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FINANCIAL RESILIENCE TO HAZARDS AND CLIMATE FINANCE: A COMPREHENSIVE APPROACH OF TOOLS AND METHODS FOR DISASTER RISK FINANCE

Abstract: Disasters cause major impacts on the economic performance of developing countries and on the livelihoods of millions of poor people around the world. With economic development and growing investment, along with the growing risk of extreme weather events, disaster costs are projected to increase rapidly over the decades. An appropriate evaluation of the costs of a natural disaster is necessary to guide the plan for financial resilience. Dealing with the consequences requires a multidimensional approach. This chapter will offer a thorough analysis of financing sources in case of disasters, classifying them according the their approach, time frame and nature. Case studies have also been included to illustrate the use of different financial instruments in the developing and developed countries. Finally, a section on climate finance have been included, as an important topic in international public discussions.

Key words: disasters, climate change, financial resilience, developing countries, financial instruments, risk management.

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1. INTRODUCTION

Disasters have a major impact on the living conditions, economic performance and environmental assets and services of affected countries or regions. These have been principally conditioned by the increases in population and assets exposed to adverse natural events, a trend likely to worsen with growing urbanization, environmental degradation and expected increase in the number and intensity of hydro-meteorological events resulting from climate change [Ghesquiere F. and Mahul, O. 2010]. It is recognized that disasters can have widespread impacts, causing not only harm and damage to lives, buildings and infrastructure, but also impairing economic activity, with potential cascading and global effects. Consequences may be long term and may even irreversibly affect economic and social structures and the environment.

While disasters impact the macroeconomic indicators in any country they occur, their impact is much more serious in developing countries and emerging economies [Gurenko, E. and Lester, R. 2004]. This is due to many factors, including the infrastructure conditions, lower building standards, absent or poor incentives for mitigation, and underdevelopment of private markets which do not provide catastrophe insurance for homeowners and small businesses, and greater constraints on government resources available to cope with disasters. Although capital losses might be smaller in absolute terms when compared to those in developed countries, their relative weight and overall impact tend to be very significant, even affecting sustainability (Ghesquiere and Mahul, 2010.). Of the 40 worst catastrophes in terms of the number of victims in 1970-2001, 39 occurred in developing countries (Gurenko and Lester, 2004). A 2013 study states that disaster losses in developing nations amount to $862 billion, which is considered under-estimate (Kellett and Caravani, 2013). These devastating events affect millions of people around the world, destroying homes and livelihoods.

With countries facing more frequent and severe disasters and increasingly constrained public finances, the development of disaster risk management strategies has become indispensable for enhancing the resilience of societies against disasters and reducing their long-term social and economic costs. In addition, in these countries, often the mentality imposes a further burden to the implementation of disaster risk management practices. This includes the mentality of governments which often develop short run strategies corresponding to the election cycle, the mentality of the private sector which develop its activity focused on short term profit, without taking into account any damages imposed to the environment and infrastructure, and the mentality of the population which do not consider insurance as a risk protection technique (Lester, 2000; Gurenko and Lester, 2004; ECLAC, 2003).

This chapter will give a comprehensive overview of one component of disaster risk management, the one that deals with economic resilience to hazards. The first part of the paper will focus on the concept of macroeconomic risk of natural disaster and will offer an overwiew of financial resilience means. Later, the following sections will deal more in detail with specific tools of disaster risk finance, focusing mainly on insurance, capital markets instruments and government intervention.

2. LITERATURE REVIEW

Macroeconomic risk of natural disasters

Hochrainer (2006) defines the risk of any natural disaster as a function of probability (risk), and loss (exposure, vulnerability). This definition does not represent a mathematical formula, instead it serves primarily to express the integration of these different dimensions in the evaluation of risk.. Figure 1 represents a way to determine the risk of a natural disaster, according to this relationship.

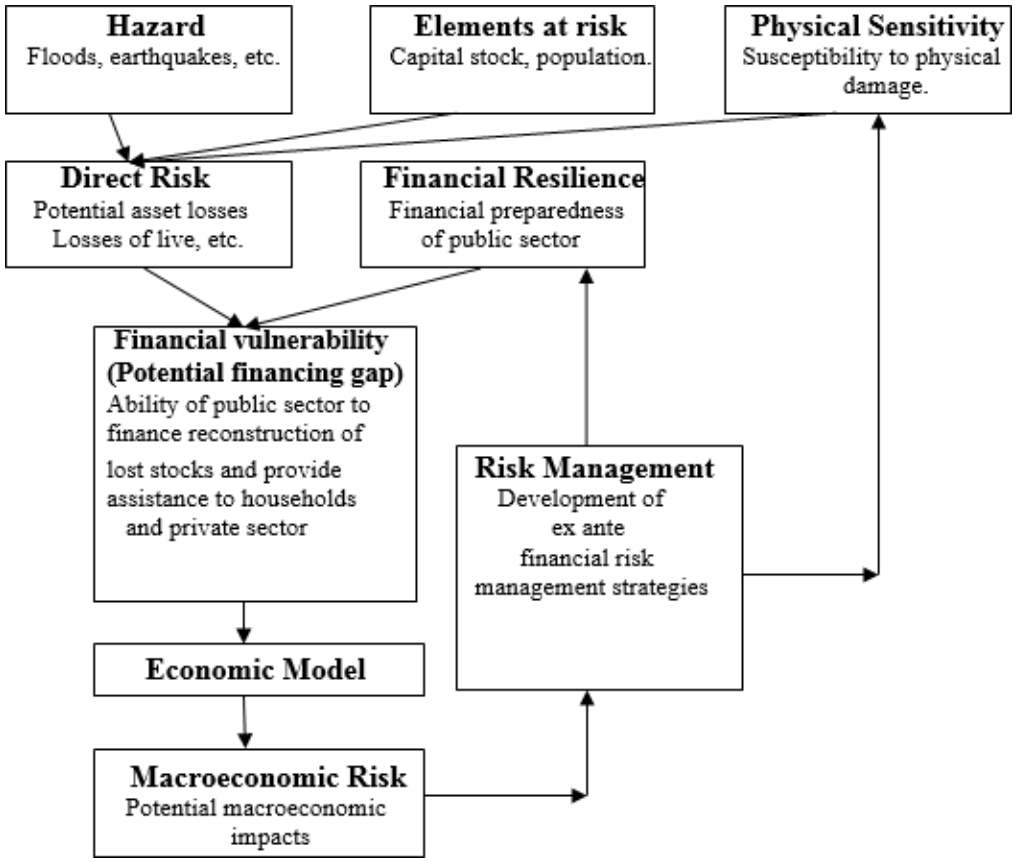

Figure 1 – Macroeconomic risk management approach, Source: Hochrainer 2006

Economic impacts of a natural disaster are usually grouped into three categories: direct, indirect, and macroeconomic effects (often called also secondary effects) (Menchler, 2005). Direct economic damages are mostly the immediate damages or destruction of assets or "stocks", due to the event per se. A smaller portion of these losses results from the loss of already produced goods. The effects can be divided up into those to the private and public economic sectors. Another category of direct

damages is the extra outlays of the public sector in matters of emergency spending in order to help the population during and immediately after a disaster event.

The direct stock damages have indirect impacts on the "flow" of goods and services, i.e. indirect economic losses occur as a consequence of physical destruction affecting households and firms. Most important indirect economic impacts include: diminished production/service due to interruption of economic activity; increased prices due to interruption of economic activity leading to reduction of household income; increased costs as a consequence of destroying roads, e.g. due to detours for distributing goods or going to work; loss or reduction of wages due to business interruption. It should be kept in mind that the social and environmental consequences also have economic repercussions. The reverse is also true for loss of business and livelihoods can affect human health and well-being.

The public sector has in most of the cases the responsibility to bear the cost of damages caused by a disaster. Therefore macroeconomic impacts also arise in case of disasters. The disaster will affect different sectors in varying degrees and thus will be reflected in the macroeconomic performance of the country's economy. Table 1 illustrates some potential impacts of a disaster event.

Table 1 – Potential impacts of a disaster event to macroeconomic indicators

Macroeconomic Indicator	Expected change
GDP	Immediately drop in GDP growth in the year of the event Rise in GDP growth in the year after the event Slowdown in second and/or third year
Agricultural sector	Significant fall in production
Manufacture Sector	Decrease in activity due to disruption of transportation, reduced production capacities
Service Sector	Decrease in activity due to disruption of transportation and payment system
Exports of goods	Reduction in the rate of growth in the year of the event In the year after return to the previous levels In subsequent years continuation of the year after
Imports of Goods	Considerable increase in the rate of growth in the event year A return to pre-disaster level a year after In subsequent years a further drop, possibly caused by reducing incomes
Gross Formation of Fixed Capital	Sharp increase in the year following the disaster
Inflation rate	Short increase caused by the disruption of production and distribution and increasing transportation costs
Public financing	Worsening of deficit due to a shortfall in tax revenues and increase of public expenditures
Trade balance	Deficit due to decrease in exports and an increase in imports, associated with the decline in production capacities and strong public and private investments for reconstruction

Source: Hochrainer, 2006

The ability of the public sector to respond to the event is determined by several factors. This ability is often referred to as economic resilience(Cardona et al, 2008). The economic resilience is conditioned by all the possible internal and external resources available to the government to respond to the event. Access to these resources has limitations and costs that must be taken into account depending on the macroeconomic and financial conditions of the country. The availability of the following options in case of a disaster event determines the economic resilience level:

- The insurance and reinsurance payments;
- The reserve funds for disasters that the country has available during the evaluation year;
- The funds that may be received as an aid and donations, public or private, national or international;
- The possible value of new taxes that the country could collect in case of disasters;
- The margin for budgetary reallocations of the country, which usually corresponds to the margin of discretion expenses available to the government;
- The feasible value of external credit that the country could obtain from multilateral organisms and in the external capital market;
- And, the internal credit the country may obtain from commercial and, at times, the Central Bank, signifying immediate liquidity.

These options will be identified and analyzed in the following sections.

The assessment of the macroeconomic risk of a country from a natural disaster will help form the main strategies for risk management. Assessing the macroeconomic impacts involves taking a different perspective and estimating the aggregate impacts on economic variables like gross domestic product (GDP), consumption and inflation due to the effects of disasters, as well as due to the reallocation of government resources to relief and reconstruction efforts (ECLAC 2003). The relationship between the effects of a natural disaster is shown in Figure 2.

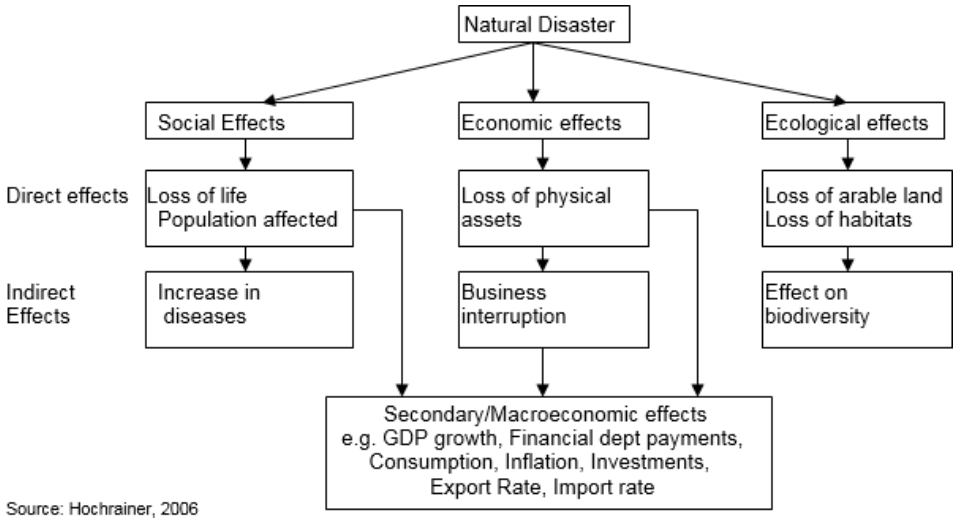

Figure 2 – Relationship between the effects of the ND and macroeconomic indicators

Approaches and instruments for financing the risk of natural disasters

Financial strategies for disaster risk management are intended to ensure that individuals, businesses and governments have the resources necessary to manage the adverse financial and economic consequences of disasters, thereby enabling the critical funding of disaster response, recovery and reconstruction. The analysis of financial exposure of a country to disasters is an important part of disaster risk management strategy. However, it is only one component of a comprehensive disaster risk management strategy. This analysis is a subset of the overall macro-economic analysis [Ghesquiere F. and Mahul, O. 2010]. Financial protection will help governments mobilize resources in the immediate aftermath of a disaster, while buffering the long-term fiscal impact of disasters. The comprehensive risk management strategy covers many other dimensions, including programs to better identify risks, reduce the impact of adverse events and strengthen emergency services (Figure 3).

