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Scoping Paper

Insurance and Climate Change

Draft

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Introduction

Insurance instruments that provide financial security against droughts, floods, typhoons and other weather extremes have recently emerged as an opportunity for developing countries to mitigate the adverse impacts of climate change on their economies and populations. This opportunity arises from a number of recent innovations - technological advances make it possible to model and price low-probability risks; index-based insurance contracts have proven to provide a viable alternative to indemnity insurance which traditionally has been plagued by the adverse selection and moral hazard problems; while the development of the Insurance Linked Securities and weather risk markets has opened new windows for non-traditional weather risk transfer arrangements. However, despite all these advancements, availability and affordability of suitable weather risk insurance or risk transfer products, particular in developing countries, remains a major problem.

In this context, it is of paramount importance for the international development community to encourage the development of innovative risk transfer instruments that can reduce economic and human losses from the growing weather extremes and variability in developing countries. Moreover, well-designed insurance instruments can provide powerful incentives for disaster risk mitigation as part of a global adaptation to climate change.

Parties to the UN Framework Convention on Climate Change (UNFCCC) have committed themselves to considering the special needs and concerns of developing countries resulting from the adverse effects of climate change in the area of insurance. Article 4.8 of UNFCCC and Article 3.14 of the Kyoto Protocol propose actions, including insurance, to meet the specific needs and concerns of developing countries in adapting to climate change. The Bali Action Plan (BAP) similarly provides for more detailed negotiations on a climate risk insurance mechanism. There is a growing interest within the global community on the vital role of insurance and related mechanisms in assisting developing countries adapt to climate change. Yet, despite the growing recognition of insurance as an adaptation tool, until today it remains a loose concept with little consensus around key definitions, objectives or the mode of implementation. Furthermore, the positive role that can be played by insurance and other market-based risk transfer mechanisms in the process of adaptation to climate change is often misconceived. The purpose of this paper to provide a conceptual framework, along with concrete illustrations, that will aid the UNFCCC process in incorporating market-based insurance mechanisms in the arsenal of proposed global climate adaptation tools.

The structure of the paper is as follows. Section I defines the role of insurance in adaptation to climate change. It outlines a conceptual framework that throughout the paper will guide our analysis of private insurance instruments and government backed insurance programs designed to deal with manifestations of climate change. In Section II we apply the developed conceptual framework to review selective government weather risk insurance programs. Section III reviews the existing market-based weather risk insurance and hedging instruments in developed as well as developing countries. Section IV analyzes major barriers to the development and mainstreaming of cost-effective market-based insurance products that can address the risks of weather. Section V analyzes the role played by governments in catalyzing and facilitating catastrophe insurance products. The Section also provides an overview of the role and significance of public private partnerships in insuring weather related losses as well as the best practices in such undertakings. Section VI identifies the most promising future strategies/initiatives in climate risk insurance that can help developing countries to cope financially with extreme weather events and increasing weather volatility. Section VII concludes by providing an overview of lessons learned and identifying opportunities for market-based insurance strategies in the global adaptation for climate change.

Section I. Defining the role of insurance in adaptation to climate change

One of the key objectives of this report is to define the role insurance can play in helping households, businesses, and countries better adapt to the main known manifestations of climate change such as:

- increases in weather variability;
- new extreme values of temperatures, precipitation or wind speed in certain regions;
- new risk exposures (like hurricanes in the South Atlantic or in the Persian Gulf);
- increased frequency and severity of weather related disasters.

The adverse economic effects of the above mentioned weather patterns can be severe, particularly for countries whose economies and populations' livelihood largely depend on weather. This includes countries where agricultural exports account for a sizeable part of national GDP or with industries with considerable risk exposure to weather such as agro food processors, power utilities, skiing and summer resorts, airports, etc.)

While insurance cannot prevent climate change from happening, it can become an effective adaptation tool that for a small premium can considerably reduce the adverse financial implications of climate change for businesses, individuals, and often whole countries. However, if insurance were to become a cost-effective adaptation strategy, insurance buyers (as well as government sponsors of insurance programs) must be well aware of its limitations and main principles of insurability. These can then be effectively applied not only in assessing the viability of existing insurance products but also for evaluating the financial sustainability of government backed insurance programs dealing with weather related risks. Hence we begin this report by formulating the main evaluation criteria for both private and government-owned insurance product lines. These criteria are then applied to analyze the financial sustainability and technical merits of all products referenced in this paper.

Assessing the viability of insurance products

In general, in our view to be viable an insurance product must meet the following criteria five criteria:

1. insurability;
2. customization;
3. affordability
4. sustainability;
5. market complimentarity (for government-backed products)

While the above described criteria are universal for all insurance products, in the case of climate change related risks, the ability of an insurer or (a risk underwriting entity) to meet them is particularly challenging. A brief discussion of each of the above mentioned key criteria follows.

Insurability of weather related risks

Traditionally, insurance has been defined as a form of financial risk management primarily used to hedge against the risk of a contingent loss by means of risk transfer from one entity to another in exchange for a premium. However, an insurance arrangement between two parties is feasible only when all of the following insurability conditions can be met:

(i) a writer of an insurance contract can assess the probability of an insured event, e.g. has adequate information about the risk, which allows to properly underwrite and price the risk;
(ii) an insurer can limit or prevent the ability of insured to influence the insured outcome to their own advantage (also known as moral hazard);
(iii) the exact timing of the insured outcome is unknown, e.g. the event is random;
(iv) all or most of insured risks do not occur at the same time, e.g. the risk is diversifiable;
(v) insured loss events are relatively rare, which makes insurance coverage affordable.

As can be seen from Table 1, not all of above mentioned climate events meet fully our definition of insurability. For instance, such risks as *sea level rise, shifts in climate zone* or *temperature rise* are clearly beyond the scope of insurability as they are continuous systematic (rather than random) events that have to be dealt with through mitigation, compensation and economic adaptation strategies.

Although *flash floods* and *drought* also do not meet fully all insurability criteria because of their frequent nature and the moral hazard which is difficult to control, they can still be insured through public-private partnerships or introduction of high deductibles or innovative parametric products which allow to cutoff more frequent loss events and reduce moral hazard.

Table 1. Insurability of climate related risks

Insurability criteria	*Climate related risks*						
	Storm surge flooding	Flash flooding	Drought	Wind storm	Sea level rise	Climate zone shift	Temperature rise
Probability assessment	Yes	Limited	Limited	Yes	Limited	Limited	Limited
Control over moral hazard*	Yes	Limited	Limited	Yes	Limited	Limited	Limited
Extent of randomness	High	Moderate	Moderate	High	Low	Low	Low
Diversification potential	High	Moderate	Moderate	High	Low	Low	Low
Frequency of insured events	Low	High	High	Low	Continuous	Continuous	Continuous

Notes: *The estimate assumes the use of traditional indemnity type insurance products.

Therefore, from now on our discussion of insurance in the context of adaptation to climate change will refer to only four insurable climate risks, of which only two risks (storm surge flooding and wind storm) are insurable without any reservations:

- storm surge flooding
- flash flooding (restricted)
- drought (restricted)
- wind storm

Customization

For insurance products to be in demand, they have to address the unique risk exposures faced by the insured. Different customer groups have different risk exposures and hence require different insurance products to address their needs effectively. For instance, a comparison of catastrophe risk exposures for homeowners and SMEs, makes it clear that the scope of coverage for these two customer segments should be different. In the case of homeowners, key risk exposures are likely to include (in order of priority) damage or property loss, damage or loss of contents, loss of dwelling usage and living expenses related to it, and loss of rental income. The case of SMEs is somewhat different as business are likely to be most sensitive to loss of earnings due to business interruption, as well as loss of business equipment and premises, which often are business owners' only assets. One can also demonstrate that in general the risk retention capability of SMEs is higher than those of homeowners, which dictates different level of deductibles for these customer groups.

Besides being useful in limiting the customers' specific risk exposures, the concept of customization also covers the potential of insurance products to be replicated on a large scale to appeal to a larger customer base required for risk diversification purposes.

Reaching the right combination of product-customization and replicability often presents one of key challenges to be addressed by insurers.

Affordability

Affordability is the key feature of any successful insurance product. Products that are priced well above the means of the targeted consumer group are doomed to fail. Yet, affordability should not be equated with under-pricing of risk or government premium subsidies. Government-sponsored catastrophe insurance programs should strive to offer affordably priced products by first minimizing the costs involved in their underwriting, distribution and servicing, as well as through capital optimization and effective use of reinsurance. The other cost reducing option is to adjust the scope and the terms of coverage, reduce the overall sum insured, as well as raise deductibles to fit the affordability constraints of the selected customer group.

Sustainability

All catastrophe insurance products and insurance entities underwriting them should be designed with a view of ensuring their long-term financial sustainability. This means that these programs should:

(i) receive enough premium to meet their operational costs, pay claims, cover reinsurance costs, and build reserves;

(ii) have a level of claims paying capacity and risk diversification sufficient to ensure for a high survivability rate, e.g. 99.5% or higher.

It is also important to ensure that the incentives of insured and insurers are aligned through a meaningful risk-sharing arrangement. For instance, the insured could be provided with financial incentives to reduce their vulnerability to weather related natural disasters over time, either through a reduced price of coverage or a lower level of deductibles.

It is also essential to build-in a provision for the withdrawal of government financial support at a later stage to ensure the products long-term financial sustainability.

The financial viability of insurance products and eventually of the insurer also depends on rigorous risk underwriting, accurate actuarial pricing and prudent risk management of insured risks.

Market complimentarity

Donor supported insurance products for climate change should be designed with the view of avoiding causing damage to the nascent private insurance markets for such products. One of the main criteria of market complimentarity is the extent to which the new product competes on price with the existing similar private insurance/reinsurance market products and services. Adherence to this principle will help minimize the distortion to the existing market, and will serve as a catalyst for the market's growth and development. For instance, while the growing donor support for index-based (parametric) insurance products in developing countries provided an important catalytic effect for market development, any future attempts to subsidize parametric products should be discouraged as they threaten to undermine the nascent new risk markets as well as the already existing traditional insurance products.

