Public Sector Financial Vulnerability to Disasters

The IIASA CATSIM Model

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Abstract

This paper addresses the financial vulnerability of developing country governments to disasters of natural origin. A framework of public sector financial vulnerability and its components of economic risk and financial resiliency is developed. The IIASA CATSIM tool, which is an interactive simulation tool for building capacity of policy makers to assess and reduce public sector financial vulnerability by employing pre-disaster financial instruments, is presented. As a case study, the tool is applied to Honduras. We conclude with some observations on the opportunities and limitations of vulnerability indicators, such as those employed in the CATSIM tool.

1 INTRODUCTION

The state, or government, plays a major role in reducing the long-term economic repercussions of disasters by repairing damaged infrastructure and providing financial assistance to households and businesses. If critical infrastructure is not repaired in a timely manner, there can be serious effects on the economy and the livelihoods of the population. The repair of public infrastructure, however, can be a significant drain on public budgets especially in developing and transition countries. In Poland, for example, public infrastructure damage from the 1997 floods amounted to 41% of the reported direct losses (Kunreuther and Linnerooth-Bayer, 2003). The Polish government absorbed close to half of these losses, which increased its budget deficit substantially. Governments of disaster-prone developing countries, for example, Honduras, the Philippines, Mexico and regions in China, face such large liabilities in repairing their critical infrastructure and providing subsistence to disaster victims that without international assistance they can be set back years in their development. After Hurricane Mitch devastated Honduras in 1998, GDP growth in the following year (despite the growth impetus from reconstruction) dropped from an estimated 3.3% to -1.9% (Mechler, 2004). Typically disasters affect government budgets by reducing tax revenue, increasing fiscal deficits and worsening trade balances (Otero and Marti, 1995). Governmental support of relief and reconstruction is critically important for economic recovery and ultimately preventing the long-term hidden deaths and suffering from disasters.

Especially in highly exposed developing countries, the state can be physically and financially vulnerable to natural disasters, what we refer to in this paper as *public sector financial vulnerability.* Developing country governments frequently lack the liquidity, even including international aid and loans, to fully repair damaged critical public infrastructure or provide sufficient support to households and businesses for their recovery. For example, following the 2001 earthquake in the state of Gujarat, India, funds for recovery from the central government and other sources fell far short of promises, and actual funding only covered around 30% of the state government's post-disaster reconstruction needs (World Bank, 2003**).** Gujarat, and other recent cases of government post-disaster liquidity crises, have sounded an alarm, prompting financial development organizations, such as the World Bank, among others, to call for greater attention to reducing financial vulnerability and increasing the resilience of the public sector (Pollner, 2001; Gurenko, 2004). In this context, *resilience* refers to the capacity of a social system to absorb economic disturbance and reorganize, or to "bounce back" so as to retain essentially the same function, structure and identity (Walker, et al. 2002).

This paper addresses the financial vulnerability of developing country governments to disasters of natural origin, and examines pre-disaster (ex ante) financial measures for increasing the coping capacity and resilience of the public sector. In the next section, a framework of public sector financial vulnerability and its components of economic risk and financial resilience are discussed, along with measurable indicators of these concepts. The IIASA CATSIM tool, which is an interactive tool for building capacity of policy makers to assess and reduce public sector financial vulnerability, builds on these indicators and is discussed in Section 3. As a case study, the tool is applied to Honduras in Section 4. We conclude with some observations on the opportunities and limitations of vulnerability indicators, such as those employed in the CATSIM tool.

2 PUBLIC SECTOR FINANCIAL VULNERABILITY

Turner, et al (2003) define vulnerability as the degree to which a system or subsystem is likely to experience harm due to exposure to a hazard, either as a perturbation or stressor. Some communities suffer less harm than others from hurricanes, fires, floods and other extreme events because they can mitigate the damage and recover more rapidly and completely. As a case in point, Bangladesh has become less physically vulnerable to cyclones. Over the past four decades deaths from cyclones in Bangladesh have decreased by two orders of magnitude as people have learned to respond to warnings and use storm shelters. Moreover, the people in Bangladesh may become less economically vulnerable to the long-term economic losses from cyclones and other disasters as affordable micro-insurance and other financial hedging instruments become available (Bayer and Mechler, 2005).

In the literature, work on economic vulnerability to external shocks (often of small island developing states) has focused on the structure of an economy (e.g. commodity-based versus high-technology), the prevailing economic conditions (e.g. degree of inflation, economic recession) and the general stage of technical, scientific, and economic development (Benson and Clay 2000). Economic vulnerability is assessed by a set or a composite index of indicators such as the degree of export dependence, lack of diversification, export concentration, export volatility, share of modern services and products in GDP, trade openness or simply GDP (Briguglio, 1995; Commonwealth Secretariat, 2000).

This paper focuses on the financial vulnerability of the public sector as a subset of economic vulnerability. Public sector financial vulnerability is defined as the degree to which a public authority or government is likely to experience a lack of funds for financing post-disaster reconstruction investment and relief. As illustrated in Figure 1, financial vulnerability depends on the asset risks the country is facing from natural hazards, which can be measured by the *hazard* frequency and intensity, the public and private capital *exposure* and the *sensitivity* of the public and private assets to the hazard.