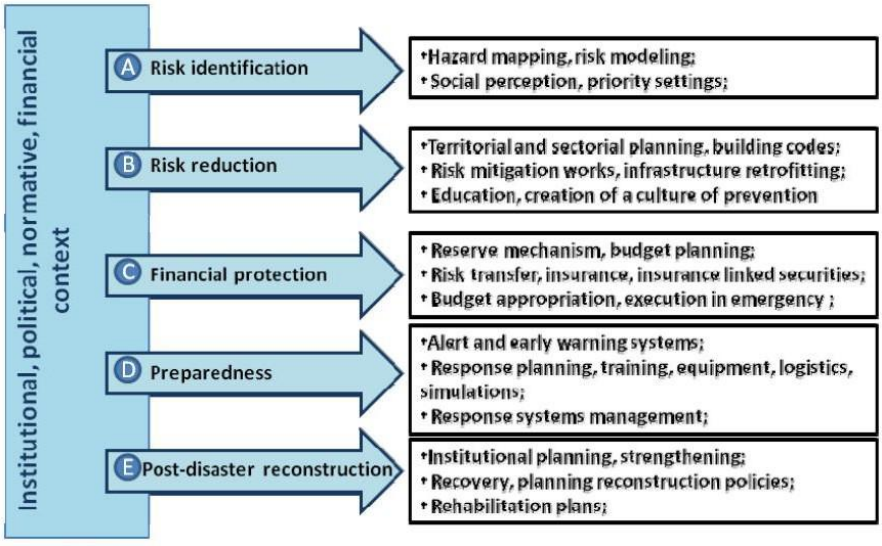

Figure 3 – Comprehensive disaster risk management strategy, Source: Ghesquiere and Mahul (2010)

Risk financing instruments against disaster risks can be categorized into risk transfer and risk spreading instruments. While the dominant risk financing instrument is a risk transfer by insurance and reinsurance, other non-market risk transfer instruments, e.g. collective loss sharing, are also available (Mechler, 2005). Table 2 illustrates the main risk management approaches and instruments.

Table 2 – Risk management approaches and instruments

Approaches	Examples of Instruments
Non-market risk transfer	Government assistance (taxes) for private and public sector relief and reconstruction funding Kinship arrangements Some mutual insurance arrangements Donor Assistance
Market risk transfer	Insurance and reinsurance, Micro insurance, Financial market instruments: Catastrophe bonds, Weather derivatives
Inter-temporal risk spreading	Contingent credit (financial market instrument), Reserve fund, Microcredit and savings

Source: Hochrainer, 2006

Risk-financing and risk-reduction strategies can be targeted to different layers of risk in terms of their severity (Figure 4). Particularly for structured investments, risk-reduction measures may be largely appropriate for low-loss events that occur frequently (low-layer risk), while risk sharing and transfer addresses risks, often at higher levels, that cannot be cost effectively reduce. In highly vulnerable countries, very low-probability, high consequence (high-level) risks are typically absorbed by

governments and donor organizations (Linnerooth-Bayer and Hochrainer-Stigler, 2015).

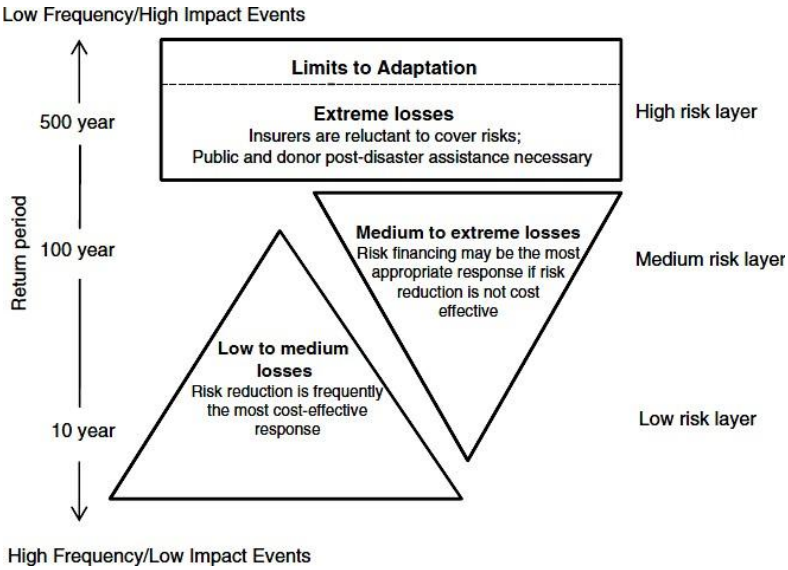

Figure 4 – Disaster Risk Layers, Source: Linnerooth-Bayer and Hochrainer-Stigler (2015)

The public sector has in most of the cases the responsibility to bear the cost of damages caused by a disaster, acting as insurers of last resort (Cardona, et al 2008). In particular, the government plays a key role in loss financing after a disaster in developing and emerging-economy countries, and even in high-income countries. According to Hochrainer (2006), post disaster government assistance can be seen as one of the most important arrangements of non-market risk transfer. Governments have principally four possibilities to ease their financial burden in the context of natural disaster losses: First, they can continue as before and recover from the effects of a disaster event as best they can, using available resources; Second, they can eliminate the risk, e.g. by locating infrastructure out of hazard prone areas; Third, they can reduce the risk (mitigation), e.g. by retrofitting existing facilities and the last and fourth option is to transfer risk to other levels (Burby, 1991).

Governments generally have access to various sources of financing following a disaster. These sources can be categorized as ex-post and ex-ante financing instruments. Ex-post instruments are sources that do not require advance planning. This includes budget reallocation, domestic credit, external credit, tax increase, and donor assistance. Often the public sector relies on such ex post financial means, where international assistance has been especially important. Even though funding from donors and international development banks can be an important part of government catastrophe risk management strategy, over-reliance on this approach has often been the cause of the lack of economic incentives for countries to engage in proactive disaster risk management (Gurenko, E. and Lester, R. 2004). In addition, ex post

international assistance in some occasions can result inadequate, since often is offered in-kind, which has several disadvantages (Keipi, K. and Tyson, J. 2002).

Households, businesses and governments can transfer their catastrophic risk by insurance and/or reinsurance. According to Bayer and Mechler (2008) insurance and other risk-transfer instruments are justified by the concept of risk aversion. 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. (Mechler, 2008). However, according to Hochrainer (2006), there are several problems of supply and demand side of the insurance market. The low insurance density in the developing world is not surprising. On the demand side, for low income households, commercial insurance is not affordable and has high opportunity costs. Many low income countries are highly exposed to natural disaster risk and therefore even fair premiums would be quite high. As a consequence, residents of such countries cannot pay the price for such risk transfers and therefore require support from the non-risk communities or internationally. On the supply side, insurers are reluctant to promote coverage because of the intrinsic problems of insurability of catastrophe risk, the lack of formal titles to property of firms and individuals in developing countries, without which no formal proof of holdings can be established and therefore no premium calculations can be done, high transaction costs, unstable business environments and insufficient risk assessment and mitigation amongst others. Hence, in developing countries, instead of insurance, households usually rely on family and public support. Furthermore, they use traditional coping mechanisms to protect themselves from the economic impacts of natural disasters: diversification of crops and livelihoods, different sources of income, remittances from family members who are living abroad or spatial diversity of family members (Hochrainer, 2006; Linnerooth-Bayer and Hochrainer-Stigler, 2015).

Other ex-ante disaster risk management practicesare considered a crucial part of disaster financial planing. Ex-ante risk financing instruments require pro-active advance planning and include reserves or calamity funds, budget contingencies, contingent debt facility and risk transfer mechanisms. In this respect, risk transfer instruments are of major importance and much emphasized in academic literature, financial strategies and international institution's recommendation, as a mean of risk management that should be considered and implemented in developing countries (Gurenko, E. and Lester, R. 2004; Keipi, K. and Tyson, J. 2002). In addition to traditional insurance and reinsurance, there is emerging interest in other alternative risk transfer instruments, e.g. catastrophe bonds and weather derivatives. Weather derivatives are index based, e.g., physical indicators such as rainfall measured at a specific location are used to define trigger events. Weather derivatives and index based insurance are seen now as promising risk transfer instruments for the developing and emerging economy countries, especially in the agriculture sector (World Bank 2005). Catastrophe bonds emerged as instruments primarily for re-insurers; however, there are

also governmental efforts in some countries (e.g. Mexico) to transfer their risk with this instrument (Hochrainer, 2006).

Finally, inter-temporal risk spreading is another approach for risk management. At the household level risk spreading over time can be achieved in the form of savings. On the country level, governments can establish catastrophe reserve funds, usually financed by taxes, which are depleted only in the case of a disaster event. Contingent credit arrangements allow borrowing money after an event, whereas the post-event annuity payments are smaller in comparison to a regular credit. Borrowing is also a kind of inter-temporal risk spreading of losses, because payments will be made in the future. As one can see, a contingent credit is a mixture of saving and borrowing (Hochrainer 2006).

A comprehensive approach to disaster risk management should emphasize both ex ante measures (prior to a hazard) and ex post activities. Keipi and Tyson (2002) give a list of the instruments that can be used by governments as ex ante and ex post sources (Figure 5).

***Ex* ante Sources**[a)]		***Ex post* Sources**
Instruments without risk transfer Nonreimbursable resources ? Calamity funds ? Reserve funds or diversion of national budgetary resources ? Development and social funds Reimbursable resources ? Contingent credits ? Development and social funds	*Instruments with risk transfer* ? Insurance and reinsurance with damage coverage based on real losses ? Insurance and reinsurance with parametric activation of payments ? Catastrophe bonds with damage coverage based on real losses ? Catastrophe bonds with parametric activation of payments	Nonreimbursable resources ? Emergency donations ? Taxes Reimbursable resources ? Emergency credits (for example the IDB's Emergency Reconstruction Mechanism) ? Reconstruction loans ? Reformulation of existing loans

Figure 5 – Classification of Disaster financing mechanisms, Source: Keipi and Tyson (2002)

Ghesquiere and Mahul (2010) provides an assessment of the time necessary to mobilize funds through these instruments (Figure 6). In the event of a disaster, immediately available and lowest-cost financing options would typically be used first. For example, financing through an existing calamity fund and/or insurance, reinsurance or catastrophe bonds would have priority. Similarly, part of budgeted resources from existing government programs would be transferred to meet immediate emergency needs. In some cases, development funds (municipal, social, urban, rural) may also be used. At the same time, the government would seek as much international aid and donations as possible and resort to contingency credits. If the government has access to emergency credits such as the IDB's Emergency Reconstruction Mechanism, it would request them and would also begin negotiations to direct resources from existing loans to finance disaster recovery (Keipi and Tyson, 2002).

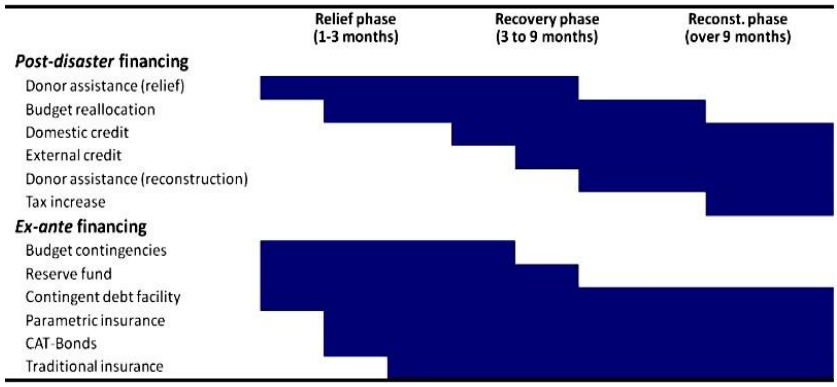

Figure 6 – Sources of post-disaster financing, Source: Ghesquiere and Mahul (2010)

Finally, as the frequency of disaster events is expected to increase with the increasing risk of climate change, exposure of businesses, infrastructure, assets and economies to disaster risk will be even more serious. The inexorable increase in disaster loss over the past 50 years underscores the fact that ad hoc action may no longer be adequate. The rising frequency and costs caused by natural hazards call for more action to reduce disaster risk. A more proactive approach is urgent, starting with a better understanding of the sources of risk, the systematic consideration of risks in development planning, and the development of financial protection mechanisms. Understanding how to involve the private sector in responding to these risks – or encouraging them to take advantage of the new business opportunities that may arise from changing climate conditions – is crucial to catalyze greater investment in activities that increase countries, businesses, and communities' resilience.

