THE CARIBBEAN CATASTROPHE RISK INSURANCE INITIATIVE

Background Document

Results of Preparation Work on the Design of a Caribbean Catastrophe Risk Insurance Facility

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THE WORLD BANK

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Design and layout: James E. Quigley

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Preface

Following the devastation caused by natural hazards in the Caribbean in 2004, the CARICOM Heads of Government asked the World Bank for assistance with gaining access to affordable and effective catastrophe insurance. In response, the World Bank is developing a risk financing vehicle to allow Caribbean countries to pool natural disaster risks, reduce the cost of insurance, and ensure swift payment by the use of a parametric system of claims determination. The general concepts for this risk financing vehicle (the Caribbean Catastrophe Risk Insurance Facility, CCRIF) were presented to technical staff from CARICOM country Ministries of Finance at a workshop held in Kingston, Jamaica on April 28, 2006. Results from preparatory studies were presented at a second technical workshop held in Barbados on October 13, 2006.

Executive Summary

At the request of the Caribbean Community and Common Market (CARICOM) Heads of Government, the World Bank has been developing a Caribbean Catastrophe Risk Insurance Facility (CCRIF, or the Facility) for Caribbean Basin countries. The Facility will allow CARICOM governments to purchase coverage akin to business interruption insurance that would provide them with an immediate cash payment after the occurrence of a major earthquake or the passing of a hurricane. Because of the speed at which a claim payment will be processed, the instrument will be particularly useful to finance the immediate post-disaster recovery, giving the affected government time to mobilize additional resources for longer-term reconstruction activities.

As a risk aggregator, the Facility will provide insurance coverage to participating countries at a significantly lower cost than individual governments could obtain on their own, by enabling participating countries to pool their individual risks into a single, better diversified portfolio. The Facility would seek to retain some of this risk through a buffer of reserve funds established with the assistance of donor partners. The Facility will transfer the risks it cannot retain to the international financial markets. This will be done through reinsurance or through other financial coverage instruments (for example, catastrophe bonds). The accumulation of reserves over time should lessen the Facility's dependence on outside risk transfer, and smooth the catastrophe reinsurance pricing cycle.

Insurance coverage will rely on parametric techniques; payouts will be calculated based on the estimated impact of an adverse natural event on each government's budget. The estimated impact will be derived from probabilistic catastrophic risk models developed specifically for the Facility. Participating countries will receive compensation proportional to the losses from the predefined events depending on the level of coverage agreed upon in the insurance contract. Some indicative cost of coverage is provided in the Section on "Pooling of Risk."

Insured countries will pay an annual premium commensurate with their own specific risk exposure. Parametric insurance products will be priced for each country based on the individual country risk profile. Annual premiums will typically vary from US$200,000 to US$4 million, for coverage ranging from US$10 million to US$50 million. To encourage continuous participation, country members of the CCRIF will be required to pay an entry fee, which is lost if they leave the Facility. The entry fee is non-refundable and is equal to the annual insurance premium.

The CCRIF will be established as an independent legal entity registered in the Cayman Islands, a market leader in Insurance Captives. The CCRIF will be managed by a Captive Manager under the supervision of a Board of Directors designated by participating donors and client countries. This Board will be supported by the technical advice of a specialized Facility Supervisor.

Donor support to the Facility will be essential to ensure its financial viability and long-term sustainability. To facilitate the channeling of funds from Donor Agencies to the Facility, the World Bank is establishing a multi-donor Trust Fund, which will enter into a Grant agreement with the Facility. A donor pledging conference hosted by the World Bank is scheduled in Washington DC on February 26, 2007.

As of January 30, 2007, 16 Caribbean countries had confirmed their participation in the CCRIF, including Dominica, Grenada, St. Lucia, St. Vincent and the Grenadines, Anguilla, Belize, the Bahamas, Barbados, Bermuda, the British Virgin Islands, the Cayman Islands, Haiti, Jamaica, Montserrat, St. Kitts and Nevis and Turks and Caicos Islands. This high level of enrollment will allow the CCRIF to efficiently diversify its portfolio and thus access reinsurance on better terms.

Introduction

The Hyogo Framework for Action 2005–2015, signed in January 2005, identifies the need to "promote the development of financial risk-sharing mechanisms, particularly insurance and reinsurance against disasters," as a priority action for "Building the Resilience of Nations and Communities to Disasters."[1] While this is only one recommendation among many, the need for innovative risk financing mechanisms is particularly relevant to the Caribbean states.