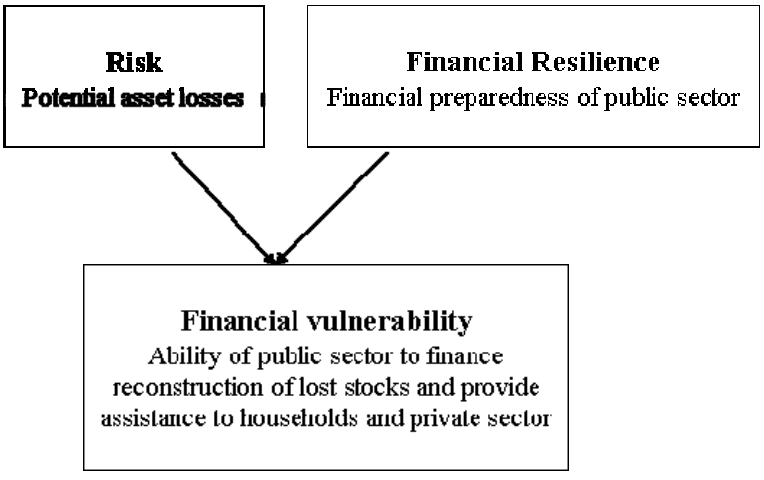

Fig. 1: Public sector financial vulnerability to natural hazards

A second important component of public sector financial vulnerability is the *resilience* or financial capacity of the public authorities to cope with the losses. This can be measured by the available financial resources for meeting unexpected liabilities of the public

sector. If the government has sufficient reserves or insurance cover to finance its post-disaster liabilities, or can easily raise capital through its budget or borrowing, then it is financially resilient to the disaster shock. However, if the asset risks are high and the government cannot cover the anticipated losses, then a *financing gap* may occur. The potential for a financing gap is an indicator of financial vulnerability. The term financing gap has been coined in the economic growth modeling literature as the difference between required investments in an economy and the actual available resources. The main policy recommendation consequently has been to fill this gap with foreign aid (Easterly, 1999).[1] In this report, this tradition is followed and the financing gap is understood as the lack of financial resources to restore assets lost due to natural disasters and continue with development as planned.

An assessment of public sector financial vulnerability, or the potential financing gap therefore considers the following two questions:

- Given the country's current exposure to hazards and changes in future conditions, what are the government's capital asset *risks* over the planning period?
- Given the government's financial situation and history of external assistance, is it financially *resilient* to these disasters in the sense of being able to access sufficient post-disaster funding opportunities to cope with losses and liabilities?

The risk of direct economic losses and financial resilience are thus essential concepts for addressing public sector financial vulnerability to natural disasters. Public policy measures can focus on reducing risks by reducing asset exposure, e.g., with structural measures or land-use planning, or by reducing the sensitivity of structures, e.g., by seismically retrofitting the public infrastructure. In addition, policies can improve the resilience of the private or public sectors, e.g., by developing appropriate systems for insuring or transferring the risks. To reduce their financial vulnerability, public authorities can consider investing both in risk reduction as well as financial instruments for assuring financial resilience. In what follows, we discuss these concepts with reference to how they can be assessed and measured.

Direct asset risk: hazard, exposure and sensitivity

Risk is generally defined as the probability and magnitude of an adverse outcome, and includes the uncertainty over its occurrence, timing, and consequences (Covello and Merkhofer, 1993). Risks of extreme events can be characterized by the frequency and intensity of the events, as well as the exposure and sensitivity of physical assets. A common measure is the probabilistic loss exceedance curve, which indicates the probability of certain losses exceeding a certain amount, eg. there is a 1% probability (called a 100 year event) that losses may exceed 1 billion US$.

Financial Resilience

Originating in the field of ecology, a key concept in vulnerability research is *resilience*, which refers to the capacity of a system to absorb disturbances and reorganize so as "bounce back" to essentially the same function and structure (Walker, et al. 2002). A resilient ecosystem can withstand shocks and rebuild itself when necessary. Similarly, a

[1] This approach has been criticized among others by Easterley (1999) as generally lacking to account for the role of incentives and institutions in economic growth. Nevertheless, it is without doubt that capital investment plays an important role in economic growth.

resilient social system, in our case the public sector, can absorb shocks and rebuild the economy such that the country or region stays on a similar economic trajectory. Systems with high resiliency are able to re-configure themselves without significant declines in crucial functions in relation to primary productivity and economic prosperity. Resilience in social systems has the added capacity of humans to anticipate and plan for the future.

Because of the role of the public sector in financing reconstruction, financial preparedness is essential for countries or regions to "bounce back" from major shocks. The preparedness of the public authorities for financing disasters depends on their access to capital after a disaster, which, in turn, depends on, among other fiscal indicators, the government's tax base, budget deficit, and internal and external debt. In addition, regional governments of developing countries rely extensively on national and international loans and aid. Despite often generous international support, developing countries often encounter shortfalls in financing reconstruction and relief post-disaster. One example mentioned above is the earthquake of 2001 in the state of Gujarat in India, where planned funding from government relief funds, bi-and multilateral sources and budget diversions would have exceeded planned expenditure; however actual funding disbursed amounted to only 32% of the planned amount (World Bank, 2003). As shown in Figure 2, the Gujarat government experienced a severe *financing gap* with regard to the planned expenditures for repairing the housing stock and public infrastructure as well as providing relief to the affected population.

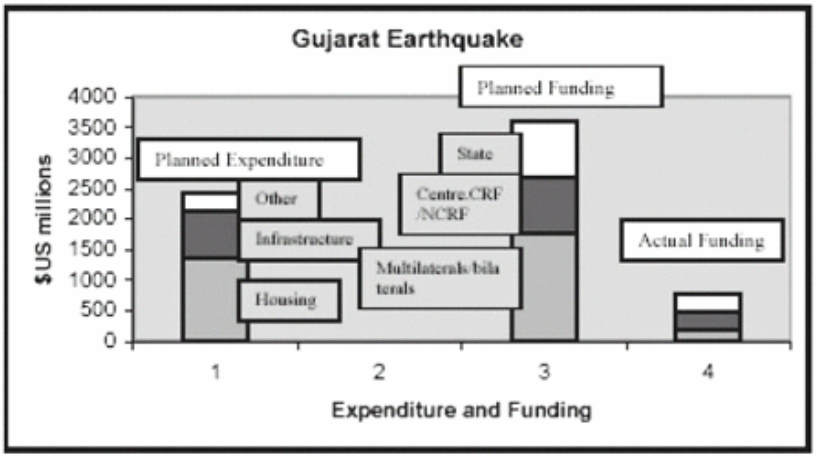

Fig. 2: Financing gap in India after Gujarat earthquake
Source: World Bank 2003: 22.