The following sections will offer a thorough overview of the main instruments of financial resilience in case of disasters. The focus will be on insurance as the main instrument of financial risk transfer used by the governments, businesses and households around the world. In addition, several innovative instruments mentioned above will be presented and summarized in the last sections. Finally, climate finance will be also discused in the last section of the chapter.

3. MARKET RISK TRANSFER

Market risk transfer instruments include insurance and micro-insurance schemes, as well as some new innovative instruments created from the capital markets. These instruments represent ex ante measures which aim is to transfer risk through financial markets (reference). In the event of a major disaster, traditional market risk transfer mechanisms might be unable to address disaster losses. Weather derivatives and catastrophe bond allow the risks not to be absorbed by international insurers, but directed by financial markets via investors, who receive a contingent interest rate calculated on the basis of the estimated risk.

Insurance and reinsurance

The concept of insurance

One of the usual techniques used to transfer the catastrophe risk is insurance. As a technique of risk management program, insurance is appropriate for loss exposure that have a low probability of loss but a high severity of loss. The transfer of risk from the individual to the insurance company is carried through a contractual agreement under which the insurance company, in consideration of the premium paid by the insured and his promise to abide the provisions of the contract, promises to make payment to or on behalf of the insured, for losses caused by the perils covered under the contract. The main purpose of the insurance is to indemnify the insured, to restore his financial position prior to the occurrence of the loss. The indemnification of the injured parties is possible through the process of pooling and sharing of losses. The losses suffered by a small group of insured are spread on the entire group of insureds, and the average loss (included in the premium) substitutes the large actual loss. But insurance companies do not cover all the kinds of risks. The next section describes the nature of risks transferred though the insurance device.

Risks transferred through insurance

According to the insurance literature the risk can be classified in several distinct categories:

- Pure risk and speculative risk
- Dynamic risk and static risk
- Fundamental risk and particular risk

Pure risk is a category of risk in which the sole outcome is either loss or no loss. Examples of pure risk include the uncertainty of loss of one's life or property by fire, flood, windstorms, earthquakes or other perils. The speculative risk is a category of risk in which the outcome will be either a profit or a loss. Examples of speculative risks include a business venture, gambling transactions, investing in real estate or stocks, etc. Insurers generally insure only pure risks, while the speculative risk is normally handled by techniques other than insurance, such as diversifications, hedging or assumption of risk etc.

Dynamic risks are risks produced because of changes in the economy. Examples of dynamic risks are variations of price level, consumer preferences, income level, technology and production innovations, etc. Such changes may cause losses to some citizens. But on the other hand, the society may benefit from long-run due to the redistribution of resources. Static risks include losses that would occur even there is no change in the economy level. Examples of static risks include uncertainties due to random events such a fire, windstorm or other people's negligence. As a result of occurrence of static risks, there is no chance of profits for anyone. Therefore, this kind of risk is privately insurable.

A fundamental risk is a risk that affects the whole economy or a large part of the population or community. Examples of fundamental risks include the wars, earthquakes, health diseases, economic recessions, inflation, etc. Fundamental risks may be static or dynamic. Particular risks affect an individual or a small group of individuals. They affect the individual and not the entire group. Insurance can be easily used for the management of the particular risks, but the government assistance is necessary to insure the fundamental risks, such as social insurance programs or unemployment compensation programs.

As a result, the natural disaster risk is:

- A pure risk as the society does not benefit when a natural disaster loss occurs, i.e. insurable risk;
- A static risk as it occurs due to random events and it is not a source of gain for the society, i.e. insurable risk;
- A fundamental risk as it affects a large group of the population, i.e. not entirely privately insurable.

Requirements of an insurable risk

There are some requirements that should be fulfilled before a pure risk can be privately insured. The criteria are as follows:

There must be a sufficiently large number of similar exposure units. Insurers use the law of large number to predict probable losses. Therefore, it is essential that a large number of independent and similar, not necessarily identical, units be exposed at the same peril. To be successful, an insurance plan must reduce the risk by making losses predictable within certain ranges of accuracy. According to the law of large number, as the number of exposure units increases, the more certain is that actual loss experience with equal probable loss experience. The insurance is the device through which the objective risk is significantly decreased.

The loss must be accidental and unintentional. The loss must be the result of a contingency, i.e. there must be some uncertainty surrounding the loss. Otherwise, there would be no risk. If there is no risk, insurance would be worthless, as its purpose is to reduce the risk. The loss should be beyond the control of the insured. To satisfy this requirement, insures usually exclude in all policies any loss caused intentionally by the insured.

The loss should be definite and measurable. The loss must be defined in time, cause, place and amount. Most losses easily determine with reasonable accuracy, such as death, property losses, etc. However, some losses are difficult to be determined such as disability or sickness, and some others are difficult to be measured such as the loss from “pain and suffering”.

The loss should not be catastrophic. A large number of units must be exposed at the same peril, but not all or the most part of the exposed unit should suffer from the loss at the same time. Catastrophic loss exposure is defined as a potential loss that is

unpredictable and capable of producing an extraordinarily large amount of damage relative to the assets held in the insurance pool (Dorfman M., 2005). The insurance principle is based on the notion of sharing losses. If all the exposure units in a certain class incur a loss at the same time, the pooling will not work, and the insurance will be no longer an effective technique.

The chance of loss must be calculable. The insurer must be able to calculate the probability of loss. Some probabilities of loss can be determined by logic alone (by deductive reasoning), for example the probability of rolling a six with a single die is 1/6. Other losses must be empirically determined (by inductive reasoning), for example the probability that a person age 30 will die before the age 50. If no statistics on the chance of loss are available, the degree of accuracy of the insurer's calculation would be low, despite the large number of insureds.

The premium must be economically feasible. The insurers collect the premium to pay the losses, the loss-adjustment expenses and to provide a profit for themselves. The rates charged by insurers should be adequate to pay all losses and expenses, and they should be not excessive in order that the insured pay no more than their coverage. If the chance of loss is much above 40 percent, the policy will exceed the amount the insurer must pay under the contract (Mehr R. 1980). Otherwise, if there is a sufficiently large group of insured, the cost may be spread over the entire group and the premium may be feasible.

As a result, the natural disaster risk meets the following requirements:

There are a large number of units exposed to the natural disaster hazards. The losses resulted from the natural disaster risk are out of the individual control. There are accidental and unintentional. If insurers cover a sufficiently large group of exposures the premium may be feasible.

The natural disaster risk does not fully meet the following requirements:

When a natural disaster takes place, often it is very difficult to measure the amount of loss, or at least the actual loss can be measured only after a certain period of time. As the "catastrophe" is the synonym of disaster, the loss resulted from the natural disasters is catastrophic. The natural disasters occur in irregular basis, therefore their probability cannot be accurately estimated. As a result the natural disaster risk does not fully satisfy the requirements of an insurable risk. Although these requirements represent the ideal, in practice, insurance is written under less-than-ideal conditions. However, private insurance ventures that depart too far from the ideal are likely to fail (Dorfman M. 2005).

The role of insurance companies in providing coverage for natural disaster losses

The insurance companies would ideally wish to avoid the catastrophic losses because they are unpredictable, the loss distribution is hardly to be evaluated, and the rate making process is very difficult. But actually, insurance companies provide coverage for catastrophic losses, natural catastrophes and man-made disasters. Financiers have developed arrangements that provide protection to insurance companies faced with catastrophic losses. That means that insurance companies have found a way to use the resources of the financial market to meet the problem of catastrophic losses. There are at least three basic methods that allow them to accept exposures that otherwise would have been refused.

First, reinsurance may be used by which insurance companies are indemnified by re-insurers for catastrophic losses. Reinsurance is a method created to divide the risk among several insurance companies. Reinsurance is the shifting of a part or the whole risk written by one insurer, called the ceding insurer, to another insurer, called the re-insurer. The transaction is carried through agreements, called treaties, which specify the ways in which risks will be shared by the participating insurers. The first decision taken by the ceding insurer is to define the retention limit, that is the amount of insurance retained by the ceding

BOX 1. THE CASE OF USA

In the US, NFIP (National Flood Insurance Program), which is an insurance scheme for flooding at the national level, works in this form. NFIP operates as an insurance company, where its policies are sold by private insurers, but also applies forms of insurance premium subsidy to poor families located in areas with high risk of flooding. For residences coverage may range from 35,000 to 250,000 USD while for non-residential properties from 100,000 to 500,000 USD. Flood insurance in the US is mandatory only in cases when the property is part of a loan agreement as collateral. Until May 2013, this program had secured a value of $ 1.28 trillion and about $ 3.67 billion written premiums. In the last 25 years, this program has paid damages worth $ 49.5 trillion. Only in 2005, at Hurricane Katrina, the NFIP has paid nearly $ 18 billion in damage. A particular feature of this program is that, the central government (federal government) provides this coverage in agreement with local government only if the latter agree to adopt and build an action plan and strategy to minimize the risk of flooding in areas that are considered at high risk. In an area where this does not happen insurance coverage is not provided. If, in a given locality, local government does not respect the agreement to take measures to reduce the risk of flooding, then additions to the insurance premium for the area may be applied or insurance coverage may be suspended. The scheme is often assisted by federal funds, to cope with major catastrophe damage, such as Hurricane Katrina.

Source: http://bsa.nfipstat.fema.gov/reports/1011.htm

company, which varies with the financial position of the insurer and the nature of the exposure. There are several types of reinsurance treaties. The excess-loss-treaty is designed largely for catastrophic protection (Cat-XL). Losses in the excess of the retention limit are paid by the re-insurer up to some maximum limit. The excess-of-loss treaty can be written to cover: a) a single exposure; b) a single occurrence, such as e natural disaster loss, or c) excess losses when the primary insurer's cumulative loss exceeds a certain amount during a certain period (Rejda, G. 2000). For example, assume that Vienna Insurance Group wants protection for all the losses resulted from floods in excess of 2 million Euro.The Vienna Insurance group can write an excess-of-loss treaty with Swisse Reinsurance Company, to cover a single occurrence during a year. In this case the re-insurer agrees to be liable for all the loss resulted from the flood, exceeding 2 million Euro, but to a maximum of 10 million Euro. If a 6 million flood loss occurs, Vienna Insurance Group would pay the first 2 million Euro (the retention limit), and the Swisse Reinsurance would pay 4 million Euro.

Second, distributing their coverage over a large geographical area and as a result the possibility of a catastrophic loss will be reduced. If a multinational insurance company would cover the fires in Russia, the earthquakes in Italy and the flood in France, then the insurance company would have a more diversified portfolio and will have more stable financial results. Distributing their coverage all over the world will permit the insurance companies to assume different types of risk. Through this geographic diversification they would be able to mitigate the risk they face.

Third, insurance companies use the financial market to transfer a part or all the catastrophic risk to investors, in the form of insurance linked securities (ILS). Examples of ILS are contingent surplus notes, catastrophe bonds and exchange traded options.

Contingent surplus notes allow an insurance company to protect itself from paying a large number of claims resulted from a disaster. The investors put the funds in a trustee that buy treasury securities. The investors receive the interest from the government securities plus an additional interest paid by the insurance company, in order to induce the investors to put the funds in the trustee then to invest the funds directly in government securities. If a catastrophe occurs, the insurer has the legal right to replace the government securities with its own contingent notes, or in some cases with its own preferred stock. The insurance company continues to pay the interest and the principal of its own notes, but

BOX 2. INSURANCE POLICY IN FRANCE

In France, private insurers are required to offer catastrophe insurance in all-hazards property policy. Policies are not risk based and the program is reinsured through a public administered fund. If the fund does not satisfy the claims, taxpayers will be called to pay.

