1 Introduction

In connection with this conference, two general case studies were prepared to highlight the general issues associated with catastrophe risk management by developing countries---Mexico and Turkey. This case study discusses Mexico. It characterizes the nature of natural catastrophe risks in Mexico, current risk reduction and risk financing strategies and the government role in risk transfer.

Over the past two years, the World Bank has worked with the Mexican government to develop an efficient strategy for coping with Mexico's risk of loss from natural catastrophes. In 1999, the World Bank published Managing Catastrophe Risk in Mexico: Market Incentives for Mitigation Investment (Kreimer et al. 1999). Much of the material in this case study comes from this publication. Additional information is drawn from a recent report t on natural disaster risk management in Mexico (Freeman 2000) and another report on the country prepared by Guy Carpenter and EQECAT 2000.

As indicated below, Mexico has an active program to handle natural disaster risk. It provides a good template to examine the issues for countries with high catastrophe exposure and a strong economic base It also represents a country that has centralized its risk financing at the federal government level. In contrast to the United States which has relied on a series of programs administered at both the federal and state level to respond to disasters, Mexico handles both its own risk of loss and the risk it assumes on behalf of others through one unified program, the Fund for Natural Disasters (FONDEN).

2 Nature of Mexican Natural Catastrophe Risk

Mexico has a high exposure to earthquakes, tropical storms and hurricanes, floods, volcanoes and forest fires. Since 1980, disasters from these perils have caused tens of thousands of casualties and aggregated direct damages of approximately $US 11 billion. Since 1980, there have been tens of thousands of casualties and aggregated direct damages of approximately USD 11 billion.

Much risk identification work has been done for Mexico mainly by the National Water Commission, the National Center for Disaster Prevention (CENAPRED) and units of the National Autonomous University of Mexico. Risk atlases identify vulnerable areas within cities. Recently, a comprehensive analysis of vulnerability of Mexico has been prepared (Guy Carpenter/EQECAT 2000).

Earthquakes

Mexico is a seismically active country. Between 1900 and 1998 Mexico experienced 84 major earthquakes, measuring more than 7.0 on the Richter scale. The major earthquakes of 1908, 1909, 1911, 1987, and 1988 occurred in the northeast section of Mexico. In September 1985, an earthquake shook Mexico City that took 6000 lives

and caused direct damages of more than USD 4 billion. This was the most destructive event in the hemisphere at the time it happened.

Tropical Storms and Hurricanes

Mexico is one of the countries most severely affected by tropical storms. Two independent cyclone regions impact it: the North Atlantic and the North Pacific. Between 1980 and 1998 Mexico suffered 43 weather related disaster events. In the most exposed regions, as much as 40% of the population lives along the coast. Hurricanes can be devastating. In 1997 Hurricane Pauline claimed hundreds of lives, caused flooding and landslides, and cut electricity, communications and water. Acapulco was badly hit when homes in squatter settlements on hillsides without enforceable building codes were destroyed.

Volcanoes

Mexico has dozen of volcanoes, 14 of which have erupted in recent history. The most recent volcanic eruption that resulted in catastrophic losses occurred was el Chichon in 1982. The eruption destroyed eight communities and claimed 2,000 lives.

Floods

Flooding caused by rivers overflowing their banks occurs every year in Mexico. The loss from flooding is high. Between 1973 and 1990 more than 1800 flooding victims have died, and economic losses are more than USD 7.7 billion.

Forest Fires

Mexico experiences forest fires every year. Damage from forest fires was particularly severe in 1998, when about 850,000 hectares were destroyed. Major causes for fires are slash and burn agriculture, whereas natural causes are only a minor influence (e.g. in 1998 only three percent of fires were triggered by natural causes).

3 Current Risk Reduction Strategies

The Mexican government established the National Civil Protection System (SINAPROC) in 1986 as the main mechanism for interagency coordination of disaster efforts. SINAPROC serves as a basis for coordinating emergency preparedness and response activities at the federal and subnational levels. Its task is to mitigate the loss of lives and material and the interruption of essential functions caused by disasters.

In 1990 the National Council for Civil Protection was added to SINAPROC. The council is an advisory, planning and coordinating committee for civil protection. It is headed by the President of Mexico and made up of 12 ministers and the mayor of the federal district of Mexico City. At the subnational levels, governors of states and

presidents of municipalities are responsible for implementing and coordinating local civil protection systems.

SINAPROC's Program for Civil Protection 1995-2000 is set up as a national regulatory and operational instrument. The program defines the prevention and response action required to deal with natural disasters. Efforts for longer-term risk reduction coordinated by SINAPROC include:

a. establishing scientific advisory committees to aid monitoring and decision making processes by the government;
b. creating standards of civil works;
c. engineering work to revise the seismic design standards and implementation of training programs;
d. retrofitting of schools to make them earthquake resistant; and
e. creating a certification program for hospitals that meet disaster readiness standards.