At the implementation stage, government-supported catastrophe insurance programs should take full advantage of the existing market-based insurance infrastructure, such as distribution systems, premium collection, loss settlement, management, IT and reinsurance. If there are government premium subsidies involved they should be targeted to the poorest segments of the market to avoid crowding out private insurers.

In cases of a capital subsidy, it is essential that that it does not disproportionately benefit individual market players at the expense of others. Ideally, capital subsidies should be granted to industry administered pools (rather than individual private insurers) that provide insurance products not offered by individual private insurers.

Summary

In this Section we have developed 5 main criteria for comparing and analyzing different financial and insurance products that can address the risk of climate change. These are (i) insurability; (ii) affordability; (iii) financial sustainability; (iv) the level of customization and, (v) market complimentarity. In the following Sections we will apply these criteria to review a range of government and private sector (climate change related) insurance products to determine their key strengths and weaknesses, identify the main impediments to the expansion of weather risk transfer insurance and capital market products, and discuss the role to be played by the governments and international donors.

Section II

Review of selective government weather risk insurance programs

The main objective of this Section is to review and compare two different government backed weather risk insurance programs – one in the US, and one in the Caribbean. While the presented insurance programs are very different in terms of their design, by applying the analytical framework developed in Section I we attempt to discern their essential operating features and rate them on five major counts – insurability, affordability, sustainability, product customization and market complimentarity.

United States Federal National Flood Insurance Program (NFIP)

Created by the US Congress with the National Flood Insurance Act of 1968, the program aims to enable property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. The program was meant to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. However, from the outset the program failed to introduce actuarially sound pricing for its policies. Although, over time NFIP has made great strides to address this problem, even today, about 25 percent of properties insured under the program do not pay actuarial rates for their coverage. In 2007, the program had 5.5 million policies in force in five flood-prone states which generated $2.3 billion in premium and resulted in over $1 trillion in overall risk exposure. Over one third of that premium has been paid to 88 private insurers participating in the program in the form of distribution and claim settlement fees. The program never has had any reinsurance, instead relying on its ability to borrow up to $1.5 billion from the US Treasury. The losses caused by the 2005 KWR hurricanes cost FEMA over $20 billion, which in the absence of access to the federal liquidity facility, would have left the program in a state of insolvency.

Yet, reliance on the government debt facility (instead of reinsurance and capital markets) for most of its claim paying capacity does not seem to be sustainable. With over $18 billion in debt from the 2005 hurricanes, the program's annual interest alone came to $0.8 billion, leaving it with little chance to restore its solvency and build reserves to prepare for another large event. To restore the program back to its solvency, the new Flood Insurance Reform and Modernization Act of 2007 forgave the NFIP's current debt and enabled it to raise premium rates. However, at the same time, the newly enacted legislation added wind coverage in addition to flood coverage in the NFIP's policy, which despite the increased scope for raising the premium rates will dramatically increase the program's exposure to catastrophe risk in the future.

Insurability. The flood coverage offered by NFIP does not differentiate between flooding (caused by heavy rainfall, rapid thawing or glacial melt) and that caused by storm surge as a result of offshore winds pushing water ahead of the storm. Both types of flood have limited insurability in high risk areas prone to frequent flooding that are at or below sea/river level and are unprotected by adequate man-made flood defences. Yet, insuring uninsurable properties (e.g. located in high risk flood zones) could be very risky. For instance, according the NFIP statistics, the highest amount of aggregate claim payments per policy over the last 30 years falls on the St. Bernard Perish in Louisiana, which at the end of 2008 was $171,635 per policy in-force (compared to the national average of $6079). To put it differently, while in 2008, the aggregate premium contributed by the Perish over the last 30 years accounted for only 0.2% of total NFIP premium, its contribution to an aggregate national 30 year loss was 6.5%.

By continuing to provide flood coverage to properties in high-risk areas at a fixed uniform premium rate, not only does the NFIP assume a higher level of risk exposure but also discourages active mitigation efforts by owners of these highly flood-prone properties. It must be mentioned however that the NFIP supports the Community Rating System (CRS) which is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are reduced for communities participating in the program to reflect the reduced flood risk resulting from the community actions.

Customization. The NFIP offers rather versatile property coverage aimed at meeting the flood insurance needs of millions of homeowners and businesses. This, for instance, includes coverage for personal homes, up to $250,000, and for personal property, up to $100,000. The program also allows choosing different levels of deductibles. The only obvious deficiency with coverage is the maximum insured limit that cannot be increased for more expensive properties.

Affordability. While the premiums vary depending on the amount of coverage, type of coverage and the level of deductible chosen, overall they do not appear cheap when compared with the average rates on FLEXA policies, on average being at least 5 times the premium rate of the homeowners policy (insuring predominantly against fire) for similar insured limits. There are only two types of premium ratings available.

Sustainability. Despite the increased scope for raising premium levels in the latest NFIP legislation, the future financial sustainability of the program still remains a major concern. In the absence of the US Treasury's backing the program will be financially unsustainable due to the lack of actuarially sound pricing of the risk (there are only two risk ratings!), and the full risk retention by the program with no attempts to control its accumulations either through differentiated pricing or risk transfer to commercial reinsurers.

Market complimentarity. Before 1968, the federal government's flood initiatives consisted of disaster relief to victims in the event of a flood, or flood control projects such as dams, levees and seawalls. While well-intentioned, this approach did little to ease the financial burden of most flood victims. Worse, the public couldn't buy flood coverage from most insurance companies, which regarded floods as too costly to insure.

In 1968, the Federal Government established the flood insurance program in response to market failure to provide flood insurance to homeowners across the United States. Since then however, the program has assumed a full monopoly on the residential flood market in the US by under-pricing coverage offered in high risk areas and effectively crowding out any competition from the private sector.

Caribbean Catastrophe Risk Insurance Facility (CCRIF)

Established in the spring of 2007, the CCRIF enables CARICOM governments to purchase coverage akin to business interruption insurance, thus providing governments with access to immediate liquidity in the aftermath of a major earthquake or hurricane. Because of the speed at which a claim payment will be processed, the instrument is designed to finance the immediate post-disaster recovery needs, giving the affected government time to mobilize additional resources for longer-term reconstruction activities.

Insurability. The CCRIF insures the risks of earthquake and tropical wind with a return period of about 20 years or longer, which makes these risks fully insurable. The availability of inexpensive reinsurance capacity from the global reinsurance market for the third year in a row provides the ultimate proof of these risks insurability.

Product customization As a risk aggregator, the Facility provides insurance coverage to participating countries at a significantly lower rate than individual states could obtain on their own, by enabling participating countries to pool their individual risks into a single, better-diversified portfolio. The Facility retains some of this risk through a buffer of reserve funds established with the assistance of donor partners. The risks that cannot be retained by the Facility are transferred to the international reinsurance market.

To ensure quick uncontested payments, insurance coverage relies on parametric techniques where payouts are calculated based on the estimated impact of adverse natural events on budgets of countries participating in the program. The estimated budgetary impacts are derived from probabilistic catastrophic risk models developed specifically for the Facility. To avoid cross-subsidies among countries, participating countries pay premium commensurate with their unique risk exposure and receive compensation proportional to the losses from the predefined events depending on the level of coverage agreed upon in the insurance contract.

Sustainability The Facility is registered and operates as an independent legal entity acting as intermediary between the participating countries and the international financial markets. It is supervised by the Board of Directors comprised of representatives of the participating Donors and the Client countries. Should the insured losses exceed the claim paying capacity the Facility will pro-rate payouts to all affected countries.

To increase the long-term financial sustainability of the program, the initial $47 million donor contribution to the capital of the Facility is priced into the cost of country coverage, which enables the Facility to use surplus for building the reserves. To illustrate, only 42 percent of the facility's premium income is currently spent on reinsurance, with the rest going into reserves. Today, the Facility has a claims paying capacity sufficient to survive a 1-in-1000-year event, with most of this coming from the international reinsurance market. By the end of 2008, sixteen Caribbean countries have participated in the CCRIF. This high level of enrollment allowed the CCRIF to efficiently diversify its risk portfolio and thus access reinsurance on better terms.

Affordability. The program enables the small countries of the Caribbean to buy catastrophe insurance coverage on pricing terms which are by far superior to those offered in the market place. This competitive pricing is achieved mainly by the ability of the pool to diversify and retain a considerable part of the lower level (more frequent less severe) risk before transferring it to the reinsurance market. There is a considerable price advantage in retaining the lower risk layers as those typically produce almost certain frequent losses which are easy to predict but hard to diversify through a risk transfer to reinsurance market. The affordability of the insurance coverage from the CCRIF is further ensured by the availability of the World Bank financing for premium payment to the poorest countries of the region.

Market complementarity. From the inception, the Facility has been striving to avoid competing with the private insurance and reinsurance market. This has been achieved by designing and offering a highly innovative parametric insurance coverage for countries that was not available from the private market. To ensure professional management and full adherence by the Facility to market practices, all functions of its day-to-day operations have been subcontracted to specialized private insurance providers. Such extensive use of private sector services also achieved high cost efficiencies, which is illustrated by the program general operating expenditures not exceeding 5 percent of its premium volume.

Summary

In this Section we applied the analytical framework developed earlier in assessing the operations and overall financial sustainability of two well-known government sponsored catastrophe insurance programs underwriting the risk of weather related natural disasters such as floods and tropical wind. In brief, two out three programs do not meet the minimum sustainability requirements as they provide insurance coverage below the technical cost of risk and make no efforts to control their accumulations or buy reinsurance protection. In fact, risk under-pricing and the lack of adequate risk management can be named among the main reasons for the eventual demise of government sponsored insurance and reinsurance programs.