Financial preparedness can be enhanced with pre-disaster planning. The public authorities can set aside reserves in a catastrophe fund (such funds exist in India), or, alternatively, they can purchase instruments that transfer their risk to a third party. Insurance is the most common pre-disaster instrument, but recently other types of novel risk-transfer instruments have emerged. These instruments and their costs will be discussed in more detail in the next section. The important message is that pre-disaster measures exist to improve sovereign financial resilience for highly exposed countries. Given that these measures are costly, it is important to ask what countries need them (what countries are financially vulnerable?) and what are their costs and benefits? These questions are addressed by the CATSIM model as described in the following section.

3 ASSESSING FINANCIAL VULNERABILITY WITH THE CATSIM TOOL

The experience of India and many other disaster-prone developing countries raises the question of how policy makers can reduce public sector financial vulnerability. The IIASA CATSIM tool was developed to provide insights on this question (for a detailed discussion of CATSIM see Hochrainer et al., 2004; Freeman et al., 2002). CATSIM uses Monte Carlo simulation of disaster risks in a specified region and examines the ability of the government to finance relief and recovery. It is interactive in the sense that the user can change the parameters and test different assumptions about the hazards, exposure, sensitivity, general economic conditions and the government's ability to respond. CATSIM can provide an estimate of a country's or region's public sector financial vulnerability. As a capacity building tool, it can illustrate the tradeoffs and choices the authorities confront in increasing their resilience to the risks of catastrophic disasters.

The CATSIM methodology consists of five stages or modules as described below and illustrated in Figure 3.

Stage 1: The risk of direct asset losses expressed in terms of their probability of occurrence and destruction in monetary terms is modeled as a function of hazard (frequency and intensity), the elements exposed to those hazards and their physical sensitivity.

Stage 2: The financial preparedness of the public sector to the direct losses is assessed. Financial preparedness is a measure of financial resilience and can be defined as the accesss of the state or central government to funds for financing reconstruction of public infrastructure and the provision of relief to households and the private sector. Financial preparedness will, in turn, depend on the general economic conditions of the country.

Stage 3: Financial vulnerability, measured in terms of the potential financing gap, is assessed by simulating the risks to public infrastructure and the financial resilience of the government to cover its post-disaster liabilities following disasters of different magnitudes.

Stage 4: The consequences of a financing gap on the macroeconomic development of the country are characterized with indicators, such as economic growth or the country's external debt situation. These indicators represent consequences to economic flows as compared to consequences to stocks addressed by the asset risk estimation in Stage 1.

Stage 5: Strategies are developed and illustrated that build financial resilience of the public sector. The development of risk financing strategies has to be understood as an adaptive process, where measures are continuously revised after their impact on reducing financial vulnerability and risk has been assessed within the modeling framework.

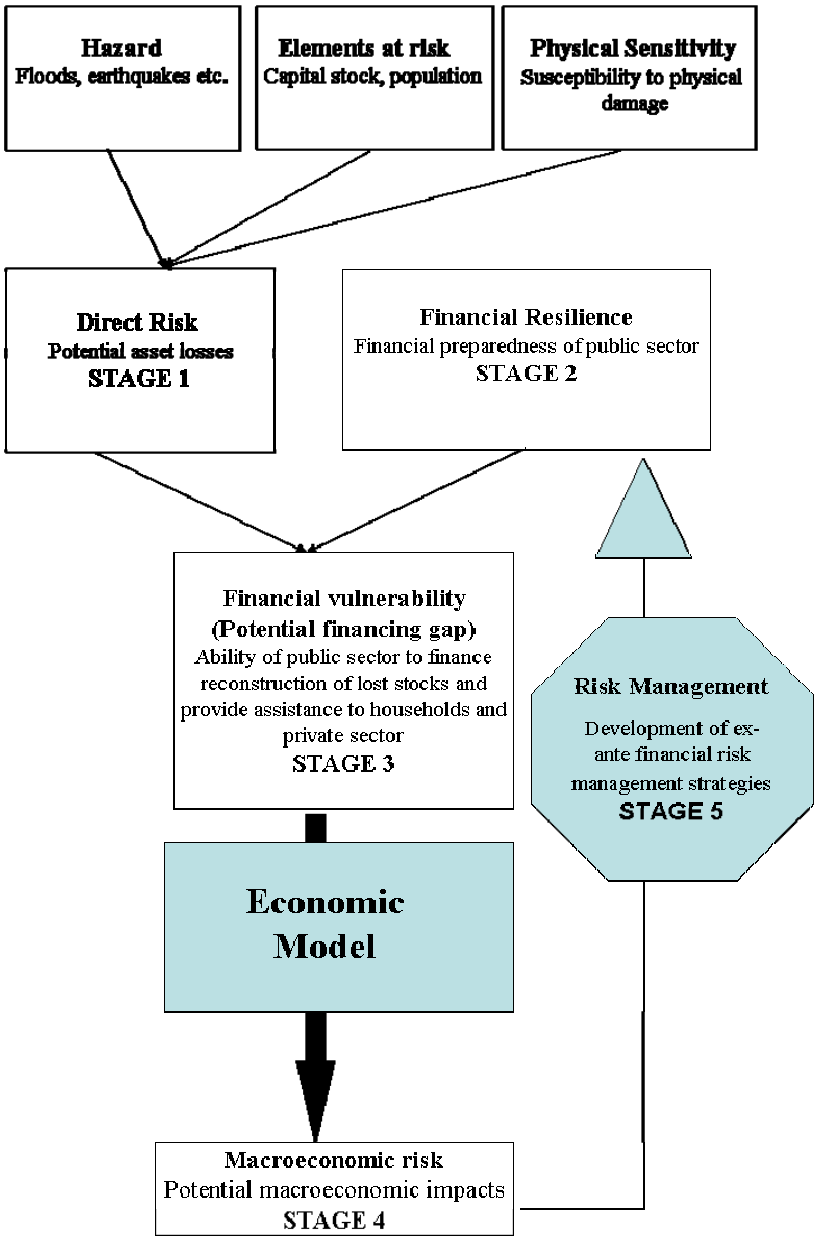

Fig. 3: Financial vulnerability and the CATSIM methodology

Stage 1: Assessing public sector risk

The stage 1 CATSIM module assesses the risk of direct losses in terms of the probability of asset losses in the relevant country or region. Consistent with general practices, risk is modeled as a function of hazard (frequency and intensity), the elements exposed to those hazards and their physical sensitivity (Burby, 1991; Swiss Re, 2000). [2] In more detail,