Source: Joanne Linnerooth-Bayer and Reinhard Mechler. 2009. DESA Working Paper No. 85. Insurance against Losses from Natural Disasters in Developing Countries.

there is also more risk of default, because it is now the insurance company and not the government which is paying the interest.

Catastrophe bonds (detailed in the next section) are another financial arrangement that allows insurance companies to transfer the risk of catastrophe. Catastrophe bonds (Cat bonds) are special bonds issued by insurance companies to help them pay for natural catastrophic losses. The investors put the funds in a trustee, called the special Vehicle Purpose (SVP), that buy safe securities (treasury bonds) and other high-quality securities. The Cat-bonds are issued by the SVP. The bonds are usually rated below investment grade (junk bonds) and pay relatively high yields. If a catastrophe event occurs the insurance company can withdraw funds from the SVP to pay claims and no repayment is made to the investors. If the specified catastrophe event does not occur, the investors receive their principal plus interest that is relatively higher.

The insurance companies can transfer the catastrophe risk through exchange traded options. These options that are sold by speculators and purchased by insurance companies, are standardized contracts that give the insurance company the right to a cash payment from the seller (the speculator) if a specified index of catastrophic losses reaches a certain level within a specified period of time.

Disaster insurance all over the world

According to the Swiss Re Sigma publication, economic losses from natural catastrophes and man-made disasters across the world were estimated USD 175 billion in 2016. Natural catastrophe-related economic losses were estimated USD 166 billion in 2016, coming mostly from earthquakes, tropical cyclones, other severe storms and droughts in Asia, North America and Europe. Insurance coverage is not universal. There was an all-peril catastrophic protection gap of USD 121 billion in 2016. Therefore, the insurance industry covered about USD 54 billion - less than one third - of the economic losses in 2016. Figure 7 shows the difference between insured and economic losses over time, termed the insurance protection gap. The rate of growth of economic losses has outpaced the rate of growth of insuring losses over the 25 past years. In terms of 10 rolling averages, insured losses grew by 4,6% between 1991 and 2016, and economic losses by 5,6%.

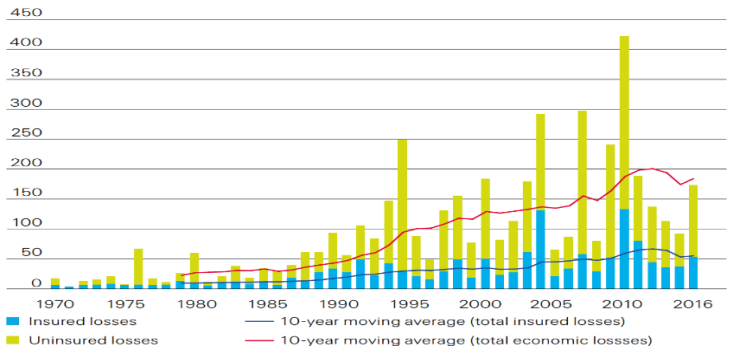

Figure 7 – Insured losses versus uninsured losses, Source: Sigma (2017)

Index-based micro-insurance programs

Micro-insurance, as a financial tool that belongs to microfinance, is widely recognized and known as a flexible and essential device in developing country context. The aim of micro-insurance is to provide insurance against natural disasters to poor individuals. It is a financial device that provides low-income households, farmers, and business with access to post-disaster liquidity, thus securing their livings and providing for their reconstruction. It has some basic features as households or farmer participation, small group involved, and small geographic area. It can be used by low income people, who cannot have access to traditional forms of insurance. This product is characterized by the member's willingness to pay and low-cost transactions. Micro-insurance can be indemnity based, where products are written against actual losses, or index-based, where products are written against physical or economic triggers, that is, against events that cause loss, not against the loss itself (Linnerooth-Bayer Hochrainer-Stigler, 2015). The index based insurance is effectively used especially in agriculture. Any independent gauge can be used and developed as an index for an insurance contract which is secure and must be highly correlated with agricultural losses (Skees, 2001). To avoid the high transaction cost of indemnity-based insurance schemes, index-based or parametric schemes create the payouts contigent on a physical trigger, such as rainfall, temperature or wind speed measured in a local weather station. In the case of weather derivatives, farmers collect an insurance payment if the index reaches a certain measure or "trigger" regardless of actual losses.

BOX 3. MICRO-INSURANCE IN MONGOLIA

In Mongolia, the herders can purchase an index-based insurance policy to protect them against livestock losses due to conditions of extreme winter weather. The insurance program is a combination of self-insurance, market based insurance and social safety net. Small losses which do not affect their viability are retained by the herders, while larger losses are transferred to the private insurance industry. Only the final layer of catastrophic losses is borne by the government.

Source: Mahul, O. and Skees, J. 2006. Piloting Index-Based Livestock Insurance in Mongolia, AccessFinance, World Bank, Issue no. 10.

The World Bank has provided technical assistance for implementation of innovative index-based crop insurance schemes in developing countries. For example, in Malawi, where the economy and livelihoods are severely affected by rainfall risk, groundnut farmers can receive loans that are insured against default with an index-based weather derivative, or in Mongoly_herders can purchase an index-based insurance policy to protect them against livestock losses due to conditions of extreme winter weather (see Box 2). The insured farmers and herders are more creditworthy, therefore insurance can also promote investments in productive assets and higher- risk/higher-yield crops. Moreover, insurance can encourage investment in disaster prevention if insurers offer lower premiums to reward risk-reducing behavior. Thus, microinsurance can be seen as an effective risk-transfer mechanism and an integral part of an overall disaster risk management strategy.

BOX 4. MALAWI MICRO-INSURANCE SCHEME

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 micro-insurance 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. In the event of a severe drought, the borrower pays a part of the loan, and the rest is paid by the insurer directly to the bank. The farmer is less likely to default, as it has a stabilizing impact on the bank's portfolio and risk profile. Without this assurance, banks would have not borrow funds to low-income farmers. The advantage for the farmers is that they obtain money to invest in the seeds and other inputs necessary for higher-yield crops.

Source: World Bank. 2012. Weather Index-based Crop Insurance in Malawi Facilitating Farmers' Access to Agricultural Credit.

A report by the International Fund for Agricultural Development and World Food Program cites 36 weather index insurance programs, including 28 addressing individual farmer/herder, slum dweller, village or cooperative risk. Index insurance reduces moral hazard since claims are independent of losses. As another innovation, albeit with only one pilot application, insurance payouts can be linked with forecasts so that clients have the liquidity to take preventive measures to reduce losses (Skees and Collier 2010). The private sector is taking an interest in micro-insurance markets. For Swiss Re, the target market includes those who can afford commercially viable premiums, which they identify as the estimated 2.6 billion people living above the international poverty line of $ 1.25/day but below $4/day (Swiss Re 2012). Few insurers, however, are optimistic about the prospects of disaster micro-insurance for

the very poor (below USD 1.25/day) unless it is supported by the government, NGOs or international donors (Linnerooth-Bayer Hochrainer-Stigler, 2015).

Financial Markets and Disaster Risk Transfer

Derivatives and their purpose

Derivatives are financial instruments that have a value based on the performance of other assets. Derivatives today constitute an important part of the financial market. The derivatives market is the largest market for financial securities in terms of trade capital value. They are financial instruments that have emerged as risk management tools, although today they are also used for speculative purposes to increase the returns of different investor portfolios. From the risk management point of view, derivatives are among the key instruments used in financial markets. Derivatives, however, differ from insurance contracts because, in addition to risk hedging, they also provide the opportunity to achieve a certain return, while insurance contracts offer merely protection. The main instruments in the derivatives market are options, forward contracts, futures contracts and swaps. There are also combinations of these instruments (eg, swaptions options) and a number of other instruments, with the most varied names built in a synthetic way from these basic instruments. To better understand how disasters -related derivatives can be built, a short description of four basic types of derivative instruments, which find use in classical financial markets is given (Bodie, Kane, & Marcus, 2013).

• Forwards are contracts signed between the two parties to buy / sell a certain asset at a certain price (forward price) at a certain time, well- fixed in advance, but always pertaining to the future. The parties are obliged to perform the transaction on the maturity date of the contract.

• Futures (term contracts) work with the same mechanism as forward contracts, but in contrast to them are standardized contracts, traded on the stock exchange market and where the counterpart is always the stock exchange market through a clergy company. They have an advantage over forward contracts because they do not have the risk of default of the obligation of the counterpart party, profit / loss is calculated and received daily under a "mark to market" procedure. In comparison with forward contract the futures are built for any kind of deadline, quantity or price.

• Options (options) are the contract under which the option buyer has the right, but not the obligation to buy / sell a fixed asset at a predetermined price (execution price) within a certain deadline. For this right, the buyer of the option pays a premium to the option vendor. If the right to buy / sell the asset can only be executed at the end of the term, options are known as the European type. If the right can be executed throughout the period up to Option maturity, the options are known to be of American type. Often in literature the options are recognized with the term "Contingency Claims".

• Swaps are an agreement between two parties to exchange financial instruments periodically in the future according to a certain graph. Swaps can be viewed as a successive series of forward contracts.

Catastrophe Bonds

The most popular capital market products associated with catastrophic risk are catastrophe bonds, briefly known as CAT Bonds. Since from their first issue in 1994 this form of financial title linked to insurance and catastrophic risk has always found more room in the different investors' portfolios. Over 85% of these types of securities are sold to the American market, which is the largest but at the same time the most innovative market in financial products (Bruggeman, 2007). Disaster bonds are a kind of secured financial title (ILS) that has a definite characteristic. If the catastrophic event set out in the contract occur, bondholders lose the interest they pay in the bond and in some cases the principal invested. From this point of view, disaster bonds are a kind of bet that investors put up if disasters of a certain nature are going to happen or not. In exchange for taking this added risk compared to ordinary bonds, investors receive a higher return from disaster bonds compared to ordinary bonds with the same valuation (rating; with the same level of failure risk).

In most emissions, disaster bonds cover only certain disasters, namely the condition of non-payment of interest or principal activated only in the event of a certain catastrophe. They are also very diverse: there are earthquake bonds, hurricane bonds, storm bonds, bonds related to terrorist acts, etc. However, there are also companies that have issued multi-perilic catastrophes bonds, involving several types of catastrophic risk. The major buyers of these securities are large institutional investors such as mutual funds, pension funds, hedge funds, banks, etc. Secondary market of these financial titles is largely limited to highly specialized institutional investors. There is a very

BOX 5. THE CASE OF MEXICO

The Mexican government has chosen to insure its catastrophe reserve fund, FONDEN, against earthquakes with a mix of reinsurance and a catastrophe bond. The FONDEN's objective is to prevent imbalances in the federal government finances derived from outlays caused by natural catastrophes. The fund does not support reconstruction of private infrastructure, nor does it act as insurer of last resort. It grants financial support only to those private individuals that, due to their poverty status, require government assistance. In 2006, FONDEN issued a USD 160 million catastrophe bond (CATMEX) to transfer Mexico's earthquake risk to the international capital markets. It was the first country that issue a multi-peril multi-region cat bond using the World Bank's Multicat Program.

Source: Cardenas, V., Hochrainer, S., Mechler, R., Pflug, G. & Linnerooth-Bayer, J. (2007) Sovereign financial disaster risk management: The case of Mexico, Environmental Hazards, 7:1, 40-53

limited number of investment funds specialized in this instrument type. Recently, these funds have made these securities also available for individual investors, though in limited quantities (Banks, 2005).

Why to invest in catastrophe bonds?

The returns from catastrophe bonds are largely uncorrelated with macroeconomic factors, a rare thing in the investment world. This unique characteristic allows them to bring valuable diversification attributes to portfolios of more traditional asset classes, and holds particular appeal in uncertain financial climates when investors may wish to protect themselves from market forces. For example in 2008, a year of intense economic upheaval, catastrophe bonds were one of the few asset classes which provided positive returns over the course of the year. One particularly attractive feature of catastrophe bonds and other catastrophe risk securities is that poor performance tends to be self-correcting. Following a particularly destructive natural disaster, a number of factors serve to inflate insurance premiums (and thus the potential returns to catastrophe risk securities), providing investors with the opportunity to recoup some, if not all, of their losses within a relatively short time-frame. These factors include increased demand for insurance, a reduced ability of insurance and reinsurance companies to take on risk, and an upward revision of the probability models that are used to price insurance and catastrophe risk securities (May & Carr, 2011).