4 Current Risk Financing Strategies

Private Insurance

As with many developing countries, Mexico has a highly stratified insurance market: the property and casualty insurance market is underdeveloped and only a small and restricted segment is insured. The country's major corporate and national public sector assets employ world standard risk management methodologies to evaluate risk reduction and transfer options. About 90 percent of the industrial enterprises and 50 percent of commercial enterprises are insured. This contrasts with the small business and private property sector, where only about 2 percent of the market has insurance. At the household level, estimates based on 1998 data indicate that only 1.8 percent of the 8.3 million households that are insurable actually have coverage.

The limited demand for insurance is related to a lack of awareness and understanding of insurance, the belief in government help post-disaster, low income levels and the high price of insurance in many hazard prone regions which again is influenced by low insurance demand. Insuring a house in Mexico City worth USD 20,000 would cost about USD 100 a year - about 3% of the average Mexican's annual income.

Mexican law requires that the public sector insure its assets. The public sector accounts for about a third of all property insurance premiums in Mexico. Federally owned property seems to be adequately insured. State and municipal governments seem to be insured on an ad-hoc basis and their coverage may be insufficient; only 2 states have bought insurance for their assets at risk.

Fund for Natural Disasters

In 1996 the Fund for Natural Disasters (FONDEN) was created to meet the federal government obligations after natural disasters. FONDEN is last-resort source of federal financing for the reconstruction of public infrastructure, the restoration of protected areas, disaster relief for those in need and the purchase of emergency response equipment. FONDEN provides reconstruction funds directly to federal agencies and to state and municipal governments, who are required to provide some matching federal funds. In addition to FONDEN, all federal public entities are required to purchase insurance for their property and buildings. An issue investigated currently is whether FONDEN should buy reinsurance to protect itself from catastrophe losses to infrastructure from hurricanes, floods and earthquakes. .

FONDEN is currently funded at USD 1 billion a year. In every fiscal year from 1997-1999, the level of funding for FONDEN was inadequate. From the period 1996-1999, 70% of FONDEN's budget funded losses from heavy rains and hurricanes, 19% for drought and freezing losses, and 10% to earthquakes. Fire accounted for 1% of FONDEN's payments.

5 Future Directions for Mexico

As mentioned earlier, the Mexican government has been actively pursuing options to improve its natural disaster risk management program. A number of recommendations exist on how to best improve the efficiency of Mexico's risk management efforts.

Risk Identification

Mexico has begun the process of creating a comprehensive, country-wide risk identification of its physical assets to damage by natural catastrophes. The exposures now being reviewed by the government include the federal, state and muncipial exposures to water systems, transportation systems, electric production and transmission facilities, urban infrastructure, schools, health care facilities, and housing. This risk identification process, based on catastrophe modeling, undertaken by Guy Carpenter/EQECAT commissioned by CENAPRED is an important first step.

Risk Mitigation

A comprehensive approach to encouraging disaster mitigation in Mexico has been proposed. Generally, disaster losses should be mitigated by educating the public, using regulatory measures for risky behavior and providing incentives for safe behavior. The starting point is a comprehensive reassessment of formal land use and building regulatory processes; a next step should be the integration of disaster risk management into urban planning. New approaches also need to be developed to contribute to public safety in the informal sector as well. Most mitigation decisions are made at the local level, policy makers must allocate resources to increasing capacity at the state and muncipial level.

As with many programs in developing countries, the key is finding adequate resources to address the different needs of the country. To date, the dedicated source of funding for natural disasters has been FONDEN. FONDEN lacks authorization to spend its resources on pre-disaster mitigation measures. It has been suggested that serious consideration be given to changing the mandate of FONDEN to include pre-disaster education and mitigation activities at the local level. (Kreimer et al. 1999). Subsequently, FONDEN financing for reconstruction post-disaster could be linked to pre-disaster loss reduction efforts, which would provide an incentive to undertake cost-effective mitigation measures.

Risk Transfer

Mexico currently relies on FONDEN to provide an annual budget allocation to fund post disaster reconstruction costs to government owned property. FONDEN is designed to pay for damages above the amount received from the mandatory insurance that all public buildings are required purchase. To date, funding of these damages has been the primary annual expenditure by FONDEN. The country is now actively pursuing alternatives through the use of private insurance and risk financing

Private Insurance

The willingness of the private market to provide catastrophe insurance is an important step in providing needed risk-shifting resources to large components of the Mexican economy. In Mexico, excess catastrophic reinsurance capacity is available and a potentially large distribution system exists. Beginning in 2000, Mexican opens its market to unconstrained competition. Consequently, the main constraints on the market are demand driven. In its current economic condition, it is hard to see a change in the current demand structure for insurance in Mexico. Rather, the government will continue to play a major role in providing post disaster resources for the population.