Section III
Review of market weather risk insurance and hedging instruments

Weather risk hedging instruments for developed markets

In the recent years, in response to the growing manifestations of climate change many companies have been trying to make their operations more weather proof. However, often due to the nature of the business this strategy may not be practical or cost-effective. As a result, to deal with their risk exposures companies often turn to weather risk hedging which offers numerous benefits. For instance, by hedging their risk exposure to unfavorable from the business point of view weather companies can reduce the volatility of their earnings, improve market valuation and the terms of borrowing.

So, what is weather risk hedging? Weather risk hedges are financial instruments that allow financially offset or considerably reduce the weather risk exposure faced by the buyer of such a contract in day-to-day business operations. By making an investment in such a hedging instrument, the buyer of the contract expects to generate income in the amount closely approximating that lost due to a bad weather.

As more and more companies turn to weather risk hedging to protect their earnings and market valuations against the vagaries of weather, demand for weather risk hedging instruments will expand beyond energy utilities and market speculators – the traditional buyers of weather risk protection. Such market development will in turn bring down the transaction costs and improve the liquidity of weather risk hedging instruments.

However, today the weather risk markets still face numerous challenges. From the buyer’s perspective, one of the main limitations of weather derivatives is a potential mismatch between payoffs and actual financial losses due to adverse weather conditions, the problem known as the basis risk. The presence of considerable basis risk is also what differentiates weather derivates from traditional insurance contracts, which typically indemnify the buyers for the exact amount lost due to an insured risk subject to an insurance deductible. For readers more familiar with insurance, weather derivatives can also be described as insurance contracts with rather high deductibles and where claim settlement is done on the agreed amount (rather than the real loss) basis. In most cases the problem of the basis risk can be addressed to the satisfaction of the buyer through a more comprehensive understanding of correlations between the chosen weather index and the company’s financial performance. In addition, businesses that are particularly concerned with the basis risk can always buy weather derivative contracts that attach at the lower and exhaust at the higher values of the weather index.

From the outset weather derivatives should be clearly distinguished from traditional insurance products which tend to deal with less frequent and more catastrophic events and which typically contain very little basis risk as they tend to indemnify or restore insured to the financial position they were before the occurrence of an adverse catastrophic event. Broadly speaking, weather derivatives can be mainly characterized as financial hedges against events which are not too far from the mean. Events covered by weather derivates occur with a medium to high probability and cause material damages to the insured entity of a kind that are significant, but not detrimental to its very existence, but, at the same time, cannot be fully absorbed by it without major adverse financial consequences.

The most common derivatives are call and put options. The buyer of the option pays to enter into a contract that may require the seller of the option to pay at the end of the option period an amount calculated from a specified weather index. Payment is made to a buyer of a call option only if the weather index exceeds a specified level (the strike value) at the end of a contract period. Payment is made to the buyer of a put option only if the weather index is lower than the strike value at the end of the contract period. Payments are linked to the difference between the value of the strike and the value of the weather index.

In the market parlor, weather risk hedging contracts are also often referred to as weather derivatives or weather indexed insurance. From its inception, following the growing demand from energy-providers for temperature based hedges, the market concentrated on such temperature measures as the accumulation of degree-days in multi-month seasons, average, as well as maximum or minimum temperatures. These temperature measures are then used by market participants, e.g. the buyers and sellers of weather hedging contracts, to develop risk hedging solutions that fit best their risk management needs. The most common temperature risk hedging contracts are degree days and average temperature contracts. The US trades almost exclusively in degree-day contracts while the global market trades in both degree-days and average temperature contracts. A brief description of these common weather derivative contracts available in the US and Western Europe follows.

<u>Degree-days contracts</u>. These contracts come in two types – Heating Degree Days (HDD) and Cooling Degree Days (CDD) contracts. In the US, the temperatures are measured in degree Fahrenheit and the temperature threshold is set at 65 degrees. Below this temperature people generally turn on their heating and above this temperature they turn their air-conditioning on. For a CDD, how much the average daily temperature exceeded the threshold is recorded. If the average temperature on a day does not exceed the threshold, a zero is recorded. For a HDD, how much the average daily temperature falls short of the threshold which requires heating is recorded. If the average temperature on a day does not fall below the threshold, a zero is recorded. So mathematically, one can define the value of CDD and the HDD index contracts as follows:

$CDD = \sum max\ (T_1 - 65, 0)$ for the number of days in the selected contract period

$HDD = \sum max\ (65 - T_1, 0)$ for the number of days in the selected contract period

The CDD or HDD value is then multiplied by the minimum tick fluctuation value per degree to arrive at the total payout of the contract, which is frequently subject to a cap. In addition to going either long or short on the heating degree days index, it is also customary to write call or puts on the HDD or CDD indices. In the latter case, payments under HDD or CDD contracts become contingent upon the cumulative value of the index exceeding a specified amount (the strike value). See Box I below.

Box I:
Calculating the value of the HDD Monthly Weather Futures Contract in New York

A monthly HDD value is simply the sum of each daily HDD value recorded during a given month or season. For example, if there were 10 HDD daily values recorded in November 2007 in New York, the November 2007 HDD index would be the sum of the 10 values. Thus, if the HDD values were 25, 15, 20, 25, 18, 22, 20, 19, 21 and 23, the monthly HDD index value would be 208. The value of a CME Weather futures contract is determined by multiplying the monthly HDD value by $20, which is the value of the tick per degree. Using the example above, the CME November Weather contract would settle at $4160 ($20x208=$4160). However, if in the above example the contract was written as a call on the HDD index with the strike value of the contact set at 100, then the contract would be worth only (208-100) x$20=$2016.

Degree-day contracts continue to be the most prevalent in the market as they fit quite well the risk hedging needs of energy suppliers and are rather liquid which makes them readily accepted by the market players. They are however are not particularly useful for other segments of economy exposed to weather risk, which are more interested in the average temperature indices.

<u>Average temperature contracts</u>. The transition to weather hedging contracts linked to average temperatures began in December 2001 when the London International Financial Futures Exchange (LIFFE) commenced offering weather futures indexed to temperature in Berlin, London and Paris. Since then the coverage of the contract has been expanded to several other European and US cities. The main attraction of average temperature contracts is a continuous spectrum of temperature with no cut-off that divides the spectrum into positive values and zero, like it is the case with degree-day contracts. In addition, the concept of average temperature is easy to explain and understand which simplifies the acceptance of these contracts by the new users of the weather derivates markets.

<u>Other perils derivative contracts</u>. Weather derivatives linked to variables other than temperature have been developing as well. Wind-speed, precipitation, snowfall, flood and stream-flow contracts have been originated on numerous occasions as well. Yet, the volume of trading in these contracts remains rather low. In addition, market is yet to learn

how to structure and price contracts dealing with two or more weather variables, like, for instance, temperature and precipitation, and do it in an economically efficient manner.

Various forms of derivate contracts. The principal contract in weather trading by dealers is the swap. A swap contract can be described as a specific case of a collar trade where the upper and lower strike levels are the same. In a swap, the transacting parties agree to tick rates and caps that are symmetric about the mid point distribution of the selected weather index. For instance, if the distribution of average temperatures of the past summers can be approximated well by a Gaussian distribution and the swap level is the mean of the distribution, the probability of each party paying would be 50 percent.

In its recent attempts to expand its customer base beyond energy suppliers, the CME Group has developed three types of contracts for hurricane futures and options in six U.S. defined areas – the Gulf Coast, Florida, the Southern Atlantic Coast, the Northern Atlantic Coast, the Eastern U.S., and CHI-Cat-In-A-Box – Galveston-Mobile. These contracts are: (i) Hurricane Event futures and options; (ii) Hurricane Seasonal futures and options; (iii) Hurricane Seasonal Maximum futures and options. The underlying indexes for Hurricane futures and options on futures are calculated by Carvill, a leading independent reinsurance intermediary in specialty reinsurance that tracks and calculates hurricane activity.

These new hurricane risk transfer contracts help insurers offering hurricane insurance coverage to increase insurance capacity in the coastal areas of the US. In addition, businesses and local governments with large and widely spread risk exposures can mitigate them by buying the protection directly from the capital markets.

Another important and growing source of risk transfer capacity for weather related risks can be found in the global catastrophe bond market (also known as the market for "insurance-risk linked securities"). The overall issuance of ILS securities in 2007, for instance, was close to $7.5 billion (e.g. bond principal at risk or "insured limit") out of which, the coverage for the US hurricanes accounted for 34%, for the European wind storm for 16% and the Japanese typhoon – 8%, respectively[1]. The most common form of risk transfer in the ILS market has been to transfer the risk of the issuer to investors by selling them catastrophe bonds, which would pay a risk premium and the LIBOR rate in return for investors' agreement to forego a percentage of principal in case of occurrence of a catastrophic event covered under the risk transfer contract. However, since the collapse of Lehman Brothers, the issuance of new ILS has been halted due to considerable problems with addressing the counterparty risk and ensuring the proper maintenance of the collateral.

Table 2 presents a brief analytical summary of the above described weather risk hedging products which we prepared in accordance with five earlier developed criteria insurance product assessment criteria.

1 The 2008 Review of ILS Transactions What Price ILS? – A Work in Progress. By: Morton N. Lane, President; Roger G. Beckwith

Table 2. Assessment of market weather risk hedging products

Hedging product	**Assessment criteria**				
	Insurability	**Affordability**	**Customization**	**Financial sustainability**	**Market impact**
Degree-days contracts	Temperature	Market price	Standardized contracts	Sustainable	Positive
Average temperature contracts	Temperature	Market price	Standardized contracts	Sustainable	Positive
Multi-variable contracts	Precipitation, temperature, speed of water flow, wind speed	Market price	Customized contracts	Sustainable	Positive
Hurricane futures and options	Wind	Market price	Standardized contracts	Sustainable	Positive
Catastrophe bonds	Wind, flood	Market price	Highly customized	TBD	Positive

Insurability. As can be seen from the table, so far the key perils addressed by the commercial weather hedging market included temperature, precipitation, and wind, although in some instances flood was addressed as well.