Caribbean countries are highly exposed to adverse natural events (including hurricanes, earthquakes, volcanic eruptions, and tidal waves), which can result in disasters affecting their entire economic, human, and physical environment (see Annex 3). Based on the experience since 1970, natural disasters inflict damage equivalent to more than 2 percent of the affected country's GDP on average. While these are estimates of average losses, individual events can result in major losses overnight. Major hurricanes can be expected to hit the Caribbean basin once every two and a half years. Other types of catastrophic events are less frequent, but can be as devastating, as demonstrated by the near total destruction of the island of Montserrat in 1995. For many reasons, ranging from the growing concentration of assets to poor environmental management, the loss burden from natural disasters is increasing (see Box 1).

Because of their small size, Caribbean countries have limited financial capacity to respond to adverse natural events. Larger countries can generally absorb the impact of these events by subsidizing the affected region with revenues from unaffected regions. This type of geographic diversification of risk is limited in the small island states of the Caribbean. The inability to effectively respond to disasters, physically and financially, often slows recovery, which exacerbates the poverty impact of natural disasters (see Box 2).

1. "Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters," World Conference on Disaster Reduction, 18–22 January 2005, Kobe, Japan, Section 4 (ii) k.

Box 1. Hurricanes in the Caribbean

Of particular concern to the small states of the Caribbean Basin are the recurrent losses due to hurricanes. The Caribbean Basin lies directly in the track of storms originating in the Atlantic Ocean, many of which ultimately affect North America. The impact of hurricanes is highly variable. During the last 27 years, 1979–2005 inclusive, 13 years were "loss free," with no significant damage to any Caribbean country. Over eight of the years during this period, a single storm caused losses in the Caribbean. Over the remaining six years, significant damage was caused by multiple storms. In 2004, for example, four storms (Charley, Frances, Ivan, and Jeanne) wreaked havoc as they crossed the region, causing combined losses of almost US$4.5 billion (see Annex 3).

In rare occurrences, storms can also cause damage to multiple countries. One storm, Ivan, in 2004 affected eight different states. During 1979–2005, losses totaled US$16.6 billion (in current value), or US$613 million annually. Apart from storm frequency, intensity is the major determining losses when a storm strikes. The record shows that storm losses to private property, state infrastructure, and other state property can be considerable. When Hurricane Ivan struck Grenada in 2004, the loss was calculated at US$800 million, about two times the country's Gross Domestic Product, of which government losses accounted for about 30 percent.

While Caribbean countries have limited capacity to spread risk geographically, their constrained borrowing capacity also prevents them from spreading their risk over time by accessing credit. A quick analysis of economic statistics from Caribbean Community and Common Market (CARICOM) states indicates an average ratio of external debt to GNI of 86 percent, compared to 34 percent for low-income countries, and 20 percent for middle-income countries (see Annex 4). Caribbean countries affected by natural disasters generally see their access to credit dramatically reduced right at the time when they need it most, limiting their capacity to respond to emergency needs. The limited lines of credit that are available, including IMF contingent facilities, often take time to materialize and add to the debt burden, as they must usually be repaid over a very short time frame (See Annex 5).

Under these circumstances, Caribbean governments affected by natural disasters have generally relied on extensive financing from international donors to address post-disaster needs. While ex post disaster funding from bilateral and multilateral agencies can be an important component of a government's catastrophe risk manage-

Box 2. The Poverty Impact of Disasters

Poverty is closely linked to vulnerability conditions. Poor populations tend to live in higher-risk areas, making them more likely to be affected by adverse natural events. With limited savings, the poor are also less able to cope economically. Being more vulnerable to the onset of disaster, and least prepared to cope with their effects, the poor are often heavily dependent on government recovery programs.

Improving government capacity to finance risk is one of the key pillars of the World Bank framework for disaster vulnerability reduction. The proposed Caribbean Catastrophe Risk Insurance Facility will provide Caribbean countries with immediate access to liquidity, strengthening their capacity to more effectively respond to the needs of the poor resulting from these events.

Box 3. Rationale for the World Bank's Involvement in the Creation of the CCRIF

Caribbean government access to catastrophe insurance and reinsurance is limited because of high transaction costs resulting from the relatively small amount of business brought to the reinsurance market. In the absence of an effective insurance market, catastrophe insurance pools turn out to be a better funding solution than the creation of reserve funds for infrequent events.