Risk Financing

Recently, a dialogue has emerged regarding the use of risk financing from external sources to more efficiently utilize the limited resources in FONDEN following natural disasters. Two strategies dominate risk financing: borrowing or risk-hedging. Borrowing permits the risk bearing entity to shift the time over which the cost of risk must be absorbed. Interest is paid to compensate for use of the borrowed funds. Borrowing may be arranged either before or after a disaster occur. Since borrowed funds used to pay for the cost of a natural disaster must be repaid, the borrower retains the full cost of risk. Borrowing entails accessing savings of another party at a cost. Governments may either access savings accumulated in their own country or access savings accumulated in other countries.

Risk hedging is the other risk financing option. Risk hedging involves the contractual transfer of a portion of risk from one to party to another for a fee. The party

transferring the risk receives value for having another assume a portion of his risk, and is therefore willing to pay something for risk transfer. The party assuming the risk will be worse off after assuming the risk and will not do so unless adequately compensated. Risk hedging will only occur if an acceptable price to both parties can be found.

One undeniable feature of catastrophe hedges is that they are expensive. Often, the cost of the hedges are 4 to 5 times greater than expected loss. This is due to high transaction costs, difficulties with assessing the risk, small markets and large variance of losses. Even catastrophe insurance is expensive, with reinsurers anticipating premiums amounts to be at least twice expected loss which among other factors is explained by the limited supply of risk-taking capital. The only economic agents willing to pay this type of cost to shift risk are those who are highly risk averse. Generally, governments are perceived as risk neutral. Consequently, they would not be logical customers for expensive risk-shifting financial options.

Inability of Developing Countries to Absorb Catastrophe Losses

The assumption that governments are risk neutral arises from the power of governments to tax. Since governments can shift risk to taxpayers, and this form of risk-shifting is highly efficient, governments generally disregard risk when making investment decisions. Rather, they assume that whatever risk they create will be efficiently spread through taxation. The assumption of government's status as the most efficient risk-shifter has been a mantra in the economics of developed countries for the past 40-50 years. Increasingly, the assumption is challenged for developing countries. Either because of the relative size of risk to the government's tax revenue base, or because of the inefficient tax system employed by many developing countries, risk of loss from catastrophes cannot be easily internally absorbed.

Instinctively, it is obvious that the theory that governments are always risk neutral does not apply to developing countries. In the past 20 years, 56 developing countries have needed to rely on external assistance from the World Bank to cope with their losses from natural disasters. If these countries could transfer their risk to their taxpayers at no cost, they would have not needed this assistance. This reliance on access to external resources is a clear indicator that the "standard" economic theory of the ability of governments to internally shift finance does not have application to developing countries.

Challenges Facing Mexico

As relates to Mexico, there are some revealing numbers. Mexico has traditionally relied on access to external resources to help in the event of major natural disasters. This reliance is a reflection of the high relative cost of disasters to gross domestic product as well as the inability to shift risk internally. Assuming an earthquake with USD 5.5 billion in damage (equivalent to the 1985 Mexico earthquake in 1997 dollars), the cost of the earthquake as a percentage of GDP would be 20 times greater in Mexico than in the United States (cf. table 1).

Table 1: Loss and availability of internal resources to shift loss for Mexico and USA

	Mexico	USA
GDP (millions)	401,000	7,834,000
GDP/per capita	4,253	29,267
Tax revenue/GDP (%)	9.8%	19.8%
Gross domestic savings/ GDP (%)	26.4%	16.0%
Net domestic credit/GDP (%)	24.1%	82.9%
Loss (Earthquake 1985, million)	5,500	5,500
Loss/capita	58.3	20.5
Loss/GDP	1.4%	0.07%
Loss/Tax revenue	14.0%	0.4%
Loss/ Gross Domestic Savings	5.2%	0.4%
Loss/Net domestic credit	5.7%	0.08%

All values in 1997 current USD.
Sources: World Development Indicators 1999, Inter American Development Bank, Munich Re 2000.

In addition, Mexico's ability to shift risk internally does not approach the ability of developed countries. Comparing the loss to the availability of the internal resources tax revenue, savings, and credit, this ability is substantially different for Mexico and the United States (cf. figure1).

