them more risky. Adverse selection occurs when those facing higher risks purchase insurance, and those less at risk do not. Especially for large-scale systems,

purchasers often have information that is not known to insurers, or costly to obtain. This asymmetric knowledge jeopardizes the insurance pool.

Because private insurers are often not prepared to fully underwrite the risks, many countries, including Japan, France, the United States, Norway and New Zealand, have legislated public-private national insurance systems for natural perils with mandatory or voluntary participation of the insured as well as single hazard and comprehensive insurance (see box below for the United States case).

The United States National Flood Insurance Program

The United States National Flood Insurance Program (NFIP), created in 1968, is unique in that the federal government serves as the primary insurer, offering voluntary policies to residential and commercial buildings (mandatory in the case of a mortgage). Because the flood peril was considered uninsurable, the NFIP was designed to increase the role of the insurance industry in writing flood insurance policies (where the government bears all the risks) and ultimately to have the industry take over a risk-bearing role. A notable feature of the NFIP is that communities must take prescribed loss-reduction measures if their residents are to be eligible for (subsidized) cover. Flood insurance is only available in those communities that adopt and enforce a floodplain management ordinance that meets or exceeds the minimum NFIP standards. With the intent of reducing subsidies and moving toward risk-based premiums, the philosophy of the NFIP (and also the earthquake insurance program in California) is that persons living in exposed areas should eventually bear their full risks. This is the case for new buildings for which premiums are based on flood risk determined by the elevation of the lowest floor of the structure relative to the elevation of the national base flood (100-year flood) standard. Interestingly, the NFIP has a pilot program requiring owners of repetitive-loss properties to elevate, relocate or demolish houses, with NFIP bearing some of the costs.

The aftermath of Hurricanes Katrina, Wilma and Rita in 2005 revealed large debts in the NFIP and its continuing dependence on taxpayer support. Insurance brokers estimated that these hurricanes could cost global insurance and reinsurance sectors up to US$80 billion. A recent government study claimed that the NFIP is not actuarially sound. It does not collect sufficient premium income to build reserves to meet long-term expected future flood losses, partly because the United States Congress authorized subsidized insurance rates for some properties. Four catastrophic hurricane-induced flood events in 2004 required extensive loans from the United States Treasury to pay claims. Another concern is that properties that suffer repeated flooding and yet pay subsidized insurance rates constitute a significant drain on NFIP resources. (United States Government Accounting Office, 2005)

The 2005 hurricane season also created major problems for private insurers. In Florida, Hurricane Wilma inflicted the fifth largest United States catastrophe loss behind Hurricane Katrina, the 9/11 terrorist attack, Hurricane Andrew, and the Northridge California earthquake, and resulted in major insurance insolvencies. The financial strength of the Florida insurance market had already been weakened due to the withdrawal of highly rated national insurers (partly because regulators required insurers to offer the same premiums to high-risk coastal and low-risk inland structures) that had been replaced by state-sponsored entities and thinly-capitalized Florida-only insurers (Insurance Journal, 2005). As one example, South Florida's second-largest insurer of

homes, condos and apartments, the Poe Financial Group, saddled by more than US$2 billion in claims after Hurricane Wilma, declared insolvency in 2006 (StormingMad.com, 2006). This was the largest insurer insolvency the state has had to oversee. Outstanding claims were borne by the state-sponsored reinsurer, the Florida Hurricane Catastrophe Fund, and by the state-sponsored insurer of last resort, the Citizens Property Insurance Company. This case illustrates that even well capitalized and diversified insurers face insolvency in face of repeated high-loss events, and demonstrates the importance of public or private arrangements that protect clients against insurer insolvency.

The Katrina disaster revealed a great deal of discontent with NFIP and private insurer procedures, especially regarding delineation between coverage for flood and that for wind damages. Because the NFIP does not reimburse wind damage, many argue that the United States should institute a national all-perils policy similar to the French system (see box below). Katrina also revealed a major problem in communication and information with respect to NFIP and private insurance policies. Many claimants were surprised to find limited cover, which has prompted some to recommend that the maximum coverage limits of the NFIP should be increased substantially (Griffin, 2007). According to Mills (2005) the restriction of insurance is often criticized; yet, in some cases it can also be viewed as recognition that society is limited in its ability to pay the increasing costs of natural disasters.

The French All-Hazards National Insurance System

Whereas the NFIP covers only flood losses, private insurers in France are required to offer catastrophe insurance in an all-hazards policy that is bundled with property insurance. Policies are not risk based, and there are large cross-subsidies inherent in the system. The program is reinsured through a public administered fund, the Caisse Centrale de Réassurance (CCR). If this fund proves insufficient, taxpayers will be called upon to contribute. In contrast, the Japanese earthquake program is backed by government reinsurance and taxpayers, but only to a certain level of losses at which point claims will be pro-rated (meaning that claimants will receive less if losses are high). The French have rejected risk-based premiums in favor of a flat rate as a percentage of the property value. To counter the problem of disincentives from the cross subsidies, a recent decree sets a deductible that increases with the number of disasters in the same area. This means that the compensation a household or business receives will continually decrease in high-risk areas, leading to incentives to relocate or take other loss-reduction measures.

In an attempt to exploit the advantages of a national pool for disaster risks, and to avoid the problems that plague systems in high-income countries, World Bank and Turkish experts designed the Turkish Catastrophe Insurance Pool (TCIP). The purposes of this pool were to reduce the government's fiscal exposure (large post-disaster liabilities) by gradually building up capital in an insurance pool funded by affordable private contributions, and to create incentives for retrofitting apartment buildings and reducing risk.

The TCIP would not have been possible without recent advances in catastrophe modeling. In the absence of large sets of historical data, advanced risk modeling simulation techniques have increased the confidence insurers place in risk estimates and

greatly enhanced the insurability of catastrophic risks (Kozlowski and Mathewson, 1997; Bier, *et al*., 1999; Clark, 2002; Boyle, 2002). Although risk assessments can be very resource intensive, by drawing attention to risk and prevention measures they can be useful beyond the pricing of insurance contracts. This is the case in Turkey, where local universities have worked together with government in assessing risks and drawing up a blueprint for prevention (see box below).

Turkish Catastrophe Insurance Pool

The Turkish Catastrophe Insurance Pool (TCIP) launched in 2000 is the first of its kind to tackle the problem of insurance affordability in a middle-income developing country (Gurenko, 2004). In response to high seismic risk, earthquake insurance policies are obligatory for all property owners in Istanbul and other high-risk urban centers. Property owners pay a premium based in part on their risk (but not their risk-reduction measures, such as retrofitting their apartment buildings) to a privately administered public fund. The system does not apply to most of Turkey's very poor households by exempting property owners in rural areas. To reduce premiums and thus make the system affordable to urban dwellers, the World Bank absorbs a pre-specified part of the risk by providing a contingent loan facility with highly favorable conditions and contingent on the occurrence of a major disaster. In other words, if the fund cannot meet claims after a major earthquake, or if the earthquake is particularly catastrophic, the World Bank provides low-cost capital to the pool.