[2] In the hazards and risk community, "sensitivity" is referred to as "vulnerability", and often exposure is included in the sensitivity component; thus, risk is defined by hazard and vulnerability. In catastrophe models carried out for insurance purposes, the contract specifications of the underwritten and exposed portfolios are added as a fourth component (eg. Swiss Re, 2000).

- Natural hazards, such as earthquakes, hurricanes, or floods, are described by their intensity (eg. peak flows for floods) and recurrency (such as a 1 in 100 year events ie. with a probability of 1%).
- Exposure of elements at risk: Total private and public capital stock is estimated.
- Physical sensitivity describes the degree of damage to the capital stock due to a natural hazard event. The method commonly used here are fragility curves setting the degree of damage in relation to the intensity of a hazard.

Based on data on the return period and losses in percent of capital stock, CATSIM generates loss frequency distributions describing the probability of specified losses occurring, such as a 100-year event causing a loss of 200 million USD of public assets, a 50-year event causing a 40 million USD loss, and so on.[3] It should be kept in mind that top-down estimates at this broad scale are necessarily rough. Since most disasters are rare events, there is often little in terms of historical data; furthermore it is difficult to include dynamic changes in the system, for example, population and capital movements and climate change.

Stage 2: Assessing public sector financial resilience

Based on the information on direct risks to the government portfolio, financial resilience can be evaluated by assessing the government's ability to finance its obligations for the specified disaster scenarios. Financial resilience is directly affected by the general conditions prevailing in an economy, i.e., changes in tax revenue have important implications on a country's financial capacity to deal with disaster losses.

The specific question underlying the CATSIM tool is whether a government is financially prepared to repair damaged infrastructure and provide adequate relief and support to the private sector for the estimated damages of 10- 50- 100- and 1000-year events? For this assessment, it is necessary to examine the government's sources, both sources that will be relied on (probably in an ad hoc manner) after the disaster and sources put into place before the disaster (ex ante financing). These sources are described below.

Ex post financing sources

The government can raise funds *after* a disaster by accessing international assistance, diverting funds from other budget items, imposing or raising taxes, taking a credit from the Central Bank (which either prints money or depletes its foreign currency reserves), borrowing by issuing domestic bonds, borrowing from the IFIs and issuing bonds on the international market (Benson, 1997; Fisher and Easterley, 1990). Each of these financing sources can be characterized by costs to the government as well as factors that constrain its availability, which are assessed by this CATSIM module. Sources not considered feasible are not included in the module.

As shown in Table 1, ex post financing can be constrained. As an example, disaster taxes are expensive to administer and generally not part of the public sector financing portfolio. As a second example, borrowing can also be constrained by the existing country debt., CATSIM assumes that the sum of all loans cannot exceed the so-called *credit buffer* for the country. In the Highly Indebted Poor Countries Initiative (HIPC) the credit buffer is defined as 150% of the typical export value of this country minus the present value of existing loans (HIPC, 2002). These ex post instruments have (sometimes high) associated

[3] It is standard practice to refer to 20-, 50-, 100-, 500- and 1000-year events.

costs; even budgetary diversions have associated opportunity costs in terms of other government investments like building highways or schools.

Table 1: Ex Post Financing sources for relief and reconstruction

Type	Source	Considered in model
Decreasing government expenditures	Diversion from budget	X
Raising government revenues	Taxation	-
Deficit financing *Domestic*	Central Bank credit	-
	Foreign reserves	-
	Domestic bonds and credit	X
Deficit financing *External*	Multilateral borrowing	X
	International borrowing	X
	Aid	X

Ex ante financing sources

In addition to accessing ex post sources, a government can arrange for financing before a disaster occurs. Ex ante financing options include reserve funds, traditional insurance instruments (public or private), alternative insurance instruments, such as catastrophe bonds, or arranging a contingent credit. The government can create a reserve fund, which accumulates in years without catastrophes. In the case of an event, the accumulated funds can be used to finance reconstruction and relief. A catastrophe bond (cat bond) is an instrument whereby the investor receives an above-market return when a specific catastrophe does not occur, but shares the insurer's or government's losses by sacrificing interest or principal following the event. Contingent credit arrangements call for the payment of a fee for the option of securing a loan with pre-arranged conditions after a disaster. Insurance and other risk-transfer arrangements provide indemnification against losses in exchange for a premium payment. Risk is transferred from an individual to a (large) pool of risks. These ex-ante options can involve substantial annual payments and opportunity costs; statistically the purchasing government will pay more with a hedging instrument than if it absorbs the loss directly.

Given the costs, many developing country governments are asking whether public sector insurance is desirable for improving financial preparedness? According to an early discussion by Arrow and Lind (1970) governments should generally not purchase insurance. Due to the large number of public assets in different locations, the government is sufficiently diversified, and post-disaster expenses can be spread over a large base of taxpayers. This means that the public authorities are not risk averse and therefore do not need to purchase insurance or other financial hedging instruments. Disaster risks and other stochastic shocks to public budgets can thus be ignored in public planning and budgeting decisions. Recent research undertaken by IIASA, however, has shown that the Arrow-Lind theorem does not hold for hazard-prone developing countries if they are facing high risks, if the pool of publicly owned assets is too narrow for sufficient diversification, and if they cannot raise sufficient funds after a disaster to finance the recovery process (Freeman et al., 2002a; Mechler, 2004). Whether insurance is desirable for a developing country government will thus depend on the government's financial vulnerability and the cost of insurance instruments compared to the cost of other financing options.