Customization. Despite the growing volumes of standardized weather risk hedging contracts over the last few years, by and large weather risk hedging and insurance market still relies on highly customized solutions. This high level of customization in many respects impairs the further growth of the market as in the absence of large transaction volumes individual transaction costs remain rather high.

Sustainability. As weather related risk (e.g. increased volatility of weather patterns) become more and more pronounced for millions of businesses world-wide, demand for weather risk hedging instruments will be only growing over time. This in turn will drive the further growth of different weather risk hedging markets and risk transfer instruments that can help business to manage their growing risk exposure to the risk of weather.

Affordability. The growth of the markets is currently impaired by considerable transaction costs due to the still rather low volumes of trading and often rather high price-to-risk multiples. Overtime however we expect the risk spread-to-expected loss risk multiples, which currently hover between 2 and 4 depending upon the time of the year and type of peril, to considerably come down due to the growth of issuance and major improvements in the quality of the underlying risk models and risk data, which are used to price these transactions.

Market complimentarity. All of the above described market instruments are innovative in nature and provide a very important contribution to the development of weather risk hedging tools in the real sector.

Weather risk hedging in emerging markets

Recently, with the help international development organizations, weather risk transfer products have started making the inroads to the developing countries as well. The three most widely known examples of the weather risk market innovations in developing countries include:

1. The weather insurance offered by Swiss Re in the Millennium Village Project.
2. The Ethiopian drought insurance index provided by Paris Re.
3. Index-based parametric insurance for agricultural producers.

Using our 5 product assessment criteria for insurance products below we provide a brief summary of these three transactions.

The Millennium Village Project

To address the risk of draught in Sauri, Kenya, Swiss Re, at the request of the Millennium Promise Alliance (a New York registered NGO), developed a customized weather index, the *Climate Impact Index (CII)*, which is composed of both a Normalized Difference Vegetation Index (NDVI) and Water Requirement Satisfaction Index (WRSI), chosen to optimally correlate with district-level maize production. The NDVI is a simple numerical indicator that assesses whether the area being observed contains live green vegetation or not – the information obtainable from satellite imagery. In this case the decadal NDVI data was received from NASA, spatially averaged. The WRSI provides an indication of a specific crop's potential performance based upon the availability of water during its growing season (vs. water demand experienced by a crop).

The risk transfer product has been designed in the form of a put on the CII and was intended to provide protection for the local maize farmers against adverse growing conditions. To the extent local precipitation data are not available, a pure NDVI product could be utilized. Live green plants appear relatively dark in the red spectrum and relatively bright in the near-infrared since chlorophyll, the most abundant plant pigment, is most efficient in capturing red and blue light.

The product provides ex ante relief as it pays out very quickly after the growing season so relief can be provided while there is a need and before liquidation of scarce local assets.

Insurability. Drought is the main risk addressed by the above mentioned products. While not being fully insurable in its least severe and more frequent and systemic manifestations, the risk could be well addressed in its more extreme manifestations by innovative index-based insurance products similar to the NDVI index.

Customization. The project scores very well in terms of finding the right balance between the needed level of product customization and its potential for replication in other parts of the world. Since the ability of the CII to approximate the local drought conditions was not predicated on the availability of the local reliable weather data (and hence expensive weather risk data generating infrastructure) or crop yield data, the product offered a unique and highly innovative risk management solution that benefited 50,000 thousand maize farmers. The product however can be replicated on a large scale or be extended to other groups of customers including governments, aid agencies, large agricultural producers, agribusinesses such as grain elevators, coops and ethanol plants, seed companies and the like.

Affordability. Since the premium was fully paid by the Millennium, the local farmers received a 100% subsidized insurance coverage.

Sustainability. Although in this case Swiss Re charged an actuarially sound premium for the insurance coverage, it was paid not by the farmers but by the NGO on their behalf. This creates a financial sustainability problem as the ultimate users of the products are unable to renew coverage in the absence of significant subsidies from government or donors. To illustrate, the pioneering Ethiopian transaction described next has not been renewed and there are all indications that upon expiration at the end of 2008, the insurance coverage provided under the Millennium insurance project will lapse as well.

Market complimentarity. Despite considerable subsidies in support of the described insurance product, there were hardly any adverse impacts on the development of weather risk or insurance market. This could be explained mainly by the fact that the product offered was highly unique and hence did not have to compete with any similar insurance products in the marketplace. However, this situation is bound to change in the future as more and more market players enter the new product niche with their own similar type products.

Ethiopia drought index

The Ethiopia Drought Insurance Pilot Project of the UN World Food Program attempted to utilize market mechanisms to finance the risk of drought in Ethiopia. Under the project, AXA RE provided WFP with the world's first insurance contract for humanitarian emergencies. The contract provided US $7 million in contingency funding in a pilot scheme to provide relief subsidies to 17 million people in the case of an extreme drought during Ethiopia's 2006 agricultural season. The insurance contract, a derivative based upon a calibrated index of rainfall data gathered from 26 weather stations across Ethiopia, took advantage of financial and technical innovations in the weather risk market. Payments are triggered when the value of the index indicates that rainfall is significantly below historic averages, pointing to the likelihood of widespread crop failure. The policy also complemented the recent UN moves towards greater effectiveness through the creation of an emergency fund which provides fast injections of cash to aid operations in the first few days following a disaster.

Insurability. Similar to the Millennium project, the Ethiopia transaction offered coverage for drought, or to be exact, more severe forms of drought, which is insurable.

Customization. The cover developed was fully customized to meet the needs of the WFP in case of a sudden and severe drought in Ethiopia. However, the extraordinary extent of the project customization was also the main drawback of the project, as the sophisticated insurance index could be no longer used once the WFM decided not to renew the original insurance contract.

Affordability. Although the coverage was relatively expensive for the UN WFP (about $1 million of premium per $7 million insured limit), it adequately reflected the odds of a severe drought event that could have triggered the payment. Had the coverage been triggered, the payments under the coverage would have been converted into the immediate humanitarian aid (the coverage was never triggered while it was on the risk).

Sustainability. Transferring weather risks from poor countries like Ethiopia to the international risk market on a larger scale allows insurers to diversify their portfolios. This diversification helps to stem the rising cost of weather-related insurance in developed countries while providing more effective financial protection to developing countries. While the risk covered by AXA Re under the contract was actuarially priced, it was paid not by the ultimate beneficiaries but by the UN WFP, which from the very beginning posed a long-term sustainability problem. Despite winning the praise from the market and the development community for the innovation, all original concerns about the sustainability of this transaction materialized when the coverage was not renewed by the WFP upon the expiration of the policy.

Market complimentarity. Although the transaction was fully funded by the UN donor agency, it did not produce negative externalities for the market as the insurance product was truly unique. The transaction however demonstrated the technical feasibility of insuring drought in developing countries and paved the way for similar deals in the future.

Index-Based Parametric Crop Insurance Products

Due to the growing adverse impacts of weather on agricultural production in developing countries and the financial sustainability problems invariably faced by government-owned agricultural insurance programs world-wide, the interest in using index-based risk transfer instruments in lieu of traditional agricultural insurance has grown considerably over the last 10 years.

Internationally index-based weather risk insurance contracts have emerged as an alternative to traditional crop insurance. Most of the agricultural risk transfer projects attempt to address losses in crop yields at the time of a widespread drought. Index-based parametric insurance (or risk transfer products) have important advantages over traditional indemnity type insurance (such as reduced costs of policing moral hazard and a faster payout). The payouts under these contracts are linked to the underlying weather risk defined as an index based on historical data (e.g. for rainfall, temperature, snow, etc) rather than the extent of loss (e.g. crop yield loss). As the index is objectively recorded at the same time for all farmers, the problem of moral hazard is minimized as there is no longer a need to monitor individual contracts, which significantly brings down the administrative costs. Weather-indexed insurance can help farmers avoid major downfalls in their overall income due to adverse weather related events. This improves their risk profile and enhances access to bank credit, hence reducing their overall vulnerability to climate variability. Unlike traditional crop insurance where claim settlement may take up to a year, quick payouts under private weather insurance contracts can improve recovery times and thus enhance farmers' coping capacity. However, one of the inherent disadvantages of weather derivatives is that because of the way the index is defined there may be a mismatch between payoffs and actual farmer losses, the problem known as a basis risk.

Various agricultural weather derivative pilot schemes are currently on the way in emerging markets. As of the end of 2008, there were 16 agricultural risk financing pilots supported by the World Bank alone. About 20 index-based insurance programs have been implemented in low- and middle-income countries. So far, however, India proved to be the only well-tested and proven success story of all.

The ICICI Lombard General Insurance Company, with support from the World Bank and International Finance Corporation, conceptualised and launched a pilot rainfall insurance scheme in Mahabubnagar, Andhra Pradesh in July 2003. The district had previously experienced three consecutive droughts. The scheme was implemented through the KBS (Krishi Bima Samruddhi) local area bank of Basix, one of India's largest microfinance institutions. KBS Bank bought a bulk of insurance policies from ICICI Lombard and sold around 250 individual policies to groundnut and castor farmers. The index capped rainfall level per sub-period at 200 mm, and weighted critical periods for plants growth more heavily than others. KSB decided that only borrowing farmers can buy weather insurance policies. Eventually KSB planned to lower the interest rate on its loans to the insured farmers due to the reduced default risk. Since then, the program grew exponentially. In 2007, over 600,000 farmers purchased index-based parametric crop insurance in India.