By making policies mandatory and risk based, and by providing for commercial and donor backup capital, TCIP designers attempted to avoid the problems of insufficient penetration and moral hazard experienced by the United States flood and French all-hazards systems, respectively. The ambitions of the designers, however, have not been fully realized. Enforcement of compulsory policies has been weak, and penetration at about 20% is far from universal. Even full penetration would not include the large number of illegal dwellings in Istanbul. Nor are premiums fully risk based, and some critics argue that the system should have been more closely linked with public spending for retrofitting high-risk apartments (Smyth *et al*., 2004). Because of increasing vulnerability and lack of wide-spread penetration, there is a concern that reinsurance capacity will not be sufficient to cover claims in the event of a major earthquake, creating a risk for the government and the insurance industry, and raising the specter of a post-Katrina-type debacle. Despite these serious issues, the TCIP sets an important precedent as the first nation-wide disaster insurance system in a middle-income developing country.

4 Insurance for farmers and herders

In 2001, global annual agricultural and forestry insurance premiums amounted to some US$6.5 billion compared with the estimated total value of agricultural production of US$1,400 billion, or 0.5% global coverage rate. This coverage is concentrated in developed countries, with only a minor percentage of global premiums paid in the developing world (Roberts, 2005). Still, agricultural insurance programs exist throughout Asia (e.g. India, Malaysia, and the Philippines), Latin America (e.g. Argentina and Brazil), and Africa (e.g. Mauritius). For the most part, they are heavily subsidized as illustrated by the crop insurance program in the Philippines, where farmers are at high risk to cyclones, droughts and pests (see box below).

The Philippines crop insurance program
The present crop insurance program grew out of an agricultural guarantee fund, which was operated by a government bank servicing the agricultural sector. The insurance is operated by a para-governmental entity, the Philippines Crop Insurance Corporation (PCIC), which began business in 1981. Designed initially to provide risk management to borrowing farmers and their lenders, the PCIC now offers policies to self-financed farmers. Participation is compulsory for farmers in the high-potential agricultural areas for two crops, maize and rice. Premiums paid to PCIC are heavily subsidized by the government and by institutional lenders (Roberts, 2005).

There is a great deal of controversy surrounding subsidized agricultural insurance. Subsidized programs in North America and Europe are viewed by many economists as failed policy. Commenting on the United States farm insurance program, Jerry Skees (2001) remarks:

> What was once a good idea — using crop insurance to share risk in agriculture — has become bad public policy in America. What was touted as a "market-based solution" is now very costly, inefficient, and inequitable…

The system is highly subsidized, from 40 to 60 per cent of premium, which not only keeps farmers in high-risk production but also gives greater financial advantages to those with higher premium, meaning higher risk, practices. Distorting market prices has led to vast inefficiencies and high costs to the government. This raises the question whether post-disaster aid – itself very inefficient - would not be preferred to the current market-based insurance solution. Subsidies are a concern for agricultural insurance programs in developing countries, not only because of inefficiencies caused by market distortions, but also because governments cannot afford to facilitate income transfers given the large segments of the population often engaged in farming. Whether these concerns should be transposed to international donors inquiring about their role in supporting pro-poor insurance programs is a subject of debate, which will be taken up in Section 6.4.

4.1 Index-based crop insurance

Traditionally, insurers have paid claims based on actual losses (indemnity-based insurance), which requires extensive networks of claims adjusters who assess individual losses following an event. It also means investing in marketing to individual farms and controlling moral hazard. Moreover, insurers in low-income countries have far less access to global crop reinsurance markets than do those in developed countries. The low volume of business and large fixed transactions costs means that reinsurers can service these markets only at high cost. Traditional indemnity-based crop insurance programs are thus costly, which is a reason why many such programs have failed in developing countries (World Bank, 2005).

To avoid the high transaction costs of indemnity-based insurance systems, index-based or parametric schemes make payouts contingent on a physical trigger, such as rainfall measured at a regional weather station, thus circumventing expensive claims settling. In the case of weather derivatives, farmers collect an insurance payment if the index reaches a certain measure or "trigger" regardless of actual losses. These schemes may offer a less costly and thus more viable alternative to traditional indemnity-based crop insurance.

The World Bank has provided the impetus and technical assistance for implementation of innovative index-based crop insurance schemes, making use of MFIs for promoting and distributing the product in developing countries. As a recent example, in Malawi, where the economy and livelihoods are severely affected by rainfall risk resulting in drought and food insecurity, groundnut farmers can now receive loans that are insured against default with an index-based weather derivative (Hess and Syroka, 2005). The Malawi example (see box below) illustrates the positive aspects of index-based insurance.

Malawi index-based crop insurance

Malawi is one of the more drought-prone countries in the Southern African region. Life expectancy in Malawi is approximately 38 years, the second lowest in international comparisons. Food insecurity is chronic and greatly worsened by drought, although 20% of the country's area is covered by water (Lake Malawi). Most farmers have small holdings, from 0.5 to 3 hectares.

In 2005 nearly 1000 smallholder farmers in Malawi participated in a pilot weather insurance project that allowed them to access an input loan package for better groundnut seed. This packaged loan and microinsurance product was offered by Opportunity International Bank of Malawi (OIBM) and Malawi Rural Finance Corporation (MRFC) to groups of farmers organized by the National Smallholder Farmers (NASFAM). Accordingly, the farmer enters into a loan agreement with a higher interest rate that includes the weather insurance premium, which the bank pays to the insurer, the Insurance Association of Malawi. The insurance payments are index-based depending on precipitation measured at one of three weather stations within the region of the pilot program.

Depending on location premiums amounted to 6-10 per cent of the insured cost-of-seed values, an amount easily repayable from the increased productivity of the seeds (estimated at about 500%). In the event of a severe drought, the borrower pays a fraction of the loan, the rest is paid by the insurer directly to the bank. The farmer is less likely to default, which has a stabilizing effect on the bank's portfolio and risk profile. Without this assurance, banks rarely loan to high-risk, low-income farmers. The advantage for the farmers is that they obtain needed credit to invest in the seeds and other inputs necessary for higher-yield crops. The World Bank together with Opportunity International (OI) played the role of a catalyst in developing this weather insurance product by providing technical assistance and training.

There is no need for expensive individual claims settling, and expedient payments will reduce the need for farmers to sell their assets and livestock to survive the aftermath of a disaster. Because of the physical trigger, there is no moral hazard; to the contrary, farmers will have an incentive to reduce potential losses, for instance, by diversifying their crops. Because they can access higher yield and higher risk crops, the insurance will promote cost effective higher-risk activities, thus reducing the chances for moral hazard. In the words of one of the designers of the Malawi program:

> We want farmers to adopt high return technologies that allow them finally to make the leap and accumulate earnings over time. Systemic risk is the factor impeding this and so far banks cannot handle the risk and the high transaction costs in rural areas. This Malawi transaction shows that there is a sustainable way to take the big rocks out of the way - drought risk – and clear the path to development! (Hess, 2005)

Although direct premium subsidies are not necessary, the program received assistance from the World Bank for starting up operations. It should be kept in mind, however, that the Malawi program provides only very limited coverage. By reducing loan repayments in the case of drought, the insurance only indirectly protects farmers from loss of livelihood and food insecurity. This is not the case with a similar pilot scheme, BASIX, launched by a rural microfinance organization in the Indian state of Andhra Pradesh, which provides cash payouts – albeit to middle-income farmers - who insure their cash crops (Hess and Syroka, 2005; Mechler *et al*., 2006). See box below.