The government's portfolio of ex ante and ex post financial measures is critically important for the recovery of the economy should a disaster occur. For this reason, an assessment of the government's asset risk and financial resilience is an essential part of disaster risk management. An IIASA study has carried out such an assessment for four highly at-risk Latin American countries: Bolivia, Colombia, the Dominican Republic and El Salvador (Freeman et al., 2002b). The study revealed differences in their financial preparedness for disasters. At the time of the study, none of the four countries had ex ante instruments in place, like reserve funds or insurance. Yet, Bolivia and Colombia were better prepared than the Dominican Republic and El Salvador to meet their liabilities. The reason was that they could more readily divert funds within their current budget. Colombia, alternatively, was far more constrained with respect to other ex post options, such as borrowing domestically and internationally. These indicators of financial resilience can be combined with the risk each country is facing to yield an indicator of potential financial vulnerability. The results are discussed below.

Stage 3: Measuring financial vulnerability by the "financing gap"

Comparing available financing with the government's post-disaster financial obligations yields an estimation of the potential *financing gap.* In the IIASA study, the potential financing gap for Bolivia, Colombia, the Dominican Republic and El Salvador was assessed for a range of probabilistic disaster losses. Figure 4 illustrates this gap only for the 100-year event in each country. In this figure, financing sources available to the governments of the four countries are compared with the governments' potential financial obligations calculated for the 100-year disaster. The shortfall between financial sources and obligations is the financing gap.

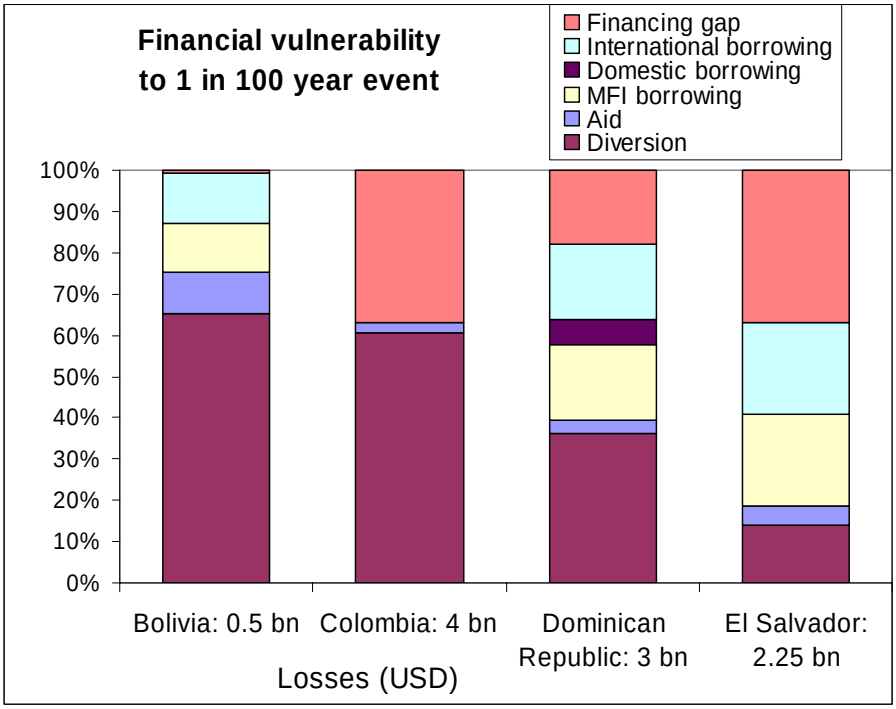

Fig. 4: Financial vulnerability to 100 year event in four Latin American countries

Estimates show, for example, that the losses to the Bolivian government due to a 100 year event would have amounted to 500 million USD (from damaged public infrastructure and

obligations for relief). If this event had occurred in the 2002 budget period, Bolivia could have financed all but about one percent of its obligations by accessing the following: international and domestic capital markets, support from international financial institutions, international donor aid, and, most importantly, diversions from its domestic budget. Colombia, the Dominican Republic and El Salvador can expect far larger financing gaps mainly because of less slack in their domestic budgets. Because of their lack of resilience and the risks they are facing, in 2002 these governments were highly financially vulnerable to the 100- year disaster event.

Stage 4: Illustrating the developmental consequences of a financing gap

Financial vulnerability can have serious repercussions on the national or regional economy and the population. If the government cannot replace or repair damaged infrastructure, for example, roads and hospitals, nor provide assistance to those in need after a disaster, this will have long-term consequences. The consequences on long-term economic development can be illustrated by the CATSIM tool. For example, Figure 5 shows the results of the simulations of growth paths in El Salvador with and without the purchase of insurance for public assets as an ex ante financial tool.