Recently, the concept of index-based parametric weather risk hedging has been applied to develop a macro-hedging solution for countries which are particularly exposed to weather risk. Malawi has been the first country to benefit from the index-based parametric weather risk hedging. In 2008, the World Bank issued its first weather risk management contract to help Malawi financially protect itself against the risk of a severe drought. The UK Department of International Development (DfID) provided financial support to cover the premium payment for the contract. Malawi suffers from chronic drought that cuts agricultural yields and depresses farmer incomes, negatively affecting the government budget. When drought strikes, it increases the price of maize, the main source of food for a large part of the population. Working with Malawi, the World Bank structured the contract as an option on a rainfall index. The index links rainfall and maize production so that if precipitation falls below a certain level, the index will reflect the value of the projected loss in maize production. Under the contract, if the maize production in the country, as estimated by the rainfall index, falls 10% below the historical average, Malawi will receive a payout of up to a maximum of US$5 million.

<u>Insurability</u>. Most of agricultural index-based risk transfer projects address the risk of drought, e.g. insufficient precipitation at the critical periods of plants' growth. Once the data on precipitation patterns have been obtained, insurance becomes a viable option as international reinsurers can properly price and underwrite the risk without being exposed to the risk of moral hazard.

<u>Sustainability</u>. The index-based parametric crop insurance products can be financially sustainable, as has been proven in India, where poor farmers were willing to pay up to 5-7% of the insured crop value in insurance premiums. Such high premiums could be justified only if the insurance payout comes very quickly, as is the case in India, and there is a strong correlation between the size of the farmer's loss and the overall insurance payment. These problems however are not easy to overcome as they require considerable investments in weather stations and a well developed payments infrastructure. Also, given the small size of individual contracts and extensive outlays on the prerequisite development of underlying risk models, data mining, product distribution and farmers education, it is essential that these products cater to the needs of a broad customer base. Covering small groups of farmers with these products is simply not viable due to the very high transaction costs involved in producing the custom-tailored products that cannot be easily replicated for other crops or locations.

<u>Affordability</u>. Due to considerable costs involved in developing the index-based products and the small targeted customer base and the relatively low incomes of the rural population, in the absence of subsidies these products typically pose a major affordability

challenge. Nevertheless, as has been shown by the India market experience with weather derivatives, if properly designed to address the buyers' specific risk management needs, weather derivatives can be attractive even to the poorest of farmers.

Market complimentarity. The index-based parametric crop insurance can be seen as a major market innovation and a major step forward in addressing the risk management needs of rural communities and even countries. While most, if not all, of the weather derivative pilots in developing countries were subsidized by the development community, given the innovative nature of these products they did not displace any other insurance products from the market. Weather risk management technology can be now applied to address numerous risk management objectives of different customer segments. The potential application of this product spans diverse sectors of economy ranging from agriculture and energy production to tourism.

Summary

The Section provided a broad overview of the existing weather risk hedging and insurance instruments in both the mature and emerging markets. Due to the complexity of weather risk, the availability of weather risk hedging products is still rather limited by the availability of data, considerable transaction costs involved in developing these products as well as the relatively low demand for such products by consumers. Nevertheless, while in developed countries the growth of the weather risk hedging business is driven by the market innovation, in the emerging markets will have to rely on the weather risk pilot projects supported by the donors and the World Bank. Although in some cases the donor supported projects have paved the way for the consequent market takeoff (as has been the case in India), more often than not the pilots supported by the donors could not be mainstreamed or replicated.

Section IV. Major Barriers to the Growth of Weather Insurance and Risk Hedging Markets

The successful development of weather risk hedging and insurance markets is strongly influenced by three factors, which are (i) the availability of good quality weather data; (ii) affordability of insurance covers; and (iii) government post-disaster subsidies. A brief review of these factors follows.

Availability of weather risk data

Weather risk insurance or other risk hedging products are contingent upon the availability of reliable, easily accessible and affordable weather data[2]. If weather risk data produced by the National Meteorological Services (NMS) were to meet the minimum quality

[2] See Annex I for a detailed description of the data requirements for weather risk hedging contracts.

standards set out by the weather risk and insurance markets, then the production process leading to it can be schematically illustrated in Figure 1 below.

As can be seen from Figure I, there are three main groups of factors that enable NMSs in more advanced countries to successfully meet the weather data needs of the market. These include: (i) economic incentives to develop new products and services that currently do exist within NMSs in SEE countries; (ii) the hardware and software components, and (iii) the human and institutional dimensions of weather data generation. Each of these market enabling factors is reviewed below.

The role of economic incentives for NMSs

According to a survey of NMSs recently carried out in South East Europe[3], currently these organizations have no incentives to seek new clients or provide more and better services to the existing ones as all additional revenues from sales of weather data and services must be transferred to the government. For NMSs to become modern and dynamic organizations, the existing system of incentives must be changed. For instance, one can think of a system where NMSs still remain their public sector identify by continuing to provide a minimum range of weather data products and services on a free-of-charge basis, while offering additional more custom-tailored services to the private sector users for a reasonable fee.

The hardware and software component of weather data manufacturing

<u>Weather stations</u>. Similar to traditional manufacturing, weather data generation process requires right "hardware" and equipment in the first place. In the absence of modern, well maintained and frequently placed weather stations across the country's territory, one could hardly expect to obtain reliable and practically useful land surface observations. Hence, one of the key priorities of the weather risk market development should be to enable developing countries to improve the density of weather stations coverage and improve the quality of weather measurements by investing in the acquisition of modern and reliable weather measuring equipment.

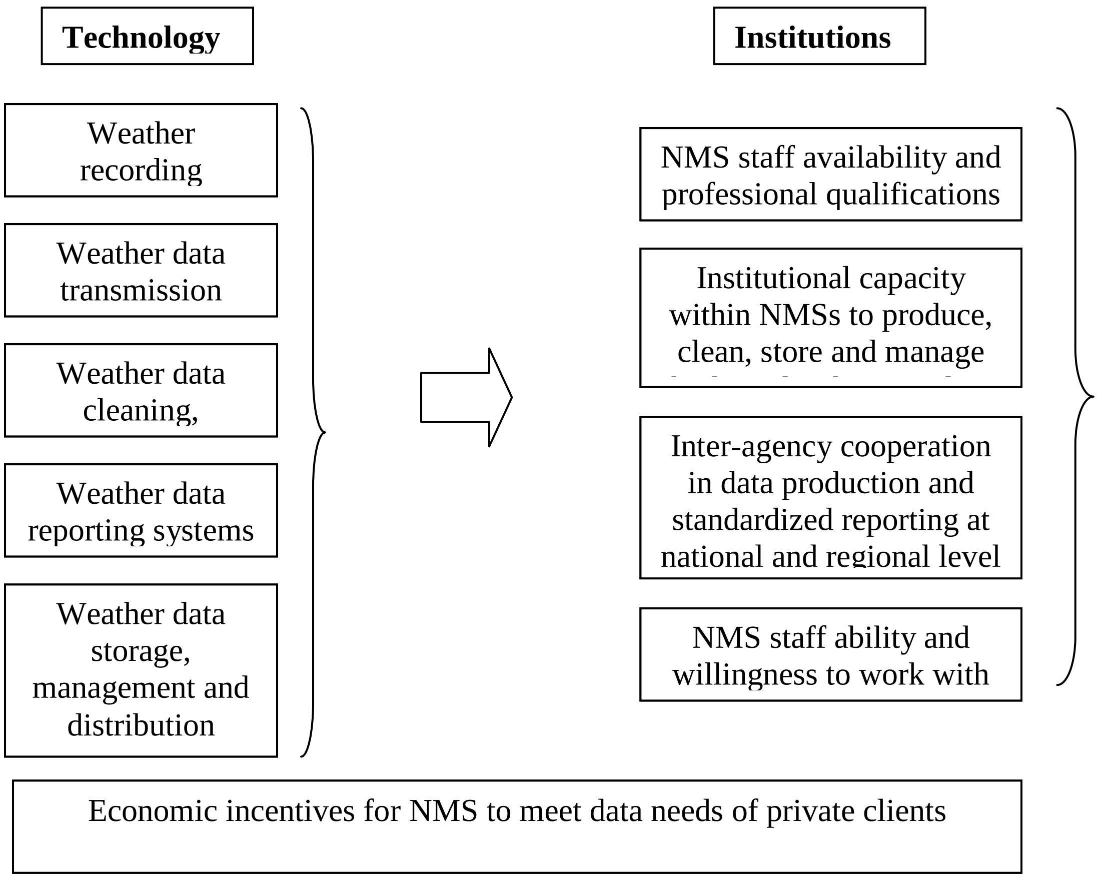
<u>Data transmission systems</u>. Once a weather station has made a weather sampling (measurement), the information must be either directly reported to end-users or transmitted to the central weather data processing facility for further cleaning and enhancement. Transmission of recorded weather data can be either manual or automatic, with the later approach becoming more and more common practice among advanced NMSs. Although the economic rationale for replacing manual with automatic weather data transmission equipment may be somewhat less obvious in countries with relatively low wages, the key advantage of automating the weather reporting process lies in considerably improved reliability and quality of the produced weather data as even the best trained human observes can often make mistakes. If NMSs in developing countries were to develop themselves into modern national institutions whose products are in

[3] See "Strengthening of the NMHSs in the Southeast Europe: Meteorological and Hydrological Information Sharing – Status Needs, Capacity Building" by Bengt Tammelin, World Bank/ISDR, 2008.

demand by different segments of economy installation of automated weather data reporting systems should be viewed as a priority.

Figure I

Key technological and institutional components of weather data production process



Data cleaning and enhancement systems. Once the weather data have been transmitted by weather stations to the central data processing facility, they must undergo a thorough cleaning, enhancement and verification processes to ensure their quality and reliability. This implies investments in modern software programs and computer equipment that can help automate most the work which is currently done manually by NMS staff in developing countries. Such an investment in data processing technologies will result in the immediate improvements of data quality and will help reduce the staff headcount and hence increase the salaries for the remaining staff. The additional benefits of such an investment will include improved reliability of produced data, ability of NMSs to dramatically increase the range of weather data products offered to their clients, including highly customized weather data products and services. In the end, all these improvements are likely to result in considerably increased external revenues of NMSs due to additional weather data sales to external clients.