BASIX index-based crop insurance

The BASIX insurance program covers non-irrigated farmers in Andhra Pradesh against the risk of insufficient rainfall during key parts of the cropping season. The policies are offered by a commercial firm, ICICI Lombard General Insurance, and marketed to growers through micro-finance banks, which are linked to the apex micro-finance entity known as BASIX (Bhartiya Samruddhi Finance Ltd.). Like in Malawi, claims are based on an index of precipitation, which is closely correlated with crop yield. The BASIX scheme owes its existence to international technical assistance provided by World Bank. The BASIX system has remarkably increased its penetration from 230 farmers to over 250,000 over a three-year period. Similar schemes are implemented or underway in Mongolia, Ukraine, Peru, Thailand and Ethiopia (Mechler *et al*., 2006).

Comparing the two schemes in Malawi and India, neither of which has public assistance from taxpayers, the question arises whether more extensive outside assistance for micro-insurance schemes of this type is necessary. Can the private market fulfill the insurance needs of the poor? The answer depends on the ability of clients to afford the requisite coverage. Middle-income farmers in Andhra Pradesh can afford the premiums for insurance that significantly reduces their insecurity; this would not be the case for very low-income farmers in Malawi, who cannot afford such extensive coverage. Unless supported by technical assistance, national subsidies or international donors, these schemes are out of reach for very low-income smallholder farmers facing high risks.

This explains why international insurers have been reluctant to commit significant capital and underwriting expertise to developing market based micro-insurance programs. Support from international donors can change this. As a recent case in point, Swiss Re has insured about 150,000 smallholder farmers in Kenya, Mali and Ethiopia against drought through a parametric product. The insurance is purchased by the internationally backed NGO, and other partners are being solicited to provide further financial support.

Enthusiasts point out that the Malawi, BASIX and Swiss Re programs, if scaled up, could provide the blueprint for insuring the more than 40% of farmers in developing countries, who face threats to their livelihoods from adverse weather (World Bank, 2005). A survey of 168 farmers participating in the 2005-2006 Malawi pilot programme provides both optimism and caution for this scenario (Suárez *et al*., 2007). The sample is not fully representative due to exclusion of defaulting participants, but the responses are indicative of farmers' perceptions about the weather insurance scheme. The results can be summarized as follows:

- Almost all participating farmers reported that they would join the scheme if offered again.
- It appears that many participating farmers, however, do not fully understand the index-based system. Only 55% of respondents reported understanding the scheme before joining it.
- Trust in the system appears to be problematic with respect to two crucial components of the program. Over a quarter of respondents did not consider the rainfall measurements from the local stations to be trustworthy. Moreover, NASFAM, the key institution for implementing the program, was not considered trustworthy by almost a third of the respondents, although it was the most trusted institution in the scheme for almost half of the respondents. This polarity points to the fragility of the dominance of one single institution.
- Although farmers participating in follow up focus groups easily grasped the concept of basis risk, most of the survey respondents were not fully aware or accepting of this risk. Without this awareness, the system may lose its legitimacy to the participants.

The survey results are optimistic in that most stakeholders remain strong supporters of the program. However, low trust in key institutions and lack of understanding of the system raise the question whether the institutional context is sufficiently mature for such schemes to operate on a large scale.

4.2 Index-based livestock insurance[5]

In Mongolia, where domestic animals provide sustenance, income, and wealth to protect nearly half the residents, a harsh winter (dzud) can have devastating effects even for experienced herders. To protect herders against livelihood losses from extreme weather, an innovative livestock insurance program has recently been developed by the World Bank. It stands in contrast to Mongolia's traditional indemnity-based livestock insurance, which was ineffective for several reasons: the high costs of settling claims across vast areas, the disincentives to reduce losses, and the incentives to falsely report animal deaths. The goal of the new public-private system according to its founders (see Mahul and Skees, 2006) is to (i) offer insurance coverage that is attractive to herders, (ii) involve the domestic insurance market while protecting it against catastrophic losses, and (iii) limit the fiscal exposure of the government (see box below).

Mongolian index-based livestock insurance

In 2006, an index-based livestock insurance (IBLI) program was introduced on a pilot basis in three Mongolian provinces. Because of lack of weather stations and the complexity of *dzud* events, the index is not based on weather, but rather on the overall mortality rate of adult animals in a given county determined by a (long-standing) yearly census.

The insurance system is made affordable to herders and viable to insurers by a layered system of responsibility and payment. Herders retain small losses that do not affect the viability of their

[5] This section is based on Mahul and Skees, 2006.

business. The next layer of losses is transferred to the private insurance industry through risk-based premium payments on the part of herders. A third layer of risk is absorbed by taxpayers, in what Mahul and Skees (2006) refer to as the "social product". Herders who purchase the first layer of protection are automatically registered for the social layer at no additional cost. The financing of the Government's potential losses during the pilot phase relies on a combination of reserves and – as a fourth layer - a contingent credit provided by the World Bank.

Even with the social product covering extreme local losses, there are significant risks associated with the commercial product as mortality rates are highly correlated across regions in Mongolia. In another innovation, the pilot design involves a syndicate pooling arrangement for insurance companies, which protects the under-developed insurance industry as well as the clients. If the pilot is scaled up, it is hoped that the pool can find reinsurance partners or investors for its securitization (e.g. with catastrophe bonds). Finally, the design offers the opportunity to switch the system entirely to the market if and when herders can pay the full risk premium (Mahul and Skees, 2006).

As with other index-based systems, the Mongolian scheme minimizes moral hazard, but since the claim payment is triggered by the event (the *dzud*) rather than individual losses, basis risk is a concern. Insurance claims depend on overall mortality, which means the IBLI provides strong incentives to individual herders to manage their herds so as to minimize the impact of major dzud events. But, the imperfect match between index payouts and individual livestock losses can be a significant issue for extreme winters with large losses, in which case the designers hope that other informal risk sharing measures will be enhanced. Like in Malawi, lack of understanding of the index system may present a problem, and focus groups with herders have already been conducted to help shape educational material. Finally, the potential for fraud in the distribution of the product, and elsewhere in the system, is not negligible despite certification of sales persons, the use of unique identification numbers and strict accounting systems.

5 Insurance for governments

Governments usually have responsibility for a large portfolio of public infrastructure assets that are at risk to natural disasters. Moreover, most governments are obligated to provide post-disaster emergency relief and assistance to vulnerable households and businesses. Governments of developing countries typically finance their post-disaster expenses by diverting from their budgets or from already disbursed development loans, as well as by relying on new loans and donations from the international community. In the past, these post-disaster sources of finance have often proven inadequate to assure timely relief and reconstruction in developing countries. For example, two years following the 2001 earthquake in Gujarat, India, assistance from a government reserve fund and international sources had reached only 20% of original commitments (World Bank, 2003). Post-disaster assistance is not only often inadequate, but it can discourage governments and individuals from taking advantage of the high returns of preventive actions.

5.1 Insuring governments

In wealthy countries government insurance hardly exists at the national level, although states in the United States, Canada and Australia often carry coverage for their public

assets. In theory, there is little rationale for insuring public infrastructure risks in large developed countries. It was noted in Section 2.2 that people buy insurance because of their aversion to large losses. In contrast to individuals, governments are not, in theory, risk averse, and thus in most circumstances should not purchase insurance (in Sweden insurance for public assets is illegal). This is the result of a well-know theorem by Arrow and Lind (1970), who give two reasons for the risk neutrality of the public sector: If the government spreads its risk over its citizens (most usually by means of taxation), the expected and actual loss to each individual taxpayer is minimal due to the sheer size of the population. Moreover, a 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.