While the recent earthquake in Japan has led to large losses in the catastrophe risk market, insurance premiums have since been pushed up by around 50% of earthquake risk and 20% for another catastrophe risk. Some investors may be worried of entering the market with the recent disaster still fresh in their minds. However, while further seismic activity in Japan may serve as a well-justified deterrent against investments in Japanese earthquake risk, the potential enhanced returns associated with elevated insurance premiums mean that this could be a good time to invest in another catastrophe risk securities.

In addition, while investors face the possibility of losing some or all of their principal investment in the event that a catastrophe does occur, their risk exposure can be dramatically reduced by diversifying across many different catastrophe bonds as the probability of numerous large-scale natural disasters occurring within the same limited time frame is very low. For example, in 2005, in spite of heavy losses associated with Hurricane Katrina, many catastrophe risk funds still made money overall.

A final benefit of investing in catastrophe bonds is that the likelihood of incurring extreme losses is far lower than the chance of benefitting from extreme returns. This is clearly demonstrated on the Figure 8, which models the distribution of probable returns to a catastrophe risk fund. At 3%, the probability of losses greater than 10% is far below that of obtaining a 14.5% return, and there is an 87% chance of positive returns (May & Carr, 2011).

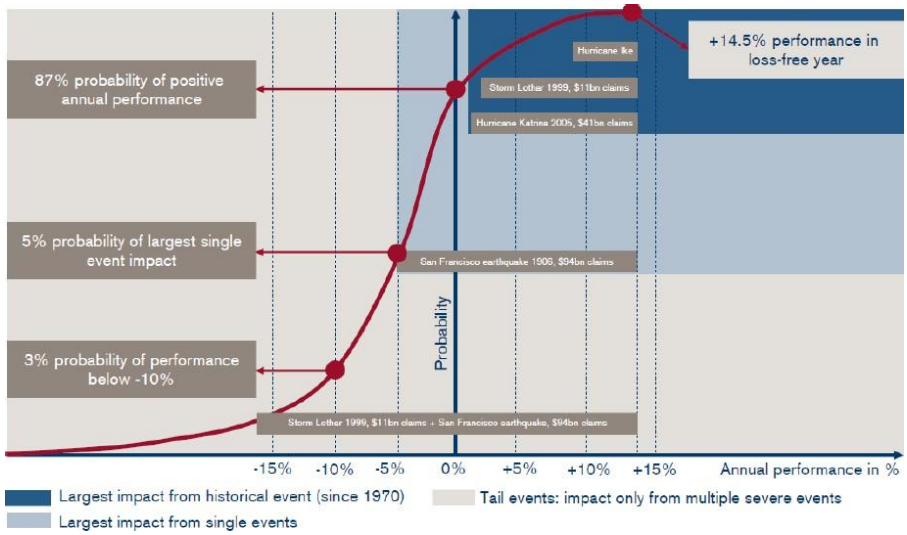

Figure 8 – Return distribution probability of a catastrophe risk fund, Source: May & Carr (2011)

Catastrophe Derivatives

Catastrophe Derivatives are financial instruments whose value is affected by the occurrence or not of disasters set out in the contract. They work basically on a contract according to which one party (the seller of the contract) pays to the other party (the contract buyer) one monetary value if a condition related to the occurrence of catastrophic events is met and damages arise. Also, these derivatives can take the form of swaps where parties "exchange" between them the different risk exposures. In essence, these are derivatives that rely not on certain assets, but on levels of risk, and specifically on the risk of disasters. These risk levels are represented by the various indexes on the level of damages (Bruggeman, 2007).

A fundamental difference between the different types of catastrophe-related derivatives are related to the place where they are traded. Like all financial titles and instruments, also in this case the breakdown is among the catastrophe derivatives traded on the stock exchange and the catastrophe derivative traded on the over the counter market (OTC)[6]. The underlying difference is that the derivatives traded on the

[6] The over the counter market is a decentralized market, without a central physical location, where market participants trade with one another through various communication modes such as the telephone, email and proprietary electronic trading systems. An over-the-counter (OTC) market and an exchange market are the two basic ways of organizing financial markets. In an OTC market, dealers act as market makers by quoting prices at which they will buy and sell a security or currency. A trade can be executed between two participants in an OTC market without others being aware of the price at which the transaction was effected. In general, OTC markets are therefore less transparent than exchanges and are also subject to fewer regulations.)

stock exchange are standardized, have standard deadlines and astandard value of the execution limit and their counterpart is always the stock exchange market through a clearinghouse. Meanwhile the derivatives traded over the counter are more flexible as the contracts are between the various parties, mainly insurance / reinsurance market participants and institutional investors in the capital market. The market over the counter is very innovative regarding the offer of new products in this area. Also, because of the flexibility this market, it offers much mire liquidity than for the catastrophe derivatives traded on the stock exchange.

Catastrophe derivatives represent a variety of products, as this is a characteristic of the derivatives market in general. The following sections will discuss briefly some of the main types of disaster derivatives that have found greater use in the financial markets. Catastrophe derivatives traded on the regulated stock exchange markets have not been very successful.

Initially, it was the Chicago Stock Exchange (CBOT) that has introduced a form of Future Catastrophe Contracts, and later options of the same purpose. These options pay cash in case of overcoming damage over a certain, measured value from an Index of claims for catastrophe damage that was calculated on the basis of data of over 100 insurance companies in the US. The buyers of these options were mostly insurance companies, while sellers usually investors who wanted to benefit from the diversification of their portfolios and provide additional revenue from the sale of options. However, this type of instrument was abandoned in 2000 due to the lack of interest from the market. Other efforts were made by the New York Stock Exchange and the Bermuda Bound but they failed to create an active stock market for catastrophe derivatives.

The most successful catastrophe derivative instruments are the ones traded in the over the counter market. Catastrophe swaps are such an instrument. Although called swaps, these are more like options. In this kind of instrument one the insurance company pays a premium to a re-insurer who in turn offers it to the insurance company a financial guarantee for damages. If the catastrophe then occurs, the re-insurer pays the money to the insurer and by subrogation gets the right over the claims for damage (treats re-insurer claims for damages). If the event does not happen, then the re-insurer remains the primer (here it differs from a typical reinsurance deal) and the insurer's portfolio remains unchanged.

Another instrument normally used in the market of Catastrophe derivatives is pure Catastrophe swaps (this term is used to distinguish it from reinsurance swaps that resemble more with options). In these derivatives, various re-insurers share part of their risk portfolios. Re-insurers exchange those parts of the catastrophic risk that are not correlated to their existing portfolio. For example if one reinsurer X has a large part of the portfolio focused on the earthquake risk zone A, it may exchange part of this exposure with a risk exposure of another re-insurer in another area. In this way both parties reach one more diversified portfolio of catastrophic risk. Moreover, by means of this mechanism a re-insurer may take exposure to the risks abroad, exposure which

cannot reach him directly. Thus, a European re-insurer can take exposure to the risk of hurricanes in the US or tsunami in Asia, signing a pure swap reinsurance with an American or Japanese re-insurer. This way the European re-insurer becomes liable for part of the damage caused by the hurricane in the US or tsunami in Asia. Damages will be paid by the relevant re-insurer in the US or Japan and the European re-insurer will reimburse the amount. These types of instruments are the most popular among re-insurers as they offer a good opportunity to diversify risk portfolio without paying premiums or costs such as those associated with retrocession or Cat bonds.

The market for disaster derivatives, as well as cat bonds, is a relatively a new market and has yet to reach that level of development that can be termed as mature. The first problem relates to Catastrophe derivatives traded on the stock exchange. As they use different indexes as the basis for the operation of derivatives, one of the problems that require in-depth study is the solution of the appropriate index. Choosing the index influences the risk that is carried by the parties and this has led to the failure of some types of instruments in this market. Using the same methodology used for Cat bonds that have the condition of non-payment depending on an index can improve the situation, since so far these instruments have not been successful (Banks, 2005). The same price fixing problems for other financial instruments associated with CAT bonds also applies in the case of Catastrophe derivatives. The key element relates to modeling the risk of disasters, which is a difficult process associated with high cost, and for which investors are generally not familiar. Adding to this the complexity of the derivatives itself, it further complicates the process of setting the price for this instrument. Moreover, this is a market which does not have that level of liquidity like most of the derivatives markets over the financial instruments. A part of the market actors who have the right expertise (companies of reinsurance) also have a number of other tools available to offer protection from disaster risk (reinsurance, disaster bonds). Moral hazard is another problem of this market. This is again related to the relatively young age of the market and lack of adeguate experitise from potential providers. Finally, the market is also complicated by the regulatory market requirements of the insurance market and of banks (banks are among the most engaged institutions in the derivatives instruments). Insurers/Reinsurers cannot engage directly in the sale-purchase of the derivatives of the catastrophe, but must do so through the entities created by them. These are financial intermediaries owned by insurance / reinsurance companies able to carry out operations in the capital markets. Banks also cannot provide insurance / reinsurance. Often they create the so-called "transformative Bermuda" companies based in Bermuda that can function as a kind of broker that sells insurance / reinsurance. These regulatory requirements complicate the process by increasing costs.

Table 3 shows an overview of both instruments, highlighting some of the advantages and disadvantages that characterize each investment.

Table 3 – Financial market mechanism for Extreme Weather Event financing

Financial mechanism	Description	Seller/buyer	Advantages	Disadvantages
Catastrophe Bonds	Financial contracts which pay out on fulfillment of a trigger condition. They are usually triggered by a loss from a particular pre-defined catastrophe	Sellers are insurance companies Buyers are major investors such as mutual and pension funds	Simple to administer Yield is high Risk is uncorrelated with other asset classes	Diversify funding for catastrophic risk by accessing capital which under normal conditions is not available to insurance Help to increase capacity in the market
Weather derivatives	Pay out on a specific trigger but covering a period of time	Sellers energy companies Byers: mutual funds, insurance companies, pension funds	Difficult to insure risks is covered. Payout is determined by index of objective measurements Eliminates catastrophe software error	Requires accurate prediction of information Expensive to set up Damage can exceed the indemnity covered

Source: Association of British Insurers, 2005

4. NON-MARKET RISK TRANSFER

Non-market risk transfer instruments include not only instruments that traditionally have been used in disaster risk management, but also some innovative risk financing mechanisms which have been created to address especially high-layer disaster risks (Linnerooth-Bayer and Hochrainer-Stigler (2015). In the event of a major disaster, traditional non-market risk transfer mechanisms are unable to address disaster losses, especially indirect ones. The consequences might escalate, and traditional risk financing mechanisms might fall short on important dimensions. Innovations include national and regional risk pools which help to increase financial resilience of the respective risk bearers and have been used successfully in several countries and developing economies (reference).

Solidarity – government and donor assistance

Governments and donor assistance are usually the most widely used ex-post disaster relief measures. This is particularly the case for vulnerable countries. Even the insurance system is often unable to meet the needs in case of disasters of higher-layer losses even in high income economies, unless they can rely on public backup in the form of government guarantees.

When large-scale disasters take place, governments assume roles as financing sources of last resort (Keipi and Tyson, 2002). Post-disaster expenses for restoring public infrastructure and meeting the needs of affected population can pose post-disaster fiscal constraints to the government. These financial commitments can be divided into three categories (Keipi and Tyson, 2002): i) funds allocated to cover the financial cost of the damages to public sector infrastructure; ii) financing made available as a result of political pressures to private businesses who lacked sufficient insurance coverage; and iii) funds to meet the government's obligations to care for the

poor. New taxes, budgetary reallocations toward rehabilitation and reconstruction activities and exploitation of reserve funds might be sources of financing for the government in these cases. However, such instruments, despite not having a financial expense in the form of commission or interest payments, bear a very high opportunity cost, as such funds could have been used for other national purposes. In addition, new taxes pose a high burden to the public, which is usually skeptical of the use of such measure.