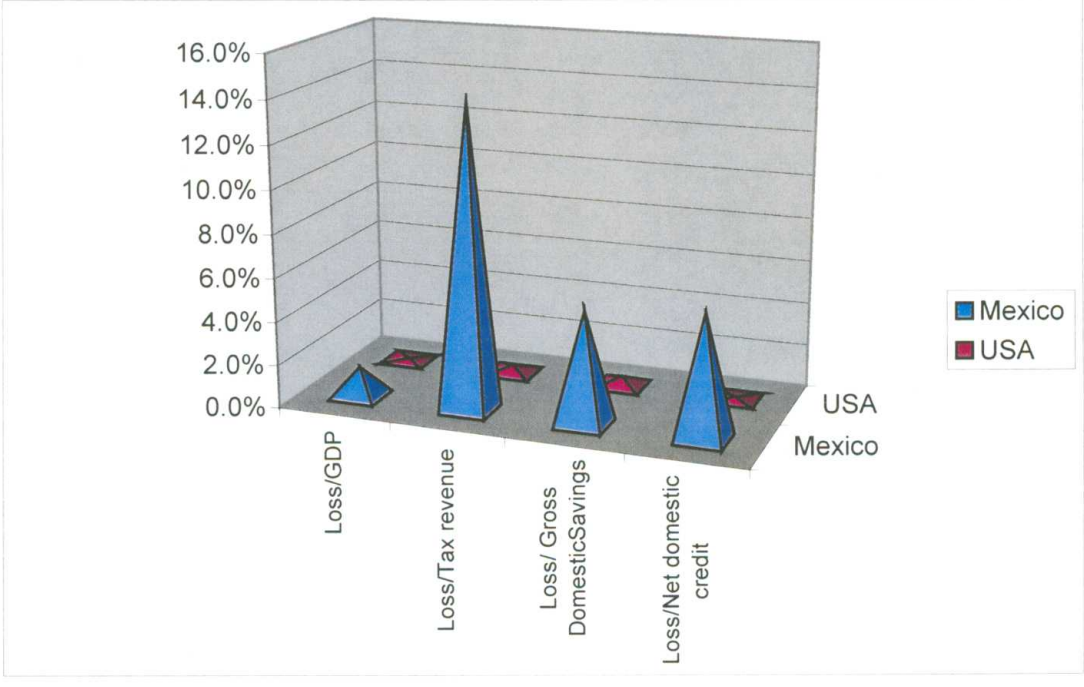

Figure 1: Internal risk shifting resources for Mexico and the USA

The most interesting figure is the size of loss relative to tax revenue. In Mexico, the loss the size of the 1985 earthquake in current dollars is equivalent to 14% of annual tax revenue. The same event is equivalent to .4% of United States tax revenue. As to the

other significant indicators, the loss compared to domestic savings and to net domestic credit, the relative cost to Mexico is 13 times and 70 times higher than to the United States. Clearly, the ability of Mexico to absorb a risk equivalent to 14% of tax revenue is limited. As it has done historically, Mexico must turn to external resources to finance its cost of natural hazard risk.

Should Mexico Purchase Hedges or Borrow Funds?

Currently, Mexico has relied first on FONDEN to pay for losses from natural disasters. In the event FONDEN has insufficient resources, it is likely that Mexico will need to rely on accessing external resources to finance reconstruction. As detailed by the consultants, an alternative for Mexico to access external resources is by purchasing a hedge. Hedges fall into two main categories, insurance hedges and capital market hedges.

How then is the decision process for Mexico to be framed between borrowing and hedging and between the different hedging options? Generally, the following factors influence this decision:

1. What is the total funding for natural disasters reasonably required by the government;
2. What is the capacity to raise needed funds from internal resources;
3. What is the cost of the different alternatives for accessing external resources;
4. How dependable is the availability of borrowing post disaster;
5. How quickly can the post disaster resources be made available by hedging or borrowing;
6. Do the proceeds from the hedge match up with the needs of the government after the disaster (basis risk);
7. How does the reliance on a borrowing post disaster impact other social programs that also rely on foreign borrowing?

While not exhaustive, this list begins to frame the decision process. Generally, borrowing is less expensive than hedging. With borrowing, both the availability and cost of borrowing may be impacted by a disaster. As a result, at the time the funds are most needed, they may not be available.

6 Lessons from the Case Study

Mexico is at the stage where it can weigh alternatives to its current risk financing strategies. It has developed sufficient information about its risk exposure, and understands it current risk management strategy. What is unknown is whether innovative proposals to hedge risk by the Mexican government make economic sense. In addressing this question, much more about the risk the government is willing to assume to respond to market failures, and the cost of its current risk financing strategies need to be better understood. Is Mexico risk averse? If so, what is its cost of financing risk? How does that

cost compare to other options available to the government? The unraveling of these issues will be crucial for Mexico and other developing countries dealing with similar problems.

As the case study describes, Mexico has an active program to handle natural disaster risk. It provides a good template to examine the issues for countries with high catastrophe exposure and a strong economic base. It also represents a country that focuses on its risk, and looks seriously at alternatives.

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