Neither of these reasons apply to small, low-income and highly exposed countries that have over-stretched tax bases and highly correlated infrastructure risks (Linnerooth-Bayer and Mechler, 2004). Realizing the shortcomings of after-the-event approaches for coping with disaster losses, sovereign insurance may become an important cornerstone for tackling the substantial and increasing effects of natural disasters (Gurenko, 2004). This message became clear to the Mexican authorities after experiencing the 1985 earthquake in Mexico City. Colossal expenses on rehabilitation and reconstruction resulted in an increase in the fiscal deficit of $1.9 billion over the next four years (Cardenas *et al*., 2007). In 1996 the authorities created a financial risk management program (FONDEN) including a catastrophe reserve fund. In 2005, after the severe hurricane season, the FONDEN fund was exhausted, leading the Finance Ministry to consider hedging against natural disaster shocks. As a result, the authorities recently engaged in an international risk-transfer transaction to provide financial protection to the fund. Mexico has thus become the first transition country to transfer its public sector catastrophe risk to the international reinsurance and capital markets (see box below).

This transaction is likely to set an important precedent for protecting highly exposed developing and transition country governments against the financial risks of natural catastrophes. To date, catastrophe bonds have been issued mainly by primary insurance companies as an alternative to reinsurance, and this market has been growing at a considerable pace. Total coverage is currently $5 billion, up from approximately $3.5 billion in 2003 (Guy Carpenter, 2006).

The Mexican catastrophe bond

In 2006, the Mexican government chose to insure its catastrophe reserve fund, FONDEN, against major earthquakes with a mix of reinsurance and a catastrophe bond. The resulting contract is linked to a parametric trigger in terms of magnitude and depth of seismicity for the three-year period 2007-09. The catastrophe bond provides a coverage of US$160 million out of a total cover of US$450 million for a premium/interest totaling US$26 million. The major reinsurance company, Swiss Re, issued the bond, which pays an interest of 230 basis points if payment is not triggered. An insurance claim payment is triggered if:

- an earthquake with specified magnitude and depth is recorded with its epicenter located in one of the specified zones; and if

- there is official declaration of a disaster by a federal agency.

Three regions in Mexico considered at highest risk were thus financially protected. Mexico received substantial technical assistance from the World Bank and Inter American Development Bank over the years, but as a middle-income developing country and member of the OECD, it financed the transaction out of its own means (Cardenas *et al*., 2007).

Since it is held by an independent authority, one major advantage of a catastrophe bond issued by a sovereign state is the avoidance of political risk, or the risk that the funds will be allocated to other government programs, which plagued FONDEN. There is no guarantee, however, that the post-disaster bond payments reach those most in need after a disaster. Moreover, the catastrophe bond transaction proved to be of very high cost. Specifically, expenses amounted to about 2% of the coverage, which is far greater than traditional reinsurance, which normally approximates 1% (Lane, 2004). The costs included payments to outside consultants for modeling risks, a myriad of legal fees, costs of the rating agency, and other administrative expenses (Cardenas *et al*., 2007). While it is difficult to standardize the placement of catastrophe bonds in the financial markets and thus reduce legal and other fees, the cost of estimating risks may be reduced by improving public domain data bases and developing internal capacity for risk assessments. For example, the World Bank is currently sponsoring work on creating an openly accessible and verifiable database for Central America, which can potentially provide the basis for risk financing transactions in that region. It should also be possible to substitute outside consultancy firms with internal expertise in estimating risks. In Istanbul, for example, the universities are developing their capacity to carry out sophisticated catastrophe modeling as a basis for risk assessments. Participants at a recent workshop on this topic emphasized the potential contribution of donor organizations to the development of data bases and capacity building (Linnerooth-Bayer *et al*., 2007).

5.2 Insuring donors that insure governments

Like governments, donor organizations provide assistance, sometimes in the form of cash payments, for post-disaster relief. In the case of large-scale droughts and other disasters, donor organizations and the institutions they support can be strapped for cash. In this case, the organizations, themselves, might consider insurance. This was the reasoning behind an innovative idea by the World Food Programme developed in Ethiopia (see box below).

The Ethiopian weather derivative

To supplement and partly replace their traditional food-aid response to famine, the World Food Programme (WFP) supported the government-sponsored Productive Safety Net Programme (PSNP) by insuring it against extreme droughts. The PSNP provides immediate cash payments in the case of food emergencies. In the case of very severe droughts, however, this donor/government system is sufficient to save lives, but not to save livelihoods. The WFP thus designed an index-based insurance system to provide extra capital in the case of extreme drought, the amount being based on contractually specified catastrophic shortfalls in precipitation measured in terms of the Ethiopia Drought Index (EDI). Rainfall data is taken from 26 weather stations representing the various agricultural areas of Ethiopia. In 2006, WFP successfully

obtained an insurance contract based on the EDI through AXA Re, a Paris-based reinsurer (Wiseman and Hess, 2007).

An advantage of the Ethiopian hedging instrument is that it provides immediate post-disaster cash, which has the advantage of not only reducing acute hunger, but also preventing families from selling productive assets. Many Ethiopian households experiencing the 1984-5 drought-induced famine sold productive assets to survive, and these households continued to experience considerably less annual per capita income growth even during the 1990s than households not experiencing the drought (Wiseman and Hess, 2007). If those in need of assistance can be helped before they have depleted their productive assets, the long-term costs of supporting households can be significantly reduced.

According to Wiseman and Hess, the potential for combining index-based approaches and safety net tools is substantial. Well-established safety net programs, such as the Productive Safety Net Program (PSNP), can be scaled-up relatively quickly to ensure that resources can reach beneficiaries before negative coping strategies are employed. A recent survey showed that beneficiary households have lower levels of asset depletion after disasters than non-beneficiary households. There are also spin-off benefits. Most importantly, the predictability of the system and the monitoring/evaluation systems can lead to more comprehensive contingency planning.

Like the Malawian, Indian and other index-based systems, a limitation of the Ethiopian insurance approach is basis risk, which has to be carefully managed both in terms of designing the index and explaining the product limitations to the user. A more problematic limitation of this system is its integration with other donor-supported programs targeted to those chronically short of food, and especially nomadic herders, who are difficult to include in the Productive Safety Net Program. Mainly for this reason, the system is currently being modified and likely will be seeking financial coverage again in 2008.

5.3 Pooling small states' sovereign risks

As discussed earlier, larger countries can generally absorb the impact of adverse natural events since the affected region can be subsidized by revenues from unaffected regions. This type of geographic distribution of risk is not possible for many small states, and for this reason they can benefit from pooling arrangements stretching beyond their borders. Only few such vulnerable developing countries, however, have insurance. Exceptions include Colombia, Madagascar, Honduras and Barbados. A limitation facing small states intent upon transferring their risk is that they pay international prices subject to wide fluctuations. For example, Barbados experienced a ten-fold increase in insurance premiums after Hurricane Andrew in 1992, despite the fact that the island does not lie in a major hurricane path.