At the same time, national catastrophe risk aggregators are not efficient in small countries with a concentrated risk exposure, like the Caribbean islands. A regional solution like the proposed Caribbean Catastrophe Risk Insurance Facility will allow the Caribbean governments to access the international financial markets in an efficient manner by pooling their risks into a joint Facility.

The World Bank is well positioned to assist countries in the design and implementation of such instrument, both because of its technical expertise and convening power.

- *Technical expertise*. The highly technical and specialized nature of setting up the CCRIF has necessitated the use of a wide spectrum of experts to tackle the legal, fiduciary, and catastrophe risk modeling and financing aspects of the initiative. To support the design of the CCRIF, the World Bank was able to bring together expertise from the Caribbean and other regions. Much of the design work benefited from the financial support of the Government of Japan.
- *Convening power*. Because of its in-depth knowledge of the client countries, its relationship with donors and the reputation of impartiality in the international financial markets, the World Bank can play a catalytic role in the development of an efficient partnership among countries, donors, and private markets in the financing of catastrophic risks.

ment strategy, over-reliance on this approach has obvious limitations. Unfortunately, donor assistance often takes many months to materialize, and usually supports specific infrastructure projects. A critical challenge confronting the governments of small states in the aftermath of a disaster is the need for short-term liquidity to maintain essential government services until additional resources become available.

Finally, Caribbean governments' access to traditional catastrophe insurance and reinsurance markets is limited because of the high transaction costs resulting from the relatively small amount of business brought to the reinsurance market. In the absence of well-functioning catastrophe insurance markets, most of the economic loss is borne by governments and households, with a disproportional impact on the poor.

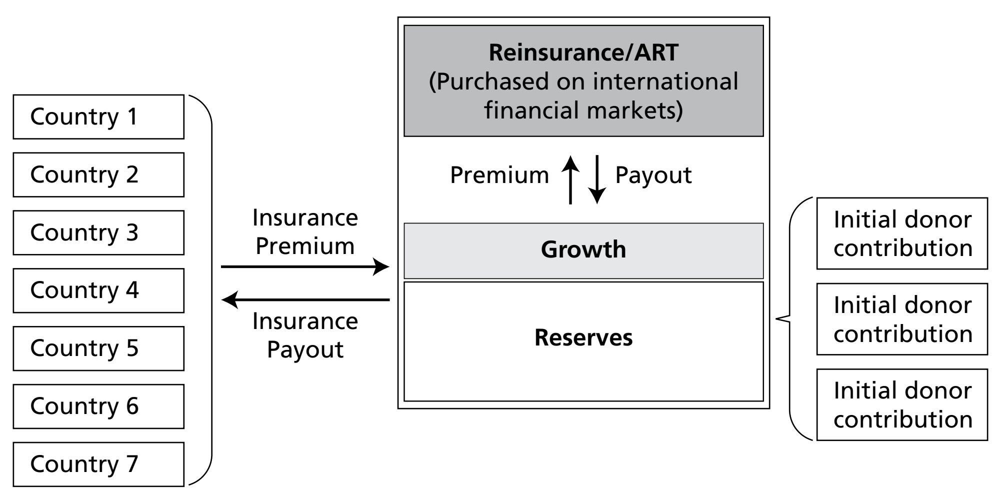
The purpose of the proposed initiative is to provide participating countries with an insurance instrument that would help shelter them from natural disasters. The instrument would function like business interruption insurance against budgetary losses caused by hurricanes and earthquakes. Because of the speed at which claim payments will be processed, the instrument will be particularly useful in financing immediate post-disaster recovery needs, while an affected government seeks funds from other sources for long-term reconstruction.

The creation of this instrument would allow participating governments to channel and share risk through a Caribbean Catastrophe Risk Insurance Facility (CCRIF, or the Facility). The Facility will provide Caribbean governments with catastrophe insurance coverage in a cost effective manner by allowing them to access the reinsurance market with a better diversified risk portfolio. The ultimate cost of coverage will depend on the extent of this risk-spreading effect, economies of scale, and the amount of initial capital available to the Facility.