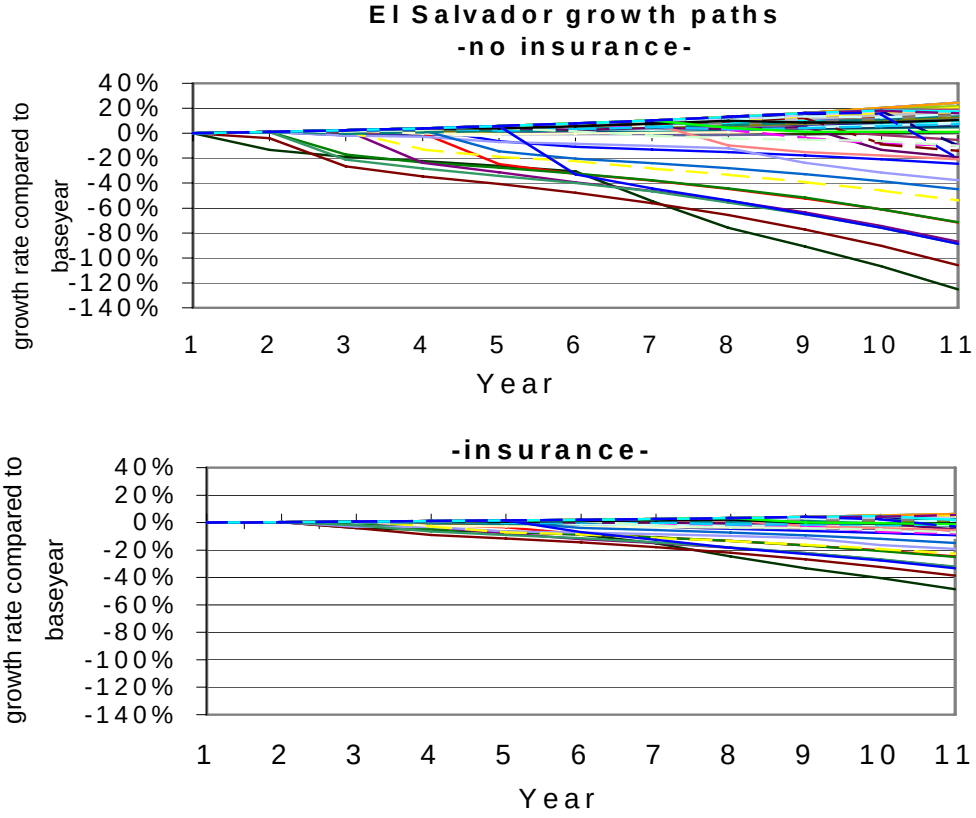

Fig. 5: Simulated growth vs. stability for El Salvador over a 10-year time horizon

As seen on this Figure, El Salvador is expected to grow over time (with the current year as the base year) as investment adds to the capital stock. However, the country can experience disasters, which can be thought of as stochastic shocks to the growth trajectory. CATSIM simulates 5,000 trajectories, although in this Figure only 100 are summarized for illustrative purposes. The trajectories do not have equal probability. The trajectories in the upper part of the Figure, which show economic growth proceeding in

the absence of shocks, have a higher probability of occurrence than the catastrophic cases in the bottom of the Figure. Economic growth in El Salvador is higher on average if the government does not allocate its resources to catastrophe insurance (upper figure), but the economy has fewer extremes and is more stable with public sector insurance (lower figure). Investing in the risk financing instruments can thus be viewed as a trade-off between economic growth and stability. Budgetary resources allocated to catastrophe reserve funds, insurance and contingent credit (as well as to preventive loss-reduction measures) reduce the potential financing gap, and thus can ensure a more stable development path. On the other hand, ex ante financing and prevention measures come at a price in terms of other investments foregone and will inevitably have an adverse impact on the growth path of an economy. The IIASA model assesses this trade-off by comparing the costs of selected ex-ante measures with their benefits in terms of decreasing of the possibility of encountering a financing gap.

Stage 5: Reducing financial vulnerability and building resilience

Vulnerability and resilience must be understood as dynamic. In contrast to ecological systems, social systems can learn, manage and actively influence their situation. There are two types of policy interventions for reducing public sector financial vulnerability: those that reduce the risks of disasters by reducing exposure and sensitivity and those that build financial resilience of the responding agencies. Based on an assessment of the financing gap and potential economic consequences, CATSIM illustrates the pros and cons of strategies for building financial resilience using ex-ante financial instruments. Four ex ante financing policy measures are currently considered in the CATSIM tool: insurance, contingent credit, reserve funds and cat bonds. Also, one generic option for loss reduction measures has been implemented in the model in order to analyze the linkage with risk financing. More detail on the model can be found in Hochrainer et al., 2002.

4 THE CASE OF HONDURAS

Honduras offers an illustrative case of a country with a potential financing gap. Over the last decade Honduras has experienced a number of hurricanes and other weather disasters. With over half of its 6.5 million people living in poverty, Honduras is socially and economically vulnerable to extremes in weather. Recent IIASA studies examined the conditions under which the government can expect to be short of funds to finance disaster relief and reconstruction and the effectiveness of ex-ante financial measures for building financial resilience (Mechler and Pflug, 2002; Mechler, 2004). Relying on historical data the CATSIM simulation tool provided insights on the overall risks of flood and storm events in the country, and the ensuing liabilities for the government. The analysis looked closely at the capacity for the government to raise funds through borrowing, raising taxes and diverting from other budgeted items. In addition, they examined the likely availability of external aid and assistance. As shown in Figure 6, the main hazards in Honduras are hurricanes and other windstorms originating from the northern coast causing flooding and landslides.