Partly to avoid this limitation, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) was recently established to provide the Caribbean Community (CARICOM) governments with limited, but immediate, liquidity in the event of a major hurricane or

earthquake at a significantly lower cost than if they were to purchase insurance separately in the financial markets. Early cash claim payment received after an event will help to overcome the typical post-disaster liquidity crunch. The facility appears well protected against insolvency with reinsurance and pro-rated contracts. Once again, a major concern about the long-term acceptance and viability of the pool is basis risk. For instance, Hurricane Dean (2007) imposed damages on Jamaica, but not sufficient to trigger compensation from the pool.

Caribbean Catastrophe Risk Insurance Facility

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) went into operation in June 2007 with the participation of 16 Caribbean countries, whose governments contributed resources ranging from US$200 thousand to US$4 million depending on the exposure of their specific country to earthquakes and hurricanes. This better-diversified portfolio is expected to result in a substantial reduction in premium cost of about 45 – 50 per cent for the participating countries. The fund covers up to 20 per cent of the estimated loss, and claims will be paid depending on an index for hurricanes (wind speed) and earthquakes (ground shaking). Initial funding by donor organizations provided support for start-up costs and helped capitalize the pool. The facility will transfer the risks it cannot retain to the international financial markets through reinsurance or through other financial instruments (for example, catastrophe bonds). The accumulation of reserves over time should lessen the facility's dependence on outside risk transfer. Should the total insured losses exceed its claims-paying capacity, payouts will be pro-rated based on the total amount of expected claims compared to the remaining available funds. In addition, donors are adding to the reserves. The governments of Bermuda, Canada, France, the United Kingdom, as well as the Caribbean Development Bank and the World Bank recently pledged a total of US$47 million to the CCRIF reserve fund.

The CCRIF acts much like mutual insurance. It is established as an independent legal entity and is managed by a specialized firm under the supervision of a Board of Directors composed of representatives from the donors. (Ghesquiere *et al*., 2006; World Bank, 2007)

6 Effectiveness of current programs

How effective are insurance mechanisms and programs for providing developing country households, businesses, farms and governments security against natural perils? This paper has described many innovative and promising recent programs, but the experience is too short to fully assess their current and prospective role in genuinely reducing the financial burdens of disaster shocks. However, drawing upon the role of insurance in high-income countries, it is possible, even with their short operating experience, to glean some insights on the effectiveness of insurance mechanisms. Effectiveness is multi-dimensional, and depends ultimately on the benefits, costs and risks of insurance systems compared to other types of risk-management activities.

6.1 Benefits of insurance in developing countries

The discussion above has highlighted the many benefits of risk financing in developing countries. Insurance is generally considered to have a fundamental role for the operations of modern society and a necessary precondition for economic development. By sharing losses geographically or temporally, it allows risk-averse individuals and businesses to limit their losses in case of an event, and by transforming uncertain large losses into a

certain annual premium seek higher-risk, higher profit activities (Liedtke, 2007). Not only does insurance provide a context for higher profit activities, but by providing low-income households, farmers and businesses with the right to post-disaster liquidity, it lessens the burdens from disasters by securing livelihoods and expediting the recovery process. For many, an insurance contract is more dignified and reliable than dependence on the *ad hoc* generosity of donors.

Insurance instruments can also have large payoffs to governments. Due to limited tax bases, high indebtedness and low uptake of insurance, many highly exposed developing countries cannot fully recover by simply relying on limited external donor aid. By providing *ex post* liquidity that enables governments to provide relief to the most vulnerable and to invest in reconstruction and recovery – and quickly get back on their feet - insurance reduces long-term losses and the significant development setbacks from disasters. Just like investments in prevention, insurance can therefore save lives and livelihoods. With internationally backed risk-transfer programs, developing country governments will rely less on debt financing and international donations, and assured funds for repairing critical infrastructure will attract foreign investment.

Insurance instruments can also provide incentives to reduce risk, but only if they do not themselves encourage negligent behavior. An example from Mauritius in the box below serves to illustrate:

The Mauritius crop insurance program
A para-governmental agency, the Mauritius Sugar Insurance Fund (MSIF) provides protection to the island's sugar farmers against losses from cyclones, fire, excessive rain and yellow spot disease. This public-private program has developed a sophisticated method for rewarding growers with good claims experience. For each crop season, farmers are placed on a 100-point scale, which determines the level of premium to be paid and the indemnity level they will receive in the event of a claim. As farmers improve or worsen their claims record, they are moved on the scale (Roberts, 2005).

Index-based insurance provides these incentives more indirectly. Mongolian farmers, for instance, can only gain by taking measures to protect their herds against adverse winter weather since insurance claims are based on average livestock loss in designated regions. As expert evidence mounts on the contribution of climate change to the intensity of cyclones and hurricanes, it will become increasingly expensive for governments to purchase reinsurance or issue catastrophe bonds, like the recent Mexican transaction, without taking measures to decrease the vulnerability of public infrastructure.

6.2 Costs of insurance in developing countries

The benefits of insurance make it a potentially integral part of an overall disaster risk management strategy. However, as documented throughout this discussion, the benefits come at a cost. In contrast to insurance for idiosyncratic risks (e.g. for health or funeral expenses) insurers offering coverge for co-variant risks face large, stochastic losses and thus must hold expensive capital reserves, diversify or purchase reinsurance, all of which "load" or add to its cost. Moreover, providing insurance at a small scale involves high transaction costs for reaching clients, estimating risks and handling claims. This was

illustrated, for example, by the *Afat Vimo* microinsurance scheme in India, where enlisting new clients costs about the same as the premium, and the cost of processing claims about three times the premiums. As demonstrated in the Mexican case, transaction costs are also proving high for alternative sovereign insurance instruments.

Because of the transaction and capitalization costs, catastrophe insurance premiums are often substantially higher than the long-term actuarially fair risk premium. This means that governments and individuals can pay significantly more for disaster insurance than their expected losses over the long term. For example, in the Caribbean region, insurance premiums (paid mostly by businesses) were estimated to represent about 1.5% of GDP during the period 1970–1999, while average losses per annum (insured and uninsured) accounted for only about 0.5% of GDP (Auffret, 2003).

With these high costs, it is pertinent to ask how insurance mechanisms can serve low-income clients facing high risk. As current programs demonstrate, insurance premiums are made affordable by targeting higher income clients, limiting coverage, providing outside support and forming partnerships. The TCIP and BASIX systems target middle-income property owners and farmers, respectively. The *Proshika* scheme limits claims to twice the amount in the savings account; in Malawi, the insurance covers only the cost of the seed: in the case of the Caribbean pool, insurance amounts to only about 20% of estimated losses to public infrastructure. Voluntary support from NGOs and international assistance also adds significantly to the affordability of insurance. Arguably, the *Afat Vimo* and Malawi programs as well as the Swiss Re's recent initiatives in Africa would not be possible without the significant support they receive from NGOs. The reinsurance and catastrophe bonds that transfer risks from Mexico and Ethiopia to the international capital markets were made possible by outside technical support from IFIs and other types of start-up assistance. The World Bank not only pays the often significant costs of starting up systems, but has also helped to capitalize the insurance pools in Turkey and Mongolia. The Indian pro-poor regulations explain the predominance of micro-insurance in India, made affordable through extensive cross subsidies. Direct taxpayer and donor subsidies are also significant for the *Afat Vimo* system, Mongolia, and the Caribbean pool.