The CCRIF as an Insurance Vehicle

The CCRIF has been designed to provide countries in the Caribbean region with an opportunity to obtain access to catastrophe insurance at the lowest possible cost. In effect, the proposed Facility will serve as a risk aggregator by enabling participating governments to pool country-specific risks into one, better diversified, portfolio. To access the reinsurance market where it is most efficient, the Facility will retain some of the risk ceded by participating countries. To perform this role, the proposed CCRIF will be established as an independent entity to act as a financial intermediary between par-

Figure 1. Structure of CCRIF



ticipating countries and the international financial markets (see Figure 1). A minimum level of reserves will need to be provided by donor partners to protect the Facility against the risk it retains in the first few years of operation.

Five main features of the proposed Facility support the goal of providing participating countries with efficient access to catastrophe insurance. These are (i) the pooling of risks; (ii) the benefit derived from a strong reserve base; (iii) the low operating costs of the proposed instrument; (iv) the possibility to buffer some of cyclical variation experienced in the cost of catastrophe reinsurance and (v) the creation of a financially sustainable instrument.

Pooling of Risk

The pooling concept makes the overall risk more stable and therefore more attractive to the reinsurance market, thereby reducing the premium cost. Since natural disaster risks among the Caribbean islands are not perfectly correlated, the variability of risk under the CCRIF insurance portfolio is less than the combined variability experienced by the individual states. Risk assessment analyses demonstrate that the correlation between government losses caused by catastrophic events varies from zero to 88 percent for hurricanes and between 0 to 79 percent for earthquakes (see Annex 5). The coefficient of variation, defined as the ratio between the standard deviation and the expected loss, is nearly reduced by a factor of 3 when country losses are aggregated in a hypothetical pool. Likewise, the Probable Maximum Loss (PML), defined as the largest

Box 4. How Catastrophe Insurance Works

The role of insurance is to serve as a recipient of risks and to diversify them by pooling losses among many policyholders. The statistical foundation of insurance is the Law of Large Numbers. Intuitively, the observed average loss (per policy) gets closer to the statistical expected loss (per policy) as the size of the insured population increases. In other words, an insurer can almost predict the average loss (per policy) and thus charge the policyholder accordingly. This result is valid when a large number of small independent risks are at stake, such as in the case of automobile insurance.

Unfortunately, contrary to automobile risks, the risks of natural disasters such as earthquakes and hurricanes are not easily diversifiable because many policyholders are affected at the same time. Moreover, deviations in the actual insurance loss from the expected insurance loss are very large. As a result, in the case of catastrophic events, insurers have to set up catastrophic reserves that will allow them to disburse large indemnity payouts after significant events. These provisions generate substantial costs to the insurer and are passed to the policyholder through a catastrophe load to be added to the actuarial cost (that is, the expected annual loss). The higher the catastrophic reserves and/or the opportunity cost of capital, the higher the catastrophe load.

The amount charged over and above the actuarial price is to compensate commercial providers for the cost of providing the coverage, which includes operating cost, commissions, cost of risk capital, and expected profit. For low frequency risks, say 1 in 100 years, the market can charge over four times the actuarial cost. As a comparison, for more frequent risks (say 1 in 7 years), the multiple is less than twice the expected loss. The clear implication is that the capital required to be held on hand for low-frequency risks must earn a positive return, which is accomplished through charging relatively higher premiums.