Nevertheless, government funds are usually limited and cannot bare the costs of major disaster events. In such cases, international assistance may come to their rescue (Linnerooth-Bayer and Hochrainer-Stigler, 2015). Bilateral and multilateral assistance may take the form of reimbursable or nonreimbursable financing and, in some cases, the refinancing or forgiving of past debts (Keipi and Tyson, 2002). However, there are several shortcomings when international assistance is considered. Firstly, foreign aid is not always immediately available, nor does it always come in the form that would be required by the particular country at a time of crisis. International aid is frequently in-kind. This creates major disadvantages, as the goods received may not necessarily be the ones that are most urgently needed and, because dealing with in-kind aid uses scarce resources during the emergency (means of communications and human resources), which could be used for other more important purposes (Keipi and Tyson, 2002). In addition, voluntary donations from the international community of individuals, NGOs and governments have averaged only about 3 % of direct economic losses in developing countries, although significantly higher for widely publicized events (Linnerooth-Bayer and Hochrainer-Stigler, 2015). Finally, the availability of ex post financing via donations or through low interest loans tends to create bad incentives, as governments may prefer to depend on these soft foreign resources rather than adequately create a proactive disaster risk management strategy (Keipi and Tyson, 2002).

Informal risk sharing - Kinship arrangements

It has long been observed that human beings rely on friends and family for assistance in times of trouble. Assistance takes many forms: help to find a job when unemployed, to deal with illness and health care costs, to compensate for a bad harvest, to cope with old age, or to overcome the death of a loved one (see more citations in Fafchamps, 2008). Mutual assistance between households is particularly important in poor countries where social insurance is weak or inconsistent and where risk is omnipresent. The community-wide formal and informal financing instruments, perform a very important role at the local level by supplying resources. When savings, credit and government support are not forthcoming, at-risk individuals in developing countries traditionally rely on financial arrangements that involve reciprocal exchange, kinship ties and community self-help (Linnerooth-Bayer and Hochrainer-Stigler, 2015). This represents ex-ante means of disaster risk management, since through these instruments the affected population creates informal reserve funds which would be exploited in case of disasters. These arrangements might be inappropriate for high-

layer, covariate risks, where whole families and regions may be affected, but could be very effective for low- and medium-layer risks. According to multiple surveys about 40 % of households in low-and lower-middle income countries are involved in private transfers in a given year (Davies 2007). The most common form of assistance is remittances, which at well over USD 400 billion in 2012, surpass foreign direct investment and development assistance combined (World Bank 2012).

Risk Pooling - National insurance programs and regional insurance pools

Public disaster programs can work in two forms which may or may not be related to the insurance activity. In the case of public disaster programs, the scheme works more or less as an insurance scheme, with specifics or changes ranged depending on the state or type of coverage. In the case of disaster funds, the schemes resemble more with a contingency fund, which is activated in cases of catastrophic nature. Using one or the other form is related to the nature of disasters that may hit a country, especially their severity and the financial ability of the country's government that has to deal with

BOX 6: TURKISH CATASTROPHE INSURANCE POOL

According to the Turkish Catastrophe Insurance Pool launched in 2000, earthquake insurance policies are obligatory for all property owners in Instanbul and other high-risk urban centers. Apartment owners pay a premium based partly on their risk to a privately administered public fund. If the fund cannot meet claims after a major earthquake, the World Bank provides a contingent loan to the pool.

Turkey pursues a model that approximates a scheme, through TCIP (Turkish Catastrophe Insurance Pool). It is a state-owned company offering disaster relief coverage. The company was created by the Turkish government in 2000, two years after the 1998 earthquake and at the same time, the earthquake insurance for all buildings became mandatory. In reality TCIP works partly as an insurance company, as a good part of its operations are subcontracted. Thus, operational management is carried out by a domestic reinsurance company, while TCIP products are sold by insurance companies operating in Turkey. TCIP provides acceptable coverage at affordable prices (up to the maximum level of 30'000 USD, but the value is indexed annually with the cost of construction index). The scheme has proven to be stable and its reserves are at adequate levels, however market penetration remains low, despite the fact that insurance is compulsory. TCIP had very good deals with the damage caused by several earthquakes in the past decade, but it still covers only a quarter of flats in Turkey.

Source: Mahul, O. and Skees, J. 2006. Piloting Index-Based Livestock Insurance in Mongolia, AccessFinance, World Bank, Issue no. 10.

them. Countries that have good ability to cope with the consequences and a moderate disaster risk prefer to choose the second form. While for those countries where the disaster risk is present at high levels and where it is required as much coverage as possible, they are oriented towards the first form, which is an alternative to reinsurance that was discussed in the paragraph above.

The first form involves the pooling of risks through a scheme similar to insurance, but with a focus on one coverage type and a specific area. In some cases the coverage can be extended all over the country. This practice has been used by some states, through the creation of special programs, in certain areas or across the country where the risk of a particular catastrophe is present. In Romania for example, in 2008, the Pool Against Natural Catastrophes (PAID) was set up as a re-insurance company, formed by the association of 12 insurance companies. The insurers, which are members of Catastrophe Insurance Pool, sell mandatory indemnity-based insurance against earthquakes, floods and landslides.

Programs work as state insurance, at affordable prices, and often mandatory ones. The difference from being directly insured is that these programs often have a social nature where the state offers reduced-cost policies, practically subsidizing insurance premiums for a part of the population. Many of these schemes are currently in trouble, as for example in the US, because if their deficit (losses) would not be covered by the state through the budget, they would get bankrupt. In addition, the coverage they provide has not been complete, as in many cases it is too low or minimal. So practically these schemes function as public co-insurance (pays minimal prime) with the government (covering losses). Such programs curb the private insurance industry because individuals, with state guarantee, tend to get less private insurance (or not at all), thus revealing a form of moral risk.

The economies of small developing countries are the ones most affected by disasters. Regardless of the measures that may be taken by the governments of these countries, the size of the economy itself, the underdeveloped insurance market, and the lack of a culture of the insured, make it difficult to finance the effects of disasters. But if some countries create a common mechanism, a regional disaster recovery fund is not only a new and rational solution, but it is an advantage for everyone.

BOX 7. NATIONAL CATASTROPHE INSURANCE FUND IN THAILAND

The establishment of the National Catastrophe Insurance Fund (NCIF) was the result of the flood crisis in 2011 throughout many regions of Thailand. There was an urgent need for the government to reconstruct and rehabilitate the nation, in order to relieve the damage to the public. This included setting water management systems and investing in public utility improvements. The crisis severely impacted the economy as well as public trust; thus, it became necessary to rectify the damage caused, prevent similar occurrences in the future and to recover the confidence of the public and foreign investors. The Fund was therefore one of the methods that was enacted under royal decree in 2012 (National Catastrophe Insurance Fund 2012). The objectives of the National Catastrophe Insurance Fund (NCIF) are:

1. To manage risks from disasters through insurance and reinsurance and to provide financial assistance to insurance companies involved in catastrophe insurance.
2. To provide financial assistance to catastrophe insurance companies with the highest coverage at suitable premium rates.
3. To provide the public with easy access to catastrophe insurance.
4. To regain the confidence of foreign investors and business operators to ensure that their businesses remain in Thailand.

The National Catastrophe Insurance Fund has sold catastrophe insurance since the 28th March 2012. In the initial stages of the Fund (right after the flood crisis), it had a total of 1.3 to 1.4 million insurance policies, and gained income from insurance premiums of around 542 million Baht (US$ 15.49 million), the majority of which were from households. As of the 7th May 2014, the National Catastrophe Insurance Fund (NCIF) had sold 1.08 million catastrophe insurance policies through 51 participating insurance companies, which has decreased from the 54 companies that signed a contract with the fund in 2012. The total insurance coverage was valued at 63,055 million Baht (US$ 1,801.57 million), and the private insurance companies had received 1039 million Baht (US$ 29.69 million) in insurance premiums. Private insurers re-insured their insurance coverage (sum-insured) for a total of 19,978 million Baht (US$ 570.80 million) with the National Catastrophe Insurance Fund (NCIF), for which they paid 642 million Baht (US$ 18.34 million) in insurance premiums. In the event of a disaster, the Fund will incur a burden of 20 billion Baht (US$ 571.43 million) as a result of retention (the difference between the risk absorbed by the Fund and the insurance companies).

Source: Thirawat, N., Udompol, S. & Ponjan, P. Mitigation and Adaptation Strategies for Global Change (2017) 22: 1021. https://doi.org/10.1007/s11027-016-9711-2

The idea behing regional insurance pools is that the risk is distributed to more areas and people. This practice is followed by the Caribbean countries, which are often hit by hurricanes. Thus, in the Caribbean there is CCRIF, which offers coverage from hurricane, earthquakes and dense rainfall for the 16 small states of this area. The program has proved to be successful in coping with damages from a number of

catastrophes, though it is still far from being a definitive solution to the disaster risk in these countries.

In addition to the disaster-related part, the above mentioned program also plays a significant role in propagating disaster risk mitigation and public education. Regional disaster funds are also considered solutions for other wider and larger areas of population, surface and high specific weight in the world economy. Even a large country like China has taken into account its involvement in a regional initiative for joint risk management disasters. In Europe, the EU recommends and takes into account countries' co-operation in the field of disaster risk management.

These projects are usually under the umbrella of international organizations such as the World Bank, which partially fund projects. These funds have been initiated by international organizations as the only way to cope with the risk of natural disasters in high-risk "hot" areas, in order to reduce the burden on the international community in case of catastrophic disasters in specific areas and participating states. Another major project in this context, called SEEC-CRIF, initiated again by the World Bank and other international organizations, is similar to that of the Caribbean and is thought to be applied in South East Europe and the Caucasus area.

Some of the major advantages of such schemes are that it:

- Reduces the exposure of governments of any country to a disaster risk by dividing it with other countries;
- Reduces the impact on the fiscal and macroeconomic parameters of each country part of the scheme from the occurrence of a catastrophe,
- Integrates insurance markets in the countries involved in the scheme, moving from small "micro-markets" to a larger market that can be easily introduced into the world reinsurance market,
- Improves risk management techniques through its diversification, due to the relatively different nature and geographies of the terrain and the economies of the countries,
- Reduces the dependence of the participating countries on the scheme from international disaster relief.
- Nevertheless, a regional fund, although offering great advantages, especially for small developing economies, still has its own problems.
- First, such schemes are more complex than national schemes that can apply to any country. This is because economic and social changes between different countries have to be considered. In case there are major differences between them, it may be more difficult to operate the scheme.
- Secondly, even in this case, the problem of moral risk is not avoided, which is always present when there is a public intervention in the insurance market.

- Thirdly, in order for the scheme to work well, the countries concerned should have the same profile of disaster risk, ie roughly the same vulnerability. By contrast, higher-risk countries would benefit at the expense of lower-risk countries.
- Fourthly, there is a need for political will and coordination which can be much more difficult and bureaucratic than in the case of a national scheme.

Regional disaster risk coping funds are thought to be a good opportunity in the future to increase financial protection from these events in small-scale, inefficient economies and small insurance markets. So far, the only experience is that of CCRIF, but the goal is to expand these schemes in South East Europe, Asia, South America and Africa.

5. INTER-TEMPORAL RISK SPREADING INSTRUMENTS

Inter-temporal risk spreading instruments offer a range of innovative ex-ante instruments for disaster risk finance, which could potentially reduce the burden on government resources and insurance system. Contingent credit, development and reserve funds and microfinance are some of these instruments already used in several developing countries.

Contingent Credit

One way to guarantee the availability of financing in case of disasters would be through a system of contingent credit lines through international banks. This represents a form of the ex-ante instrument, as an alternative financial recourse on which the state can rely in case of a disaster event. Contingent credit arrangements do not transfer risk, but spread it intertemporally (Mechler, 2003). In exchange for an annual fee, the right is obtained to take out a specific loan amount post-event that has to be repaid at contractually fixed conditions. The argument behind the use of this instrument relies in the increasing scarcity of post-disaster credit. This instrument guarantees a loan at a pre-determined rate, contingent on a disaster or some other defined event occurring, against a predetermined fee paid by the government (Linnerooth-Bayer and Hochrainer-Stigler, 2015). Contingent credit options are commonly grouped under alternative risk transfer instruments.