Production of meta-data. The produced weather data (both original and "cleaned") must be then adjusted for changes in the location or type of instrumentation used in the past to form historic data series. A clear and well documented description of the factors that may have influenced the data at any point in the past (the "metadata") must be compiled and made available to market participants.

Development of on-line access to weather data. What is also essential is how easily the data produced and stored by NMSs can be made available to end users. Hence, investment in developing historic weather databases that can be accessed on-line by the subscribers in real time should also be viewed as a priority.

The human and institutional components of weather data generation

Staff. Availability of qualified staff is among the key prerequisites for the production of reliable good quality weather data. In most developing countries, NMSs appear to face genuine problems with attracting new talent and retaining the existing well qualified staff. Among the main challenges are low salaries, obsolete and inefficient work processes that result in staff overloads and leave no time for exploring new ideas and developing new products. While investment in automation of many existing work processes is likely to free up staff for more interesting tasks, it is also expected to considerably reduce the staff headcount for less technically challenging jobs (like weather observers) and therefore increase the pool of financial resources available for raising the wages of the remaining qualified personnel.

Hence, the development community should consider assisting NMSs with modernizing their staff structures (with corresponding changes in the pay scales) to enable these organizations to carry out new more knowledge and technology intensive tasks.

Inter-agency and inter-regional cooperation. Often, the quality of weather data and users ability to interpret them suffers from the lack of inter-agency cooperation in individual countries and regionally. Yet, if one were to draw meaningful conclusions about regional climate patterns and even about weather, which is a more locally confined phenomena, in a region comprised of many small countries, access to historic data produced by weather stations located in different bordering countries becomes crucial. This brings to the fore the importance of standard weather data reporting protocols (e.g. the type of data reported, time of reporting, measurement and data enhancement methodologies, etc.) across different NMSs in all developing countries as well as the ease of access to these data for external users. To meet these data reporting and data integration requirements, intra-country and inter-regional coordination among different NMSs becomes essential.

NMSs interface with the private sector. The ability of NMSs to produce weather data and other products and services that will be in demand among private sector users to a large extent depends on personal skills, training, internal organization and incentives of people working there. In this context, as part of the NMSs institutional reform, international development organizations may consider supporting the creation of special divisions within NMSs that will cater exclusively to the weather data needs of private clients.

Acting as an internal interface between the private end-users and NMSs such departments can then provide constant feedback to their organizations about the quality and the type of weather data sought by the market. To be effective, these special divisions of NMSs must be staffed with dynamic and well qualified personnel and have the right economic incentives to perform at their best.

Hence, for the weather risk market to develop in developing countries to the level where it can provide the low cost custom-tailored weather risk hedging products for local businesses, a considerable investment will be required by the international community in the modernization of NMSs, development of seasonal forecasting capabilities as well as the creation of public-private partnerships between NMSs on the one hand and specialized data vendors and weather risk consultants on the other.

Affordability issues and ways to overcome them

Affordability of insurance products is yet another major impediment to the rapid development of the private weather insurance market. Although microfinance has shown that the poor are bankable, the critical question is whether they are insurable as well. Given that up to 45 percent of premium income in the formal insurance industry is used for costs other than paying claims (e.g. agent commission, operational costs, policy taxes, etc.), large-scale success of insurance products for the poor ("micro-insurance") requires substantial cost reduction through innovation. Products and procedures must be simplified and customised for clients with irregular income streams. Special intermediaries are needed between the formal sector and the target group, who can deal with moral hazard, design and price appropriate products, and supplement it with education on risk management at the household and enterprise levels. In addition, education and clear communication of insurance products is essential, and particularly so for new weather-indexed products. The BASIX experience in India shows that targeting the right customer segment early on in the process of product marketing and doing it in a cost efficient way can be crucial for the future commercial viability of the program. The challenge of keeping the product affordable is compounded by the difficulty of managing the highly correlated and technically complex weather risk.

The specific cost challenges faced by climate risk insurers include (i) the need for specialised actuarial capacity; (ii) shortage of reliable statistical data; (iii) time and effort to make potential clients appreciate the benefits of insurance; and (iv) high product distribution costs given large number of clients can pay only small premiums for a limited coverage.

MFIs providing insurance for weather related risks run the risk of insolvency as long as they tend to operate in limited areas and cannot diversify their lending risks. But they can use weather-indexed insurance to protect their lending portfolio (e.g. BASIX). They can also potentially make use of alternative risk transfer instruments like catastrophe bonds or but the relatively small size of their portfolios may make them unaffordable.

The above mentioned problems of weather risk market development are not unique for developing countries. The existing experience suggests that due to the high transaction costs and relatively small volumes of business, stand-alone insurance operations are simply not cost effective to cater to individual farmers and small businesses. Instead, the delivery models tested in developing countries for insurance include micro-lenders, specialized insurance agents, as well as self-help, mutual, or cooperative models. For instance, by bundling lending products with weather insurance the MFIs can considerably reduce the loan default rate for its loan portfolio. Case studies (SEWA, BASIX) also show that insurance is more effectively sold to the poor as part of other services (credit, farmers' cooperatives, agricultural input supply), rather than as a stand alone product. In India, DHAN Foundation helps SHGs in dealing with insurance companies, while Spandana provides insurance directly to the target groups.

Disaster subsidies

Indiscriminate post-disaster government aid to homeowners and farmers affected by weather related disasters remains one of the main impediments to the development of weather risk markets world-wide. While timely government aid to victims of disasters is often instrumental to the successful economic and social recovery, it is essential that such assistance does not create widespread expectations of government assistance in the future and hence dampen economic incentives for buying private insurance.

The adverse implications of government interventions can be quite pronounced also in cases when catastrophe insurance is provided at heavily subsidized rates that do not reflect the true cost of risk. This may lead to the withdrawal of private insurers and reinsurers from the distorted market, which, on the one hand, leaves government-sponsored insurance programs with more demand for its insurance coverage and, on the other hand, saddles them with considerably increased risk exposure that cannot be transferred to the reinsurance market due to insufficient underlying premium. As a result, over time government catastrophe insurers may find themselves in a situation where their catastrophe risk exposure grows well ahead of their claims paying capacity, which puts them on a sure path to insolvency or a need for a government bailout in case of a large catastrophic event.

Besides post-disaster aid, governments commonly provide heavily subsidized weather risk insurance of their own. The main problem with heavily and indiscriminately subsidized insurance premium rates is that in the absence of price signals about the level of their risk, homeowners and businesses have no reason to invest in mitigation to reduce their vulnerability or undertake any other risk prevention measures. As a result, more properties are built in disaster prone areas and very little is done about reducing the physical vulnerability of dwellings to catastrophe events. Over time this leads to further increases in government catastrophe exposure, until it becomes fiscally unsustainable. To deal with this extra fiscal burden government would then have to raise taxes or issue more debt or … simply pass on the unfunded loss back to insured businesses and individuals.

Summary

The Section reviewed the extent to which weather risk markets are affected by the availability of weather risk data from the National Meteorological Services; the eventual cost of weather risk insurance products as well as the government policy on post-disaster subsidies. We have established that one of the key preconditions for the growth of the market is the upgrading of national meteorological services in developing countries, which currently make it difficult to collect weather data in the format required by the market. One of the key findings of the Section is the importance of establishing a transparent and well-articulated government policy on providing post-disaster subsidies to manage people's expectations with regard to the amount of state post-disaster aid. By articulating the availability and the expected size of the government assistance to individuals affected by weather related disasters, the government will reduce the financial uncertainty and hence will encourage individuals to buy private insurance.

Section V. The role of governments in developing public private partnerships in weather risk insurance

While provision of non-life catastrophe insurance has been by and large the domain of the private insurance market, in the case of catastrophe insurance governments of many disaster prone countries have been more than just simple by-standers. More often than not, governments intervened by creating specialized catastrophe insurance programs under the pretext of correcting market failure. Most of the government sponsored catastrophe insurance programs have been designed with at least some element of private participation varying from a simple product distribution function to risk sharing and operation of these programs. The objective of this Section is to examine the role of government in the provision of catastrophe insurance and to determine whether the creation of government-sponsored disaster insurance programs is consistent with the very role of government.

Most national catastrophe insurance programs have emerged in the aftermath of major natural disasters. These disasters revealed, at least for a short period of time, the shortcomings of pure market solutions. Among the most common market failures have been frequent and well-documented insurance market break-downs in the aftermath of major catastrophic events. For instance, in the aftermath of the 2005 US "KRW hurricanes" (Katrina, Rita and Wilma) more than three million homeowners in the East coast of the US west of the Appalachian Trail have received cancellation letters from their insurance companies, which are determined to avoid another $40 billion Katrina bill. In response to the dramatically reduced availability of catastrophe insurance coverage, state governments in the East coast of the US have resorted to the creation of state-owned catastrophe insurance pools which aim to provide catastrophe insurance coverage to businesses and homeowners who cannot obtain such coverage from the traditional insurance market. The main question is whether such government actions are consistent with the very role of government and the extent, to which such actions may adversely affect the development of the private insurance market. Below we attempt to provide some guidance on the role government can play in the provision of catastrophe insurance coverage.

Any government intervention in catastrophe insurance market must be based on clear evidence of market failure to provide the needed coverage for the population at risk for a long time. Typically, in the case of catastrophe insurance such a case can easily be made in most of emerging market economies where the level of private catastrophe insurance coverage remains well below 3-5 percent of total livable housing stock and is next to non-existent for the poorer segment of society. The low level of insurance penetration however should be considered in the context of long-standing government policies on post-disaster aid, administratively imposed maximum limits on insurance premium rates, and existence of subsidized government disaster insurance. The very existence of these government policies may be the key obstacle to the development of the private market and their removal may be sufficient to see the resumption of rapid market growth.