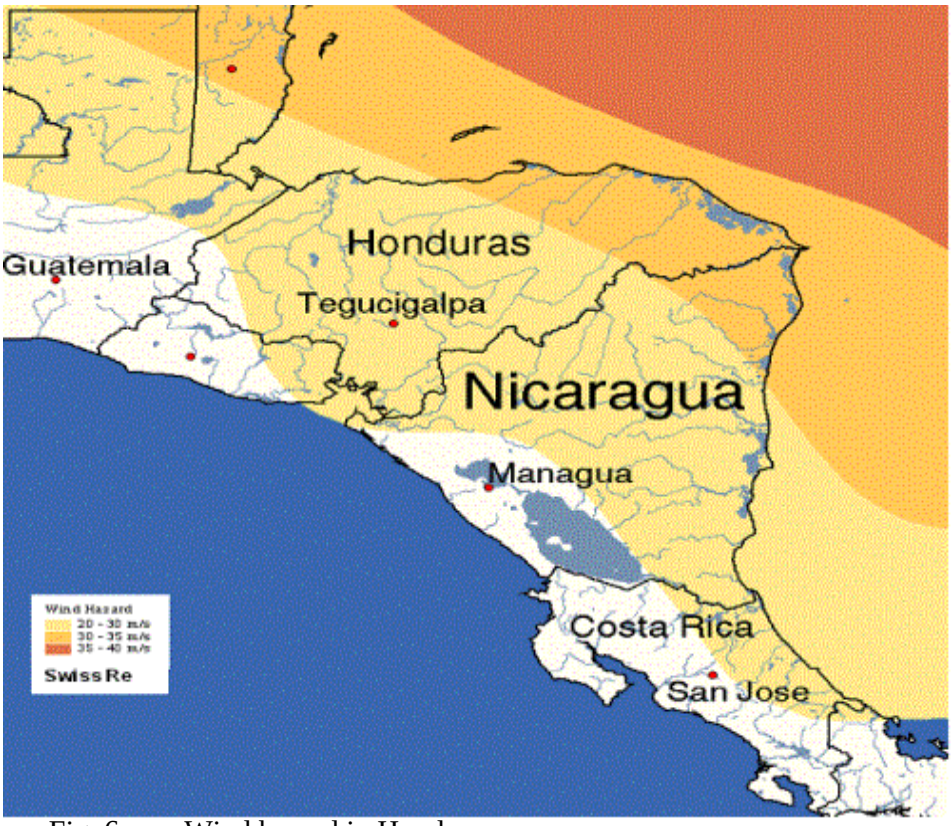

Fig. 6: Wind hazard in Honduras
Source: Swiss Re in Freeman et al. 2002a

Information on the intensity and frequency of hazards as well as the sensitivity of the exposed assets to these hazards was obtained from Swiss Re. Capital stock was estimated at 13.9 billion USD for 2004. It was assumed that about 30% of capital stock is public and that government will finance another 20% of total capital losses due to its political commitment of relief to private victims after disasters (Freeman et al., 2002b). These assumptions are consistent with country data and past experience.

Based on this information direct asset losses were estimated. Figure 7 shows a screen shot of the CATSIM model illustrating the cumulative loss exceedance curve for public sector assets plus anticipated relief to the private sector in 2004.

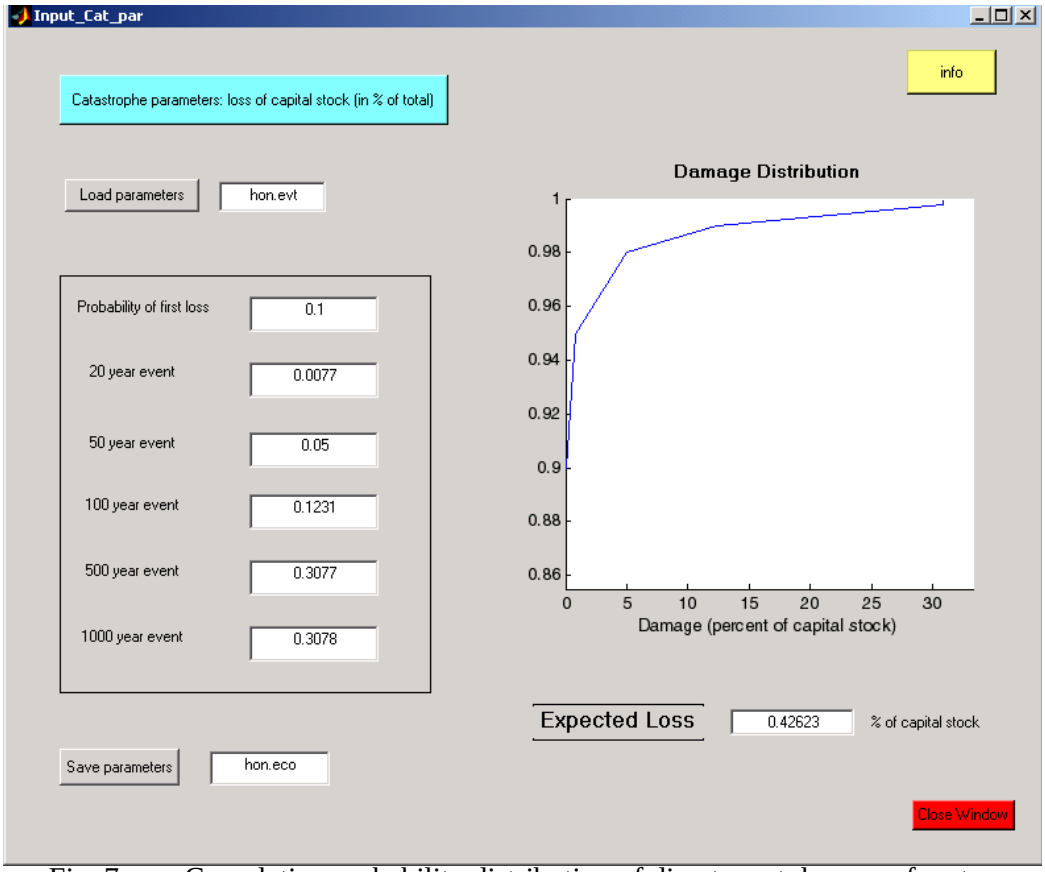

Fig. 7: Cumulative probability distribution of direct asset damages for storm and flood for Honduras

As shown on Figure 7, for very rare storm and flood events (once in 1000 years) the capital stock losses could approach 30 percent of the total capital stock in Honduras. Lower frequency events, for example, the 100-year storm and flood, is estimated to destroy around 12% of total capital stock. The expected losses due to storm and flood risk are 0.43%

Figure 8 displays the CATSIM screen shot illustrating the financial vulnerability of the Honduran government to floods and storms. As shown in this Figure, the government can (in 2002) can depend on traditional sources to finance the losses from moderate flood and storm disasters (with a recurrence period of less than about 100 years) and thus should not consider any form of risk transfer covering these events. But for very rare, high-consequence events – one-in-109 years or worse – there is a sizable financing gap. This means that Honduras will not be able to provide sufficient relief to private victims nor repair its infrastructure in a timely way, which can set Honduras back significantly in its economic development.