Despite their ability to provide fast financial resources to meet the emergency needs and can provide a government with lower cost capital relative to either insurance or the accumulation of reserves, its major disadvantage is that it can also, exacerbate a country's debt burden (Hochrainer 2006). In addition, as this instrument will transfer the cost from the current moment in the future, it basically do not change the behavior of economic actors. Therefore is very important to carefully analyze the needs for these kind of instruments, since the cost of repaying the debt will be borne by future generations. Many multilateral and bilateral international agencies can offer assistance

in analyzing the feasibility of different financing mechanisms given a country's economic circumstances and risk aversion.

As an early example of the use of this instrument, Colombia secured contingent credit from the World Bank to provide immediate and less expensive capital to the government in the event of a natural disaster (Cummins and Mahul 2008).

Reserve Funds and development funds

Specialized reserve funds for disasters have been created in several countries. In a reserve fund arrangement liquid funds before events should be accumulated, by making annual deposits of the funds. The idea is for the fund to accumulate throughout the years when no catastrophe event have occurred. The government and population can then rely on this fund in the case of a disaster event to finance the losses. In this case the funds will be ready to be used.

There is a risk with the reserve funds that the other arrangements do not exhibit: the risk of depletion of a reserve fund is relatively high, particularly in capital-scarce economies where it has been observed that such funds are depleted once there is a need for financing of other important issues or disasters have not occurred for a long while. Sometimes even the budgetary process does not allow to accumulate funds over budget years (Mechler, 2003). Thus the long accumulated time needed to build up substantial capital reserves is a problem.

Development funds are another instrument of ex-ante disaster risk finance. It usually works for prevention and mitigation with the purpose to finance activities which lead to the reduction of vulnerability. The risk that associates this instrument if the risk of exhausting their resources in case of an event that causes significant losses. This means that the development fund should not be used as a reserve fund. Therefore a need for a clear regulation for creating a development fund is crucial. These funds should not provide financial protection to the public or private sector after a disaster. Consequently, their bylaws should clearly stipulate that their resources are not available to finance emergency, rehabilitation or reconstruction activities (Keipi and Tyson, 2002).

There is a wide array of development funds that can be used to finance investments in prevention and mitigation. Keipi and Tyson (2002) illustrate the case of Latin America and the Caribbean, where there are municipal (urban and rural) development and environmental funds that can allocate resources for the prevention and mitigation of catastrophic events in addition to their normal activities. Some of these funds operate with reimbursable resources and allow the financing of major investments. For each of these funds there is a wide array of basic considerations that require special attention in the design stages. This refers to their legal structure and sources of capitalization, operating policies and rulings for the financing of projects, etc. Administrative and financial independence from political authorities (public or private administration) and the systems established to administer the resources are important

additional planning factors that affect the financial sustainability of these funds (Keipi and Tyson, 2002)

BOX 8: GOVERNMENT ASSISTANCE IN EUROPEAN COUNTRIES

Another form used by some European countries, such as Austria, Belgium, Denmark, Holland, Germany, Italy, Sweden, Norway, Poland, are special funds where the government compensates for event losses that are not taken over by the private insurance industry. In this form, two types of disaster funds are distinguished. The first type includes ad hoc funds, a scheme used by Germany, the Netherlands, Italy or Sweden. According to this scheme, the government officially declares a situation if it is a disaster and defines the distribution scheme. A part of the literature considers this strategy as an ex-post strategy for disaster risk management, although elements of these schemes have many elements in common with ex-ante risk management strategies. While the second type of schemes are part of the predefined schemes, it was Belgian or Austrian model, where the government does not expect occurrence of the disaster to distribute aid, but creates a "contingency fund for catastrophes" that can be used if needed, according to a predetermined scheme. The fund is usually funded by the state budget through taxes, but over time it can create its own resources through fundraising. The tendency of a large part of the European Union countries is to move to such schemes by combining them with the role of the state as a re-insurer. Such a form through specific funds is simple, but there is a limitation in coverage. However powerful it may be, a state cannot give guarantee indefinitely. Costs are paid by the public through taxes, and the state simply undertakes the role to redistribute the risk to the entire population. In countries where solidarity in the community is strong this scheme is more or less acceptable, especially when government opportunities are great to face financially the consequences. Also, many developing countries tend to choose such a form to face the risk of disasters, especially an ad-hoc basis (practically an ex-post passive strategy), creating an emergency fund for disasters, which, however, in most cases is not sufficient. These countries may choose this strategy also hoping to be supported by international donations to cope with the consequences. Politically, the second form (special disaster funds) has more advantage, of course, because the effect on the public is greater. In the case of a public security program, the effects of intervention appear more in the long run and are less vulnerable. Governments may be too "generous" to a part of the public even for purely electoral reasons. There are few cases where compensation is given to political preferences. One more problem is the public's "distrust" to the public security programs. These programs often make differentiations between different layers of the population, or provide incomplete coverage and public perception is often that is paying for something that does not completely solve the problem in case of a disaster. The major part of the public, in any case would prefer direct assistance as a more acceptable form. Also, the public may not be confident that the government will really reimburse it, especially in those countries where financial opportunities are not very large.

Microfinance and savings

Microfinance has played an important role over the years through providing support to people all over the world and creating resilience. In contrast to government financing, i.e. state insurance and alternative insurance instruments which provide security to vulnerable governments, microfinance targets the poor class of communities which often lacks access to proper livelihood activities (Association of British Insurers, 2007). In a broader context, microfinance is potentially an integral part of an overall disaster risk management strategy that reduces the financial vulnerability of individuals and households.

There are different microfinance products and services that can be offered to reduce the financial vulnerabilities of communities at risk. The term microfinance refers to the provision of financial services to low-income individuals, including the self-employed (Ledgerwood, 1998). According to this definition, financial services include savings and credits; however, insurance and payments are also considered as microfinance services.

From Micro Finance Institutions point of view, there is a range of products designed for the provision of any benefits to individuals' voluntary savings, pre- and post- disasters rehabilitation loan and relief loans, etc. (Akudugu, 2011). The variety of possible approaches reflects ambiguity regarding which product to offer in what kind of disaster stages, i.e. pre-disasters, or whether to let disasters strike the community and then launch a readily available product for relief, rehabilitation and reconstruction activities (Brown and Nagarajan, 2000).

Savings products generally play a crucial role in helping clients overcome their losses and rehabilitate to their pre-disaster social position. Regarding the case of Bangladesh, however, the compulsory saving products offered by most Micro Finance Institutions show the provision of limited benefits to their clients because of difficulties in accumulating meaningful balances and meeting substantial demands for withdrawals. Further, the research suggests different saving strategies for Micro Finance Institutions to help the affected communities in times of disasters, i.e. these institutions may allow voluntary withdrawal access and convenience in frequency and location of collection of the clients, which consequently, help clients accumulate larger balances. Despite the benefits of voluntary saving products in disaster protection of clients, some issues remain regarding the potential demand for voluntary savings and regulatory restrictions of MFIs (Brown and Nagarajan, 2000).

Concluding remarks

The previous sections offered a comprehensive overview of disaster risk finance instruments available to the government, businesses and households. The sections emphasized the classification of such instruments according to their approach (market or non-market instruments), the level of planning (ex-ante or ex-post instruments), as

well as their nature (traditional or innovative instruments). The wide availability of these financial instruments comes together with their costs and benefits.

Insurance and reinsurance require payment of premiums for a secure loss indemnification for insured elements. For many, an insurance contract can be a more dignified and secure means of coping with disasters than depending on the ad hoc generosity of donors (Linnerooth-Bayer and Hochrainer-Stigler, 2015). On the other side, the availability of microfinance provides low-income households, farmers and businesses with the right to receive post-disaster liquidity. It can this way reduce the burdens from disasters and expedite the recovery process—thus contributing to resilience. Contingent credit arrangements ensure promptly available funds and increased capital inflows in the affected country, in exchange for a fee to be paid over the years before the event. However, it might affect the ability of the country to take out future debt (Mechler, 2003). Reserve funds create an immediate financial response in case of events, but are prone to political pressure, which can cause the depletion of the fund before the event. They also do not insure that enough funds have been accumulated. Other innovative instruments, require knowledge, infrastructure and institutions that will lay the foundations for disaster safety nets (Linnerooth-Bayer and Hochrainer-Stigler, 2015).

Other costs and risks associated with disaster risk finance instruments include the modeling and pricing uncertainties, institutional stability, public confidence and trust; as well as moral hazard, adverse selection and basis risk (Linnerooth-Bayer and Hochrainer-Stigler, 2015). These instruments often impose additional financial burdens to the government or households, especially in the case of contingency credit and new taxes. The public is often reluctant to accept new means of disaster risk management, especially if they impose additional costs for their implementation. Both trust and financial literacy can be improved through educational awareness, and simulation games have been developed to improve understanding of insurance products. Moral hazard, although affecting insurance sector, could be eliminated using index-based or parametric contracts. Finally, often the implementation of new financial instruments requires risk modeling, for designing and pricing the instrument. Such models need data for calibration, and reliance on historical data is problematic, especially in developing and low income countries where there is a serious lack of data.

6. CLIMATE FINANCE

Climate change is expected to increase risks to businesses, infrastructure, assets and economies. Climate change is ecxpected to affect the likelihoos and severness of disaster events all over the world. Therefore strategies of disaster risk management should include climate change modeling. Appart from disaster risk financial means, there are further financial strategies targeting directly climate change. Despite the general recognition that risk financing instruments have a role in Climate Change Adaptation, there are concerns about striking the right balance between insurance and other financing instruments with needed efforts to reduce loss and damage. As Disaster

risk reduction and risk financing contribute importantly to climate change adaptation by lessening exposure and vulnerability and enhancing resilience to the potential adverse impacts of climate extremes. Recognizing the complementarities between risk reduction and risk financing as they contribute to disaster events of different severities can improve the contribution of DRM to CCA. The risk layer approach can be helpful to policy makers and practitioners in striking the right balance between investments to reduce risk, transfer risk and is effectively prepared for and manage disaster impacts, and to negotiators in appreciating the link between risk financing, risk reduction and climate change adaptation.

Climate finance is increasingly targeting a portfolio of strategies that include mitigation, adaptation, and technological development to address both issues will be required to diminish the risk associated with climate change. These synergies will also increase the cost effectiveness of actions to tackle the impacts of climate change. Understanding how to involve the private sector in responding to these risks – or encouraging them to take advantage of the new business opportunities that may arise from changing climate conditions – is crucial to catalyze greater investment in activities that increase countries, businesses, and communities' resilience. Development Finance Institutions (DFIs) are a means to drive private sector investment in climate resilience. Studies have found that a combination of policies, regulations, and longer-term debt from DFIs can trigger private investments in climate resilience, especially in the context of compliance with European regulations and pressure to meet changing market demand. Technical assistance measures can help stimulate demand for private investment by addressing knowledge gaps. For instance, through support to water-dependent businesses to identify opportunities for climate resilient investments, and engaged local banks in the financing of water-efficient technologies.

Addressing climate challenges will require the implementation of different projects and programs in the area of climate change mitigation and adaptation. While multinational donors, such as the GEF, have certainly become the mainstay of funding for projects with global environmental objectives, it is also becoming increasingly apparent that funds of this nature alone do not provide the long-term answer to financing global environmental protection measures. Consequently, additional sources of revenue that can provide predictable funding flows are needed, not only to ensure that future projects can be fully financed, but also to ensure that measures instigated by the past and current work of bodies such as the GEF are maintained (Miles, 2008). A decentralized approach to 'innovative financing', focusing on taxation, development-based charges, entry fees, small-scale enterprises and initiatives taken at the local level between the private sector, government authorities and NGOs. This could fill in the gaps left by large environmental funds and, in this way, ensure sustainable funding for global environmental objectives. International and domestic options are available within these innovative financing sources.