A schematic summary of potential roles that can be assumed by government in provision of catastrophe insurance is provided in Table 3 below. As one can see, there are at least 20 different ways for government to intervene in the provision of catastrophe coverage, which may vary from highly interventionist implying direct government involvement in the provision of coverage and making insurance compulsory to relatively mild indirect involvement that rely on public awareness building and introducing economic incentives for buying insurance coverage.

Table 3. Government role in provision of catastrophe insurance

#	Level of intervention (High-Low)	Supply-side	Demand-side
1	H	Provision of re/insurance through government insurance entity	Provision of re/insurance premium subsidies
2	H	Provision of operator maintenance subsidies	Insurance claims subsidies
3	H	Regulatory requirement to provide catastrophe re/insurance at below market rates	Tax benefits
4	H	Capital subsidies (low cost debt or equity or government reinsurance)	Insurer’s performance guarantee
5	H	Relaxed solvency requirements	Legal compulsion to buy coverage
6	L/H	Tax incentives (through equalization reserves, etc.)	Adding insurance requirements to mortgage lending, utility bills or taxation
7	L	Creation of public-private partnerships	Public education and insurance awareness building

8	L	Investment in public goods (risk maps, risk data, risk models, etc.)	Linking disaster aid to insurance
9	L		

Below we provide a brief summary of each of above mentioned government policies.

<u>Supply-side policies</u>:

1. Provision of reinsurance or insurance through specially created government owned insurance entities is one of the most common and the most interventionist ways of addressing marking failures on the demand-side. On the reinsurance side, a typical example of such a policy would be the Florida Hurricane Catastrophe Fund (FHCF) and, on the insurance side, the above described Citizens Property Insurance Corporation. The major risk of such government interventions is in mispricing of risk and government inability to control the burgeoning risk accumulations which eventually may result in the transfer of private insurance liabilities to taxpayers.

2. Provision of insurance operations subsidies is typically rationalized on the grounds of lowering the entry barriers to a given segment of insurance market with the view of encouraging competition and hence lowering prices as a result. Under the US Crop Insurance program, the government subsidizes the crop insurance delivery and administrative costs of private insurance companies, as well as the companies' underwriting risk through the Standard Reinsurance Agreement. There is no evidence however that these policies resulted in a more cost efficient operation of agricultural insurers enrolled into the program.

3. Often governments require private operators to provide certain types of catastrophe coverage at subsidized or technically inadequate rates. However, unless such a requirement is backed by the financial and technical capacity from the government (as is the case in France with the CCR), it is likely to be circumvented by the private sector. Such price restrictions are also likely to lead to the exodus of private re/insurers from the local market, thus leaving the government no choice but to provide alternative insurance and reinsurance arrangements. For instance, in the case of Florida, regulatory restrictions on the premium rates for hurricane coverage necessitated the creation of the Citizens Property Insurance Corporation as well as the Florida Hurricane Catastrophe Fund (FHCF), which also provides reinsurance to the local market at about 40 percent of the technical price of risk.

4. To make catastrophe insurance affordable, governments may provide capital subsidies to the private risk taking entities either in the form of attractively priced debt or equity capital or through subsidized reinsurance. The former solution is more common (see CCR and FHCF). The problem with subsidized reinsurance is that it tends to distort the market signals about the true cost of risk and, in the end,

forces private reinsurers to withdraw from the subsidized segment of the market, thus leaving all the risk on the balance-sheet of government reinsurers.

5. From time to time, government may relax solvency margin requirements for catastrophe reinsurers to enable them recapitalize after a major natural disaster or after a major financial market crisis. The current weakening of capital requirements for foreign reinsurers accepting US based cat risk is the case in point.

6. Tax incentives are yet another form of less interventionist government policy aiming to increase the level of catastrophe coverage. Tax incentives typically are provided in the form of non-taxable equalization reserves (Switzerland), which enable reinsurers to reduce the cost of doing business.

7. Creation of public-private partnerships in catastrophe insurance is perhaps the most common and proven forms of government interventions. While the level of private participation may vary from dominant (CCRIF) to insignificant (FONDEN), typically private sector is at least involved in the distribution and claim settlement of insurance policies. The litmus test of the quality of such PPP programs is the level of risk transfer to the private sector.

8. The least controversial and most successful government policy of all is investment in public goods such as development of risk maps, collection of quality data, and the creation of the market infrastructure that may include weather stations and satellite imagery for the purposes of product pricing as well as provision of funding for the development of complex risk models.

Demand-side policies:

1. Insurance premium subsidies is perhaps the most commonly used form of government intervention in the provision of weather related insurance coverage. Often, governments provide insurance coverage below its actuarial cost, which conceals the true cost of subsidies and ultimately results in large one-off financial shortfalls in the case of major natural disasters. For instance, the NFIP in the US has been providing flood coverage below actuarial costs for several decades only to find itself short of $20 billion in claims payment capacity in 2005, in the aftermath of KWR hurricanes. All government owned national agricultural insurance programs without exception provide considerable premium subsidies to insured farmers.

2. Insurance claims subsidies is yet another way to reduce the cost of insurance for consumers and hence stimulate demand for coverage. The US Crop Insurance Program provides a good illustration of how claims subsidies can be used to reduce the cost of coverage. The main problem with this policy is that it conceals

the true cost of coverage for the insured and hence distorts the true level of risk they have assumed. It also makes it difficult to budget and administer for the government as end-year underwriting results for weather related catastrophes may vary considerably from one year to another.

3. To entice consumers to buy insurance, often government may provide for advantageous tax treatment of insurance premium (e.g. making it tax deductible) and retained losses (e.g. losses retained under the deductible and in excess of the insured limit). As long as the preferential tax treatment applies to all insured policies for catastrophic weather perils in the market, this policy will cause very minimum distortions to the insurance market. Tax incentives are also likely to contribute to the uptick in demand for catastrophe insurance coverage as long as the premium rates paid by the insured (and the tax benefits received) are relatively high in relation to their incomes.

4. Re/insurer's performance guarantee typically comes in the form of formal government commitment to pay residual claims (e.g. claims in excess of re/insurer's own claims paying capacity) of a specific catastrophe re/insurer in case of a highly unlikely and severe natural catastrophe. This feature forms a corner-stone of most public-private partnerships in catastrophe insurance as it enables such programs to realize considerable savings on the cost of additional layers of excess of loss reinsurance which they would have to procure otherwise. The major risk with such approach however is the increased moral hazard as the management of guaranteed entities is likely to feel more inclined to have the company assume more risk.

5. Introducing the legally binding requirement to buy catastrophe insurance coverage through the passage of special insurance legislation is perhaps the most effective form of government policy in terms of boosting the level of catastrophe insurance penetration and addressing the adverse selection problem. The policy however is hard to implement as it requires many years of national consensus building on the subject and a clear government commitment to see such legislation through.

6. Often to avoid political resistance to the introduction of mandatory catastrophe insurance coverage, governments opt for a more narrow solution by requiring that all new mortgage borrowers take out catastrophe insurance. For instance, in the case of the NFIP in the US, mortgage borrowers are required to buy flood insurance by law[4].

7. Although ranking as a soft policy measure, educating the public on their true risk exposures to natural perils and the benefits of insurance and personal risk

[4] The law is enforced by requiring mortgage lenders that make loans in flood prone areas to present the evidence of flood insurance on properties financed in these areas to Fannie Mae and Freddie Mac – the federally charted buyers of the mortgages.

management can be highly effective policies in increasing the level of insurance penetration for natural disasters.

8. To reduce consumers' reliance on post-disaster reconstruction subsidies and encourage the uptake of insurance, governments can limit such subsidies to a fraction of insured limit or even make such payments contingent upon the availability of catastrophe insurance. In Spain, for instance, post-disaster reconstruction subsidies for private citizens have been completely outlawed to encourage citizenry to buy insurance coverage from the Consortio de Seguros - the government backed catastrophe pool. This policy has been very effective leading to an almost 100 percent rate of catastrophe insurance coverage.

Summary

The Section established that any government intervention in catastrophe insurance market must be based on clear evidence of market failure to provide the needed coverage for the population at risk for a long time. Typically, in the case of catastrophe insurance such a case can easily be made in most of emerging market economies where the level of private catastrophe insurance coverage remains well below 3-5 percent of total livable housing stock and is next to non-existent for the poorer segment of society. The Section also provides an overview of key government policies in disaster risk financing from the point of view of their effectiveness and long-term sustainability.

Section VI. Examining the latest promising climate change insurance initiatives

One of the latest most promising initiatives in weather risk insurance has been the one recently recently proposed by the Munich Climate Insurance Initiative (MCII) – a global NGO comprising representatives of the UN, the World Bank, reinsurance and insurance industry, research and academic community[5].

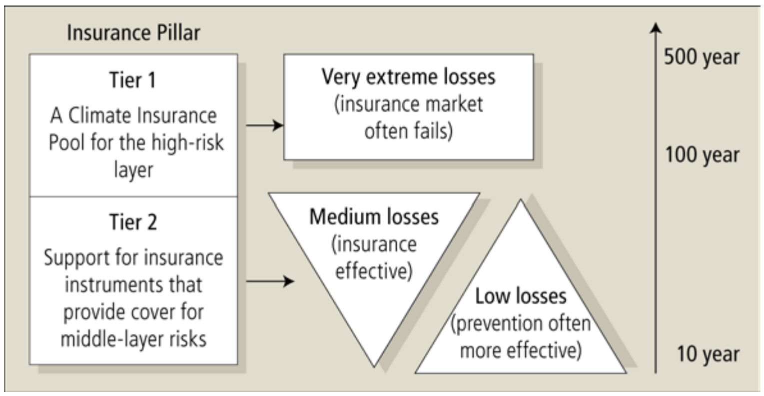
The proposed insurance program has two different windows, reflecting the different levels of risk that need to be addressed by an effective climate adaptation program for developing countries - the "high level" risk which would exceed the ability of any given country to pay in the case of an extreme event, and the "middle level" risk which can be addressed by an affected country if the proper facilitating framework were in place.