6.3 Risks of insurance in developing countries

The compelling benefits of pre-disaster financing strategies tailored to the needs of developing countries and the prohibitive costs of these strategies for low-income individuals and fiscally strapped governments, make a strong case for donor-supported public-private insurance systems to serve the poor. Yet, as recent and past experience in developing and developed countries shows, there are risks to an insurance strategy. Broadly, these risks can be categorized as resulting from:

- the problem of solvency and sustainability of insurance systems;
- inefficiencies and market distortions arising from outside support;
- moral hazard, adverse selection and basis risk;
- problems of institutional stability, public confidence and trust, and
- climate change.

The solvency and sustainability of insurance systems

Since recent insurance systems and initiatives offering coverage for natural perils in developing countries are for the most part still in pilot stages, and none have experienced a major and widespread catastrophic event, it is necessary to examine their viability and sustainability in the longer run. This issue is all the more pressing given the recent experience of insurance serving high-income clients, such as the flood insurance programme in the United States, which despite a largely diversified system and public involvement is facing strong pressures from Hurricane Katrina and other recent catastrophes. Moreover, the withdrawal of private insurers from high-risk markets in the United States and insurer insolvencies after the 2005 hurricane season also raise warning signals for insurance in high-risk developing countries.

As emphasized repeatedly in this discussion, the solvency of private and public insurers will depend on the capitalization and diversification of the insurance programmes, the terms of the contract and backup systems provided by governments and international donors. For many systems operating in developing countries, there is little transparent information on the extent of reinsurance and other financial backup systems (Mechler *et al*. 2006). This issue was explicitly raised with regard to the *Proshika* system, which offers insurance to over 2 million clients throughout Bangladesh. Can it withstand a major flood or other event impacting large areas of the country? If not, will the government or other institutions pay claims (like in the Florida cases of insolvency)?

There may also be grounds for concern even with highly capitalized systems. For example, with penetration of the TCIP below expectations, it can be questioned whether the reinsurance in place, even with the World Bank contingency credit arrangements, will be sufficient to withstand a major earthquake in Istanbul. The Caribbean offers a more positive example. Given the extent of reinsurance, donor capitalization and contract conditions that provide for pro-rated payments if accumulated funds prove insufficient, the CCRIF appears resilient even to an extreme hurricane season. Yet, clients may lose confidence in a system that (legally) pays out only a fraction of claims. In the absence of strong regulatory bodies in many developing countries, the question is whether the intervention of international bodies can provide the requisite expertise and authority for assuring sufficient capital, reinsurance and diversification for long-term sustainability?

Inefficiencies and market distortions arising from outside support

Despite compelling arguments for internationally supported partnerships between insurers, NGOs and governments, there are concerns that excessive support will distort market prices and greatly jeopardize the incentive effects of insurance, crowd out private initiatives, and create unstable systems due to the inability of donor institutions to make long-term commitments. Critics rightly point out that subsidized premiums in the United States farm insurance program have weakened incentives to plant more robust crop varieties, or to move away from farming in high drought or flood risk areas. If the intent is to provide transfers to the poor, it is argued, it is far better to compensate them directly rather than subsidize insurance systems.

Tempering this argument is the fact that even donor-supported insurance has a greater incentive effect than the current practice of free public assistance to disaster victims. While there is a great deal of concern about distorting prices and thus giving the wrong signals for risk reduction, it is also important to keep in mind that risk markets may not be operating optimally and thus prices may already have distortions. Donors can compensate for price distortions by linking their support with vulnerability reducing measures. The challenge is thus to design incentive compatible public/private programs, such as those in Mauritius and Mongolia.

Moral hazard, adverse selection and basis risk

Moral hazard and adverse selection have contributed to the reluctance of private insurers to enter many catastrophe markets, most notably flood coverage, and motivated governments to form public-private insurance systems. As noted above, moral hazard can be countered with measures, like in Mauritius, that provide incentives for insurance clients to take protective measures. Besides setting premiums to reflect individual risks, insurers can set high deductibles and otherwise fashion contracts that share responsibility (e.g. co-insurance). Even in developed countries, however, insurers are understandably reluctant to invest heavily in monitoring risk behavior, preferring to rely on the government to regulate risk-reduction measures. This is the explicit strategy of the French national insurance system, although incentives have been added to the insurance system. Claimants receive less and less payments for repetitive damages.

Risks of adverse selection and moral hazard facing conventional insurance systems are absent in the case of index-based programs, for example, in Malawi, Mongolia, Ethiopia and the Caribbean. Yet, basis risk may be one of the most difficult challenges facing these programs. Will farmers in Malawi or governments in the Caribbean continue supporting a system if a major loss occurs for which they are not compensated, especially (as in Malawi) if clients are not well informed about basis risks? This question has been raised in the Caribbean, where Hurricane Dean swept across Jamaica but did not trigger payment from the pool. The non-payment became an issue in the Jamaican elections that followed closely after the hurricane. Although the government continues to support the pool, the controversy highlighted problems in designing an appropriate index. Not only are there concerns about the hurricane index in the Caribbean, but also in Mongolia, where a fraudulent animal census could greatly prejudice the insurance outcome.

Institutional stability, public confidence and trust

The Mongolian case raises a more general issue. Are implementing institutions and governance systems stable and trustworthy, a condition essential for the sustainable operation of insurance systems? Without competent regulatory bodies that assure conditions for both insurers and clients, the market cannot provide sustainable insurance contracts. Among other reasons, there will be no protection for clients if insurers renege on claims, and well capitalized firms will be undercut by those with insufficient capital.

Responses to the Malawi survey showed widespread mistrust in the implementing institutions and insurance mechanisms, notably in the administrating NGO, the private insurer and the weather station data. Even more worrying is the apparent lack of

understanding of the insurance contract. Many farmers in Malawi did not fully understand the index-based system. In India, there are concerns that farmers' enthusiasm for the BASIX system is based on generous payouts in recent years. Will farmers continue to pay premiums after several "good" years with no payout? Misunderstandings and misinformation are a serious problem even in industrialized countries, which became apparent after the acute disappointment of Hurricane Katrina victims with respect to the extent of their flood and wind insurance coverage.

Fraud can also plague insurance systems. The risk of census fraud in Mongolia is not an isolated concern. In Mexico, purchasers of the catastrophe bond are protected by international controls, but there is no guarantee that post-disaster payments to FONDEN will be appropriately allocated to help the most vulnerable. It should be kept in mind, however, that fraud is also a major issue with the alternative of free post-disaster donor assistance.

The risks of innovative financial instruments, like index insurance and catastrophe bonds are also present at another level. In a recent analysis of the United States financial crisis brought on by the sub-prime loan debacle, a leading commentator points to the dangers of financial innovation.

> What we are witnessing is essentially the breakdown of our modern-day banking system, a complex of leveraged lending so hard to understand that Federal Reserve Chairman Ben Bernanke required a face-to-face refresher course from hedge fund managers... How did things get so opaque? The answer is "financial innovations... (which) were promoted as ways to spread risk, making investment safer. What they did instead... was to spread confusion, luring investors into taking on more risk than they realized (Krugman, 2007).

Krugman points out that behind the crisis lies a collapse of trust – market players don't want to lend to each other. Yet, at the deeper level the problem is ideological: policy makers, committed to the view that the market is always right, simply ignored the warning signs.