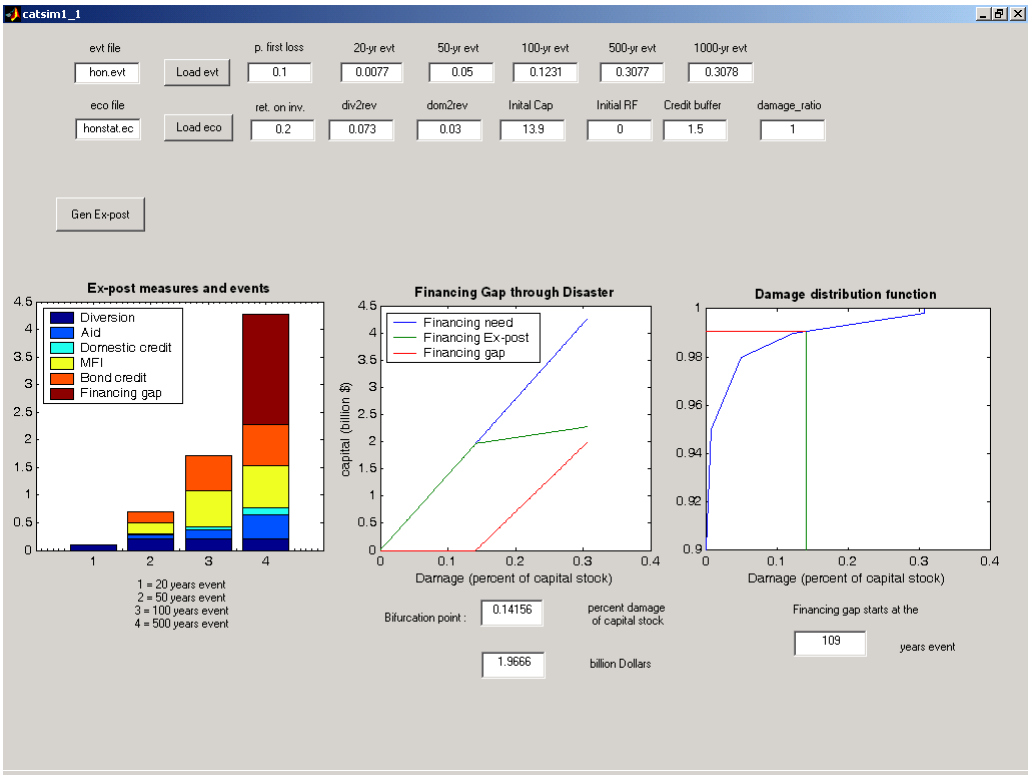

Fig. 8: Assessing financial vulnerability to storm and flood risk in Honduras

Based on an assessment of financial vulnerability and its economic consequences, a case for increasing financial resilience using ex ante instruments may be justified. The IIASA CATSIM model illustrates the cost efficiency and economic consequences of selected ex ante instruments, including their consequences on public sector indebtedness and economic growth. More details on the development and illustration of ex ante risk financing strategies can be found in Hochrainer et al. (2004).

5 BEYOND INDICATORS: BUILDING CAPACITY FOR VULNERABILITY REDUCTION

Financial vulnerability of the public sector represents only one aspect, albeit an import one, of vulnerability to natural hazards. Other indicators are necessary to give a more complete picture of vulnerability. For example Cardona et al. for the *Information and Indicators Program for Disaster Risk Management* of IADB, ECLAC and IDEA have complemented the IIASA methodology of financial vulnerability (termed *disaster deficit index* in their report*)* with other vulnerability indicators, such as the *Prevalent Vulnerability Index* that accounts for social vulnerability in terms of exposure in hazard-prone areas, socio-economic fragility and social resilience (Inter-American Development Bank, 2005).

These and other indicators of vulnerability generally rely on quantitative indicators and thus communicate a degree of objectivity, which can be misleading if not handled with great care. Since the numbers often rely on incomplete data and numerous assumptions, there can be large uncertainties and subjective choices. Because of these uncertainties and subjective judgments, indicators may work best if they are created and applied within a participatory approach that includes the key stakeholders (Morse 2004).

CATSIM has been created as a participatory, interactive tool for building capacity of policy makers by sensitizing them to the tradeoffs inherent in planning for disasters. By means of a graphical user interface the user can explore financing issues in the probabilistic context of natural disasters, can change important parameters, and test the sensitivity of outcomes to those changes. In addition, the user is cautioned that the model does not yield "optimal" strategies, but gives insights on the pros and cons of different policy options.

The model underlying CATSIM was originally developed for the Regional Policy Dialogue of the Inter-American Development Bank, where it was applied to Latin American case studies (Freeman et al., 2002b). Based on this model, the CATSIM simulation tool was designed and successfully employed for informing economists, financial experts and policy makers in stakeholder workshops, who are interested in taking account of disaster risk in public finance theory and practice on the financial management of disaster risk. A first multi-country workshop sponsored by the ProVention Consortium and the World Bank was held at IIASA in 2004 with participants from Mexico, Colombia, Turkey, India and the Philippines. Several follow-up efforts are underway and more national or regional workshops are envisaged.

IIASA will continue developing and extending the CATSIM modeling framework. Work is underway to improve the evaluation of mixed ex ante and ex post financial instruments and to make the model more dynamic by taking account of future changes in the risks (including climate change) and financing capacity. Furthermore, the representation of the private sector and its vulnerability to natural hazards needs to be modelled more explicitly. The tool will be tested further in participatory stakeholder workshops involving policymakers intent upon reducing the vulnerability of their country or region to the long-term consequences of natural disasters.

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