[5] Insurance Instruments for Adapting to Climate Risks, A proposal for the Bali Action Plan[5], Version 2.0, MCII.

As pictured in Figure II, the "high level" tier of risk would be addressed by insurance cover provided through the Climate Insurance Pool (CIP) to developing countries falling victim to infrequent and severe climate-change-related events.

The second "middle level" risk tier, to be retained by countries, would be dealt with through a Climate Insurance Assistance Facility (CIAF) that provides assistance for setting up national and possibly regional risk-pooling and -transfer mechanisms that cover medium-loss events.

Figure II: A two-tiered insurance program as part of a risk-management module



Tier 1: A Climate Insurance Pool for extreme weather events

The first tier of the Insurance Program would provide premium-free insurance cover in developing countries for losses caused by extreme weather events with a (negotiated) predetermined severity and return period. The latter would be based on historical data from a baseline period to avoid a reduction in support as climate increases the frequency of severe events. This insurance entity, further referred to as the Climate Insurance Pool (CIP), will be financed by annual contributions from the (proposed) multi-lateral adaptation fund, which itself may be financed by the developing countries. The main rationale behind the CIP is to supplement other climate adaptation funding with insurance indemnity payments via an insurance scheme that can best address the increasingly frequent considerable government budgetary outlays on recovery and reconstruction work in the aftermath of weather related natural disasters. Below we summarize the key features of the CIP.

The key features of the proposed Climate Insurance Pool:

- **CIP Premium Paying Entities**: Countries contributing to a multi-lateral adaptation mechanism would agree to a premium payment formula (many possibilities, such as based on "ability to pay," "polluter pays," or other concepts).[6] The CIP would receive a fixed annual allocation from a multi-lateral adaptation fund equaling the expected average annual costs of the insurance scheme.

- **Beneficiaries of CIP Coverage**: Countries that agree to participate in the scheme will benefit from CIP coverage in the event they fall victim to rare but extreme climate-related disasters that go beyond their capacity to respond and recover within a reasonable time. To become eligible for CIP indemnification payments, governments will have to fulfill basic standards of fiscal and budgetary transparency and commit themselves to certain risk reduction measures. Thus, it is envisaged that beneficiary countries will make NO premium payments, but may be subject to meeting certain standards of risk management.

- **Risk Carrier:** The CIP operations could be managed by a dedicated professional insurance team responsible for risk pricing, loss evaluation and indemnity payments, as well as placing reinsurance.

Figure III: Key features of the Climate Insurance Pool (CIP)

To rate the proposed MCII Insurance Program we apply our earlier developed framework for scoring large catastrophe insurance programs, which includes such criteria as: (i) insurability, (ii) customization, (iii) affordability, (iv) sustainability, and (v) market complimentarity.

Insurability. To qualify for coverage, any weather related event triggering payment from the CIP must be extraordinary in the statistical sense (e.g. lie in the extreme percentile of the historic distribution) and occur within the geographically predefined zones that meet the economic vulnerability criteria. Generally, the CIP coverage is likely to be extended to cover very high loss events occurring at low frequencies, often in the frequency range of every 100 to 500 years, in pre-defined areas of developing countries that are vulnerable to weather related catastrophic perils. A list of eligible for coverage catastrophic scenarios (e.g. frequency and severity of events and areas where they are likely to occur) will be established by an independent modeling firm and then negotiated with the countries. Further verification of events eligibility will also be administered by an independent modeler. To reduce the uncertainty involved in covering highly unpredictable catastrophe event, the CIP coverage will be provided on a parametric basis.

[6] In principle such contributions could be proportional to the current or accumulated CO_2-emissions, while a threshold for paying entities of CO_2/capita emissions could be fixed, with countries below this threshold being fully exempted from the payments. One component could also be GDP based.

In addition, every loss scenario qualifying for the CIP coverage will be capped at the maximum insured limit.

Hence, we can conclude that by restricting the coverage to only highly catastrophic weather events on a parametric basis and by capping the payout to the overall insured limit, the CIP will be effectively in the position to insure weather related risks to economic development – the perils which otherwise do not lend themselves easily to insurability.

Customization. The coverage provided by the CIP will be highly customized to the needs of individual country members. This will be accomplished by identifying the most catastrophic loss scenarios from weather related events in each participating country, which will require country specific risk assessments. This level of customization however will not be an obstacle to the further mainstreaming of the program, as the commercial risk models developed for the participating countries can be then reused and updated to revise, if necessary, the existing coverage parameters (e.g. coverage attachment point, price, etc.).

Affordability. The coverage will be highly affordable to participating countries which will make NO premium payments, but may be subject to meeting certain standards of risk management. The CIP premiums will be financed by annual contributions from the (proposed) multi-lateral adaptation fund, which itself may be financed by developed countries. While the exact formula of contributions and disbursements of an enhanced adaptation fund is yet to be determined, there is a growing consensus based on principles of the UN Framework Convention on Climate Change that adaptation funds will be (1) raised according to common but differentiated responsibilities and respective capabilities of countries (UNFCCC, Art. 3), which can be translated into criteria such as "ability to pay" and "polluter pays"; and (2) disbursed to those who suffer most from climate change. The CIP conforms to these principles.

Sustainability. Our sustainability rating comprises two important criteria – financial sustainability and incentives for proactive risk management.

The long-term financial sustainability of the CIP appears to be the weakest link of the proposal as the scheme is entirely dependent on the politically negotiated and agreed contributions of developed countries to the multi-lateral adaptation fund. However, it appears that there is a growing international support for such a global climate adaptation insurance fund. Without being comprehensive, the recent proposals include: levies on the auctioning of emission rights (e.g., the US International Climate Change Adaptation and National Security Fund); the European Union's ETS Auction Adaptation Levies; withholding and auctioning a portion of assigned amount units as recently proposed by the Norway; a levy on carbon emissions as recently put forth by the Swiss; extending the levy on revenues from the Clean Development Mechanism to other international Kyoto mechanisms; and levies on international aviation and maritime transport (the Tuvalu Adaptation Blueprint). With at least of one of these proposals taking strong hold, the sustainability prospects for the CIP will be greatly enhanced.

Another important element of sustainability rating relates to how well the proposed insurance scheme incorporates incentives (e.g., deductibles) and/or conditions (e.g. eligibility criteria) for proactive risk preventive measures. The CIP includes country criteria to foster prevention and risk reduction. Countries that wish to participate in the program will be required to commit to long-term national disaster risk management and overtime will have to show good progress on fulfilling these plans.

Market complimentarity. To avoid distorting the private catastrophe risk reinsurance and capital markets, the CIP will utilize market based pricing of its covers and will rely heavily on risk transfer to private risk carriers. The CIP would retain no more that approximately 25% of the risk. Market based pricing will be ensured by having the CIP reinsure its risk retention (across its whole risk program) on a quota share basis[7] to the reinsurance or capital markets at a market price, which will then be applied to price the CIP's own insurance contracts with country beneficiaries. This approach will establish the true cost of retained risk every year, stimulate further development of the sovereign risk transfer market globally, and will add some additional claims payment capacity to the CIP over time. To avoid insolvency in the case of very high losses, for instance, from multiple events, the facility should also reinsure on an excess loss (XL) basis (insuring losses above a certain limit). The capital surplus that the CIP will build over time will be retained in the fund and used for absorbing more risk (e.g. higher risk retention) during years of high reinsurance prices (hard reinsurance market). Therefore the proposal scores high on the market complimentarity count.

Summary

The Section reviews one of the most promising recent global initiatives in weather risk insurance – a two-tiered insurance program proposed by the MCII. The proposed insurance program has two different windows, reflecting the different levels of risk that need to be addressed by an effective climate adaptation program - the "high level" risk which would exceed the ability of any given country to pay in the case of an extreme event, and the "middle level" risk which can be addressed by an affected country if the proper facilitating framework were in place. The proposed design of the facility is then analyzed using all five criteria of long term sustainability.

Section VII. Conclusions

As climate change increases not just average temperatures but also weather variability and the frequency of extreme weather events, its economic and social effects are

[7] A quota share reinsurance treaty is a reinsurance contract that provides protection on a proportional basis. For example, the CIP may wish to reinsure the first $100,000 of loss by allowing reinsurers to share in 80 percent of the risk on a quota share basis. If a $100,000 loss is paid, the CIP retains 20 percent and reinsurers pay 80 percent.

particularly pronounced in developing countries, which simply do not have the financial resources to cope with the crises. In this context, insurance and other weather risk hedging instruments can play a key role in helping vulnerable countries to adapt to climate change.

While the Bali Action Plan calls upon policymakers to consider insurance as part of an adaption strategy, it offers little detail on how this goal can be achieved. Yet, weather risk insurance markets still remain rather nascent, particularly in the developing countries, due to the lack of reliable data, low incomes and often misguided government policy on post-disaster compensation. Despite major advancements in weather risk modeling technology and development of innovative weather risk transfer instruments, these by and large remain inaccessible to enterprises and households in developing countries.

To make weather risk insurance a main stream post-Kyoto adaptation strategy in developing countries, a strong commitment is needed on the part of international development organizations, donor governments and the governments of developing countries to the development of national, regional and global weather risk markets as well as alternative risk transfer mechanisms in the countries where the markets are still nascent.

The donor community and governments should be mindful of potential risks arising out of misguided interventions in the functioning of nascent risk markets. Excessive post-disaster and premium subsidies are fraught with potential market disintermediation, which will only exacerbate the growing exposures of governments, businesses and households in developing countries to climate related natural disasters. In shaping future insurance market interventions policy-makers should consider scoring these proposals against the long-term sustainability criteria developed in this paper. These include insurability, customization (vs. replicability), affordability, sustainability, and market complimentarity.