What does this crisis mean for innovative instruments insuring the developing world? It may be argued that the risk of a widespread breakdown in the system is not likely with innovative insurance and securitization. While catastrophe bonds are novel for insuring catastrophe risk, it should be kept in mind that governments routinely issue bonds for financing projects, and these bonds are often traded in global markets. Still, trust and market regulation are essential conditions for sustainable operation of the markets. For example, governments must assure that catastrophe bonds are held by an independent authority, that they are rated by an accredited agency, and that there is transparency in the risk estimates. Farmers purchasing insurance must have an understanding of the contractual conditions to assure that they do not take on more risk than they realize.

Climate change

Finally, climate change will likely impose additional stress and risks on weather insurance. Weather-related disasters are increasingly viewed as getting intensified by greenhouse gas emissions, changes in land-use, and other contributing factors. The Intergovernmental Panel on Climate Change (IPCC) has predicted that climate change will increase weather variability as well as the intensity and frequency of climate-related extremes. There is some evidence of a "climate signal" with the IPCC (2007) reporting observations of long-term and widespread changes in wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones.

There is a growing acknowledgement on the part of insurers that the impact of climate change on future weather losses may be profound. The chairman of Lloyd's of London deemed climate change to be its number-one issue, and Europe's largest insurer, Allianz, stated that "climate change stands to increase insured losses from extreme events in an average year by 37 percent within just a decade while losses in a bad year could top US$400 billion" (quoted in Mills, 2007). After its members suffered US$7 billion in projected insured flooding losses during the summer of 2007 (130,000 claims), the Association of British Insurers is currently calling on the government to step up its investment in flood defenses as a necessary condition for maintaining insurability (ABI, 2007).

6.4 Role of donors, NGOs and other international organizations

There are compelling reasons for the donor community to follow the examples of financial institutions like the World Bank and the World Food Programme and invest in risk-transfer programs. By sharing responsibility with individuals and the state, donors leverage their limited budgets and substitute a calculable annual commitment to a financial risk transfer system for the unpredictable granting of post-disaster aid. Viewed as an alternative to post-disaster assistance, support of insurance programmes has the added advantage of requiring detailed assessments of risk and thus directing early attention, not only to insurance, but to prevention. What makes donor-assisted risk-transfer programmes attractive are thus the mutual benefits to developing countries and the donor community in reducing the long-term need for assistance.

Despite these benefits, the appropriate role of donors, NGOs and other international organizations with respect to their support of insurance in the developing world is controversial. This role was debated by experts at a recent meeting on *Insurance Instruments for Adaptation to Climate Risks* in Laxenburg, Austria (Linnerooth-Bayer *et al.*, 2007). The arguments can be roughly characterized as follows:

- *Against outside assistance:* Financial and other types of donor support for enabling insurance, especially if given in the form of direct subsidies, will lower premiums and therefore lessen incentives for reducing vulnerability. As a case in point, the highly subsidized United States crop insurance programme has led to inefficiencies caused by farmers planting in very high risk areas. If the intent is to provide transfers to the poor, it is argued, it is far better to provide direct cash

transfers directly rather than subsidize insurance systems. Not only is excessive outside support for public-private systems inefficient, but it risks crowding out private capital necessary for fledgling insurance markets. While partnerships, like the TCIP, actually create an opportunity for the private market to carry out business, there is a danger that by offering deep premium subsidies ill-conceived public-private partnerships may prevent private companies from entering the market. Finally, donor institutions seldom make long-term commitments, thus jeopardizing the sustainability of insurance programs dependent on their support. For all these reasons, donors should restrict their assistance to correcting market failures, e.g. information deficits and the private provision of public goods.

- *Pro outside assistance:* The disaster insurance market is not fully efficient even without subsidies, nor can it be expected to provide insurance to vulnerable individuals and governments unable to pay the (full) price. Moreover, direct cash transfers sufficient to build an insurance market for these risks are unlikely, given current levels of support from donors. The alternative to supporting insurance systems is *not* reducing poverty to the extent that all citizens of the developing world will be well insured (even developed countries have not achieved this), but the alternative is, rather, continuing to aid victims after disasters strike. Post-disaster aid is characterized by even greater inefficiencies than subsidized insurance programs, as well as being ad hoc and undignified. Moreover, insurance as opposed to post-disaster aid can create a favorable environment for investment. For these reasons, donor-supported insurance systems are a legitimate route for addressing poverty, especially if they keep market distortions as low as feasible. It was precisely this motivation that resulted in the social insurance systems that contributed so greatly to the equitable development of Europe and other industrialized countries. The case is stronger given the responsibility of industrialized countries for the damage inflicted by greenhouse gas emissions on vulnerable and low-emitting countries. Since the global market is already massively distorted by the failure of the developed world to internalize these costs, support for adaptation measures, such as insurance, is not only justified, but a moral imperative.

Experts at the Laxenburg meeting explored a middle way between these two views. Most participants agreed that, if at all, donors should contribute only to sustainable, incentive-compatible insurance programs that serve clients who cannot be served by the commercial market. It is important thus to reduce the cost of insurance for those who cannot afford it through minimally distorting interventions. Donor support might thus take the following forms:

- Providing improved information (e.g. assistance in conducting risk assessments), market institutions (e.g. insurance regulations), and market infrastructure (e.g. weather stations);
- Assisting in the delivery and administration of insurance contracts;
- Reducing the price of high layers of risk (e.g. the low-probability, the very high impact events) but maintaining the "pure risk price" on lower levels (e.g. by providing low-cost reinsurance or directly absorbing these risks);

- Pooling insurance programs that have uncorrelated or negatively correlated risks, e.g. the spatially differential effects of El Niño events in Africa;
- Brokering reinsurance deals, e.g. the case of the Caribbean pool.

In sum, there are many issues of equity and efficiency involved with both support for and opposition to donor support for insurance. A middle way forward would avoid excessive support that distorts market prices and crowds out private capital, but would enable highly exposed poor communities and governments to access insurance.

7 Concluding remarks

The questions motivating this discussion were whether developing countries should follow the path of the developed world in building public-private partnerships to insure against catastrophic events, and which insurance instruments and modifications may be appropriate for better tackling the developmental dimensions of natural disasters.

While most would agree that private and social insurance systems have provided security against old age and disability, unemployment, and other risks in the developed world, the record of insurance for providing security against floods, earthquakes and other hazards is more tenuous. Due to the specific nature of covariant risks, insurance penetration is weaker and uneven. Private insurers have been reluctant to commit capital to many types of hazards; adverse selection and moral hazard continue to plague indemnity-based systems; subsidies have proven disruptive to markets; private and national programs alike are often under-capitalized; and climate change appears to be contributing to increased insurance losses and, in some cases, un-insurability. These are problems that will limit the effectiveness of insurance in developing countries as well.