There is no single, perfect institutional arrangement to mobilize and deliver climate finance, and efforts to strengthen coordination around climate finance must contend with messy domestic landscapes, with new sets of policies needed for diverse sets of actors. Ministries of environment, finance and non-governmental actors, all have vital roles to play: the key is to create incentives and accountability for these institutions to work together. Institutional arrangements for climate finance lie on a continuum wherein they 'dock' international or external climate finance in the national system, or 'mainstream' climate considerations into core policy and associated investment decisions and financial frameworks. A key to coordinating climate finance can be summarized as:

- A drive to overcome a highly fragmented approach within central government, local governments, private sector and civil society actors all playing significant roles in low emission and climate resilient development.
- Developing well-defined policies, for instance, in the solar energy and energy efficiency markets, triggered by national climate policy to spur climate related finance through a variety of domestic and international, both public and private, sources.
- Integrating the main institutions responsible for climate finance to overcome a wealth of stakeholders at the national and subnational level, in both the public and private sectors to develop a clearer sense of opportunities and priorities using both domestic and international finance.
- There is a need for a coherent strategy on climate finance, which interfaces ongoing efforts on mitigation and adaptation with the emerging domestic and international financial arrangements.

Some adaptation financing mechanisms that could be used to address adaptation in several sensitive areas are summarized in Table 4. They include both international and domestic funds.

Table 4 – International and domestic financing mechanisms

Source of funding	Financing instruments	Field of action	Examples of adaptive measures
International funds	Grants and Donations Soft credits and loans Swap contracts IPA	Biodiversity; Forestry; Ecosystems; And/or any other areas of international importance	• Measures related to the reforestation, forest regeneration, grazing control, fire prevention and introducing agro-forestry practices in Forest Areas • Measures in the protected areas (PAs) including management of coastal PAs, lagoons, biodiversity restoration and monitoring plans • Coastal wetland restoration for increasing ecosystem resilience and adaptation capacity
Domestic funds From the private sector:	Payment for Environmental Services (PES) Financial conditions for the approval of private activities located in tourist or protected areas Compulsory insurance of property Licensing fees for touristic operators	Tourism Agriculture Forestry	• Technological improvements • Provide appropriate tourist Infrastructure in response to the changes of the sea level
Domestic funds: From households	Environmental taxes and charges for municipal services Compulsory insurance of property	Population and Settlements	•Increase adaptive capacity and livelihood support to the coastal human communities •Adaptation of buildings, construction techniques and building models in order to minimize the negative effect of high temperatures
Domestic funds From the state sector:	Review of budgetary allocations for infrastructure, forestry, agriculture; Civil Emergency Fund Environmental taxes Insurance Entry fees in protected areas and touristic locations Subsidies	Infrastructure Hydrological Regime and Water Resources Forestry Agriculture Biodiversity	• Protection of water resources from coastal erosion • Introduction of agro-forestry practices • Forest fires prevention and warning systems • Introduce monitoring system in protected areas • Improve the lagoon systems

7. SUMMARY

This chapter offered a thorough analysis of financing sources in case of disasters. These sources were classified on the basis of their approach, time frame and nature. A literature review regarding the macroeconomic risk of natural disasters and some approaches and instruments for financing the risk of these disasters was presented at the beginning of the chapter. The focus on this first part was the economic impacts of a natural disaster. After this overview, a more detailed analysis of the specific tools of disaster risk finance was the focus of the ongoing sections of the chapter. These tools were grouped into three main categories such as: insurance, capital market instruments and government intervention. The main idea of this part is the transfer of the risk through different financial instruments. In order to have a more practical idea of the issue, some case studies were also included to illustrate the use of different financial instruments in the developing and developed countries. Finally, a section on climate finance was included, as an important topic in international public discussions. It is very important for businesses to gain opportunities that may arise from changing climate conditions and to catalyze greater investment in activities that increase countries, businesses, and communities' resilience.

8. QUESTIONS

Part 1

1. Discuss on the direct, indirect and macroeconomic costs that a major flooding event might have on your country
2. How does the insurance companies in your country handle the natural disaster risk?
3. Which are the ex-ante and ex-post instruments of financial strategy in case of disasters? State the difference between the two groups. Discuss on the challenges faced by a country when considering ex-ante financial instruments. Discuss on the problems related to ex-post disaster risk financing.
4. Discuss on the impact of climate change, and why it is important to include climate change planing in disaster risk reduction strategies.
5. How does a disaster event affect imports and exports of a country in the short and long run. Discuss on such impacts
6. Discuss on the role of financial plans in the framework of a disaster risk management cycle.

Part 2

1. Discuss on the traditional and inovative financial instruments for disaster risk reduction. Why are new financial products created? How they adress different issues related to traditional financial instruments?
2. Think about a natural disaster peril. How does it satisfy the requirements for an insurable risk?
3. Which of catastrophe insurance model, discussed in the text, may be implemented in your country context? Discuss.

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ANNEX 1: ADDITIONAL CASE STUDIES[7]

In these cases of catastrophe planning, the main point of discussion is the consideration of using the capital markets by the governments to deal with catastrophes. First, governments have regulated policy holders' premium payments and insurance surcharges to accumulate reserves immediately and helped, in some cases, by serving as the insurer of last resort and/or the initial reinsurance provider. Second, governments have created credit facilities with the power to levy emergency assessments similar to an excise tax on insurance policies to meet low frequency, high risk events. There are three cases below that bring the conclusion regarding the expectation that the capital markets will have the capacity to accept the spreading of the risk of post-event claims-paying ability. These catastrophic risk, financial intermediaries have been successful in their brokerage and asset transformation roles. Moreover, these financial intermediaries currently enjoy strong credit strength thus far.

[7] Source: Hildreth, W. Bartley and Miller, Gerald J. & Sewordor, Emefa, State Government Catastrophe Risk Financing and the Capital Markets (2011). National Tax Association, 2011 Conference, New Orleans, November 17, 2011.

THE CASE OF FLORIDA

In the years following the devastation caused by Hurricane Andrew on August 24, 1992, Florida created three financial intermediaries to deal with private property loss due to future hurricanes: the Florida Insurance Guaranty Association, the Florida Hurricane Catastrophe Fund, and the Citizens Property Insurance Company. Each institution is examined, and its implications for the primary state government are discussed.

Florida Insurance Guaranty Association. The Florida Insurance Guaranty Association (FIGA) was found wanting as a guaranty fund in the aftermath of Hurricane Andrew, which led to six insolvent insurers. Quickly passed legislation allowed the FIGA to obtain access to the tax exempt bond market through a revenue bond issued by a municipality. In 1993, the City of Homestead, dead center of the destruction zone, issued $473 million in insured revenue bonds for FIGA rated "A3," with repayment secured by a surcharge of up to two percent on all property insurance policies in the state, with some exceptions. Although this debt is now paid off, with no new debt issued, the FIGA retains authority to borrow money through cooperating municipalities.

Florida Hurricane Catastrophe Fund. As a single-peril entity, the Florida Hurricane Catastrophe Fund Finance Corporation (FHCF or 'Cat Fund') was created as a state enterprise fund to help participating insurers cover losses after a hurricane. Residential property insurers, with limited exceptions, must participate in the Cat Fund, retain certain loss levels, and pay annual premiums to the FHCF proportionate to their share of FHCF's risk exposure. The legal assessment rates allowed mean that, given Florida's $33.6 billion assessment base in 2011, the FHCF could levy annual surcharges of up to $2 billion for one contract period and $3.4 billion for multiple years. In 2007, the FHCF issued $3.5 billion in taxable pre-event floating-rate notes with maturity on October 15, 2012, set at 1-month LIBOR+78 basis points. This has been the seventh largest municipal issue in the country since January 1, 2007, to May 2011. However, the FHCF's financial advisor has judged that the market would have less room to accept FHCF debt. The financial advisor estimated that the FHCF would need $11.22 billion in post-event bond proceeds. Placing this bonding agenda in perspective helps. Since 2009, the largest single issuance was by the State of California for $6.54 billion in 2009. According to its financial advisor, FHCF's potential borrowing magnitudes are "extremely large by market standards" at the same time that a "smaller [overall municipal bond] market with a more limited buyer base may present challenges that did not previously exist for the FHCF in issuing bonds" (Raymond James, 2011, p. 5). With $5.65 billion in debt outstanding and despite a high-quality bond rating (Aa3/AA-/AA

by Moody's/S&P/Fitch, respectively), a participating underwriter warned: "At some level, the necessary size, structure and immediacy of FHCF's borrowing needs may collide with a limited tax-exempt capital base" (Raymond James, 2011, p. 25).

Citizens Property Insurance Corp. Florida created the third, and most controversial, financial intermediary in 2002 as the residual property insurer of high-risk coastal areas. The Citizens Property Insurance Corp (CPIC) was established as a not-for-profit, tax-exempt political subdivision of the state, not an insurance company. The CPIC is a (discretely presented) component unit of the State of Florida, meaning that its finances are reflected in the State's audited financial statements. Given this statutory status, the CPIC qualifies as an issuer of tax-exempt securities. CPIC accesses the bond market for the largest and highest risk of its three accounts – the coastal account. To Fitch Ratings (2011, p. 1), the CPIC "can place an 'emergency assessment' on nearly every insurance policyholder in the state for an unlimited duration and in an unlimited cumulative amount to pay debt service on the bonds." As such, it is an assessment on the policyholder, not an obligation of the insurer. Debt capacity for all three Florida entities is a concern. In each case, their bond offering statements are clear that the bonds are payable solely from specified pledged revenues and are not a pledge of the taxing power or general credit of the State of Florida or any instrumentality thereof. There is concern that if post-event bonds were needed by one or all of the entities, the "headline risk" of the disaster could lead to higher interest rates and, at the same time, the other state-sponsored hurricane financing intermediaries would likely face similar capacity needs, thereby leading to an "overload of Florida debt issues in the capital markets" (Newman, 2005, p. 75).

THE CASE OF LOUISIANA

Beginning in 1968, the State of Louisiana created a series of last resort insurance entities that were consolidated into the Citizens Property Insurance Corporation (LCPIC) in 2003, which under federal tax law means that its income is exempt and its debt obligations qualify for tax exemption. To Fitch Ratings, the LCPIC is authorized to issue assessment revenue bonds backed by emergency assessments on "nearly every property insurance policyholder in the state for an unlimited duration and in a sizable, cumulative amount to pay debt service on the bonds." That its finances are reported as a (discretely presented) component unit of the State of Louisiana's audited financial statements confirms the State's financial accountability for the LCPIC. Insurance claims resulting from Hurricanes Katrina and Rita in late 2005 wiped out its reserves, requiring the LCPIC to issue bonds backed by emergency assessments. Once it

became clear that emergency assessments of 15 percent on all property insurance policyholders throughout the State would be imposed for losses incurred in south Louisiana, the governor and lawmakers quickly sought avenues to offset the imposition, even offering tobacco settlement securitization transactions to generate funds for a one-time refund to property policy holders (Desue, 2006). On December 2006, legislation passed that allows ratepayers to claim a refundable income tax credit for LCPIC emergency assessments paid. The LCPIC bond offering statements are clear that the bonds are not a debt or liability of the State of Louisiana. Instead of carrying the State's "AA" rating, the LCPIC debt of $912 million has an "A-" bond rating.

THE CASE OF CALIFORNIA

Following the January 17, 1994, Northridge earthquake, the insurance industry severely curtailed the availability of earthquake coverage for residential and commercial policyholders. To preserve a market, lawmakers created the California Earthquake Authority (CEA) in 1996 as a residual insurer. To Fitch Ratings, the CEA is treated as a private insurer and uses that term (unlike the Louisiana and Florida catastrophe intermediaries, which are treated as "tax" like and by their public finance credit group). Moreover, the State of California does not consider the CEA as part of its financial accountability so the CEA's financial information is not included as part of the State of California's audited financial statements, again a practice that differs from its Florida and Louisiana counterparts. However, as an instrumentality of the State, the CEA has tax-exempt status under the federal income tax and can issue tax-exempt securities. To protect its claims paying capacity, the CEA purchase reinsurance contracts (of an innovative manner4) but has entered into only one issue of municipal securities - $315 million taxable revenue bonds in 2006. An annual mandatory sinking fund payment of $31.5 million prevents the CEA from treating this as a bullet maturity with all coming due at one point, ten years later. Pledged policyholder premiums are used to pay the semiannual interest and annual sinking fund payments. Bond proceeds are invested for the payment of future claims. The CEA's 2006 bond offering statement is clear that the bonds are not a debt or liability of the State. CEA's "A" credit rating by Fitch Ratings is the same as the State's.