At the same time, recent and innovative insurance programmes in developing countries may potentially offer a preferred alternative to reliance on post-disaster donor aid. With this in mind, it is important to closely examine the development of nascent insurance systems throughout Asia, Africa, and Latin America. As summarized below, this brief review has highlighted opportunities and challenges of many pioneering efforts that aim to provide security to low-income households, businesses, farms, and governments:

- Micro-insurance systems are providing low-cost coverage for disasters to low-income households and businesses, with an apparent large potential for scaling up. A challenge is to create public-private systems – backed by international expertise and capital –that can sustain major events and at the same time provide coverage to those who cannot afford risk-based premiums. To serve more affluent developing country clients who can afford sufficient cover, the challenge is to create favorable market conditions by putting into place the requisite regulatory bodies, such that private insurers can operate in non-subsidized markets;
- Early experience with index-based crop and livestock insurance suggests that it can be a cost-effective alternative to indemnity-based agricultural insurance, and can avoid moral hazard and adverse selection. The challenge is to design systems that can operate in countries with weak financial and regulatory institutions, that minimize moral hazard and promote public trust;

- Insurance and alternative insurance instruments are already providing security to vulnerable governments. There is a significant potential for these instruments to supplement international assistance in assuring sufficient and timely capital for the recovery process. In light of the significant costs of these instruments, the challenge is to identify the appropriate layers of risk to transfer and the lowest cost/risk solutions;
- By spreading risk across hazards and regions, regional, national and (potentially) global) pools for public- and private-sector risks can greatly reduce the cost of risk bearing. A challenge is to develop unified risk estimation procedures and a common "risk culture" for the regions and countries involved.

In sum, there is a large potential for insurance in the developing world: for changing the way development organizations provide disaster assistance, engaging the private sector in vast markets, providing reliable and dignified post-disaster relief, supporting adaptation to climate change and, not least, spurring economic development. There are also many challenges: assuring sustainability and affordability in light of co-variate risks and adverse selection; defining an appropriate role of donors in light of the inefficiencies of subsidies; and assuring that systems avoid moral hazard and contribute to "good" investments. Pilot programs are offering a testing ground that should be carefully monitored and built upon by governments, international development organizations, NGOs, private insurers, and the climate-adaptation community.

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Annex 1: Evidence on the costs and benefits of disaster risk management

Table: Appraisals of the Costs and Benefits of disaster risk management

Source and type of analysis	Actual or potential benefits	Result/return
Appraisals (assessment before implementation)		
Kramer (1995): Appraisal of strengthening of roots of banana trees against windstorms	Increase in banana yields in years with windstorms	Expected return negative as expected yields decreased, but increase in stability as variability of outcomes decreased
World Bank (1996): Appraisal of *Argentinean Flood Protection Project*. Construction of flood defence facilities and strengthening of national and provincial institutions for disaster management	Reduction in direct flood damages to homes, avoided expenses of evacuation and relocation	IRR: 20.4% (range of 7.5%-30.6%)
Vermeiren and Stichter (1998): Hypothetical evaluation of benefits of retrofitting of port in Dominica and school in Jamaica	Potentially avoided reconstruction costs in one hurricane event each	B/C ratio: 2.2 – 3.5
Dedeurwaerdere (1998): Appraisal of different prevention measures against floods and lahars in the Philippines	Avoided direct economic damages	B/C ratio: 3.5 – 30
Mechler (2004a): Appraisal of risk transfer for public infrastructure in Honduras and Argentina	Reduction in macroeconomic impacts	Positive and negative effect on risk-adjusted expected GDP dependent on exposure to hazards, economic context and expectation of external aid
Mechler (2004b): Prefeasibility appraisal of Polder system against flooding in Piura, Peru	Reduction in direct social and economic and indirect impacts	Best estimates: B/C ratio: 3.8 IRR: 31% NPV: 268 million Soles
Mechler (2004c): Research-oriented appraisal of integrated water management and flood protection scheme for Semarang, Indonesia	Reduction in direct and indirect economic impacts	Best estimates: B/C ratio: 2.5 IRR: 23% NPV: 414 billion Rupiah
Ex-post evaluations (assessment after implementation of measures)		
FEMA (1998): Ex-post evaluation of implemented mitigation measures in the paper and feed industries in USA	Reduction in direct losses between 1972 and 1975 hurricanes	B/C ratio: ca. 100
Benson (1998): Ex-post evaluation of implemented flood control measures in China over the last four decades of the 20th century	Unclear, probably reduction in direct damages.	$3.15 billion spent on flood control have averted damages of about $12 billion
IFRC (2002): Ex-post evaluation of implemented *Red Cross mangrove planting project* in Vietnam for protection of coastal population against typhoons and storms	Savings in terms of reduced costs of dike maintenance	Annual net benefits: US$7.2 mill. B/C ratio: 52 (over period 1994-2001)
Venton & Venton (2004) Ex-post evaluations of implemented combined disaster mitigation and preparedness program in Bihar, India	Reduction in direct social and economic, and indirect economic impacts	Bihar: B/C ratio: 3.76 (range: 3.17-4.58) NPV: 3.7 million Rupees (2.5-

and Andhra Pradesh, India		5.9 million Rs) Andhra Pradesh: B/C ratio: 13.38 (range: 3.70-20.05) NPV: 2.1 million Rupees (0.4-3.4 million Rs)
ProVention (2005): Ex-post evaluation of *Rio Flood Reconstruction and Prevention Project*, Brazil. Construction of drainage infra-structure to break the cycle of periodic flooding	Annual benefits in terms of avoidance of residential property damages.	IRR: > 50%
FEMA (1997): evaluation of National Flood Insurance Program: 18,700 communities adopting floodplain regulations, zoning, building requirement, flood insurance	Reduction or elimination of flood damage and associated costs of recovery.	Annual benefits of $770 million Costs: Program largely funded by insurance premiums
MMC (2005): review of FEMA mitigation programs	Programs to help mitigate effects of multiple natural hazards from 1988-2000.	Average B/C ratio: 4 based on a review of 4,000 mitigation programs.
FEMA (1997): Acquisition/relocation of Castaic School District buildings, California	Relocation of schools away from dam inundation & gas pipeline burst due to earthquakes. Buildings built to earthquake code.	Cost: $27million Estimated benefits: cost of reconstruction, building rental, daily education, 1300 lives saved
MMC (2005): Cost effective analysis of Freeport, New York flood mitigation project	Elevation of homes, businesses, main roads above 100-yr flood level. Electrical lines moved underground. Early warning systems and education programs initiated	B/C ratio averaged over all projects: 12.6
MMC (2005): Cost effective analysis of Jefferson County, Alabama mitigation projects	Early warning systems, vulnerability and hazard maps, education programs	B/C ratio averaged over all projects: 2.6
MMC (2005): Cost effective analysis of Tuscola County, Michigan mitigation projects	Mapping of flood vulnerable areas, improved drainage, acquisition and retrofitting of homes and businesses	B/C ratio averaged over all projects: 12.5
MMC (2005): assessment of the National Earthquake Hazards Reduction Program	Seismic retrofitting of multiple buildings, reduction in fatalities and injuries in US, development of shake maps	B/C ratios: 1.4 – 2.5
Mizina (1999): evaluation of mitigation programs for agriculture in Kazakhstan under climate change scenarios	Projects range from education, capacity building, and reducing soil erosion	Cost effectiveness using ADM range from: 0.65 – 5.5
Fuchs et al. (2006): cost effectiveness of avalanche risk reduction strategies in Davos, Switzerland	Reduction in deaths and damage to infrastructure, better land use planning and zoning, snow fences	B/C ratios range from: 0 – 3.72

Source: Moench, Mechler and Stapleton, 2007.