Figure 2. Probable Maximum Losses (PML), 1-in-200 Year Event

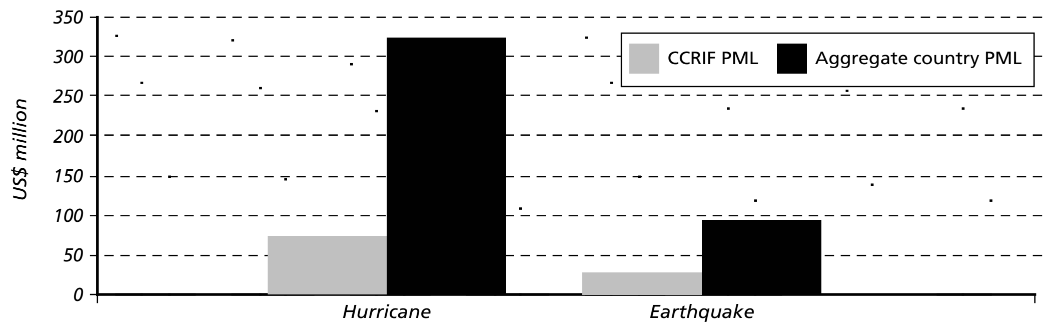
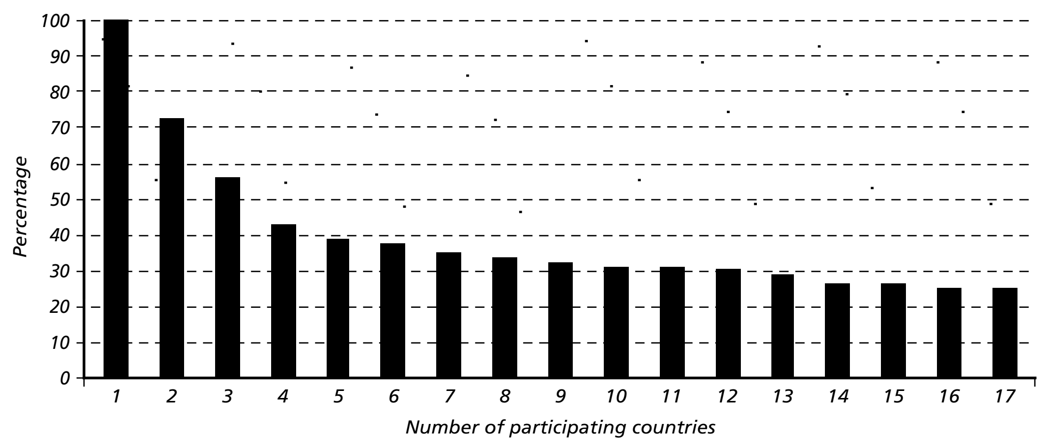


Figure 3. Risk Pooling Benefits and Country Participation, Hurricane Insurance



Note: CCRIF 1-in-200 year PML as a percentage of the aggregate country 1-in-200 year PMLs.

likely loss from a specific catastrophic event for a given return period, is significantly reduced when the risks are combined.

This implies that the cost of coverage is less, and the amount of reserves per policy (beyond the expected loss) to be set aside (also called catastrophe load) is lower, when country-specific risks are pooled into a joint Facility (see Box 4). Because the catastrophe load is one of the main drivers of the cost of coverage, initial financial simulations show that pooling country-specific catastrophic risks in the Caribbean enables the Facility to reduce the individual insurance premium by almost half, compared with the cost of coverage a country would pay if it had to approach the reinsurance market independently.

Figure 2 illustrates the benefits of risk pooling by comparing the probable maximum loss (PML) — for a 1-in-200 year event — of the Facility's insurance portfolio including all CARICOM countries to the sum of the country specific PMLs.[2] The analysis shows that the amount of reserves in a combined portfolio is reduced by 76% for hurricanes and 68% for earthquakes.

Refining this analysis, Figure 3 shows how the participation of each additional Caribbean country affects the level of risk capital needed by the Facility.[3] For example, the relative risk capital requirement of the CCRIF is reduced by 65% when 7 countries participate into the Facility. It is further reduced to 75% if the CCRIF portfolio insurance includes 17 Caribbean countries.

Strong Reserve Base

The Facility is designed to be a financially sustainable concern. Consequently, it will charge commercial premiums set at a level that covers expected losses, operating costs and reserve growth (net of inflation). At the same time, like any mutual insurance company, the Facility will not be expected to pay dividends over time, considerably reducing the catastrophe load (cost of reserves) on the portion of the risk that it retains.[4]

To illustrate the benefit of additional risk capital, Figure 4 shows the estimated technical rate-on-line (technical insurance premium over coverage amount) of hurricane insurance for an hypothetical portfolio with different levels of initial reserves. The analysis shows that an increase of initial reserves from US$20 million to US$40 million would allow for a reduction in the cost of premium on the order of 15 percent on average. This price reduction is doubled if the initial reserves are set at US$80 million.

The benefits of the Facility's reserves will depend on the amount of capital gathered at the launch of the Facility. Indeed, with sufficient initial reserves, the Facility will be able to dedicate a decreasing share of the premium collected towards the purchase of reinsurance and allocated in increasing share towards growing its reserves, thereby reducing the Facility's dependence on the reinsurance market. On the other hand, insufficient initial reserves will make it very difficult for the Facility to grow its reserve base, eventually affecting its ability to become a sustainable venture.[5]

2. See Box 4 for a description of the the CCRIF insurance portfolio.
3. The order of inclusion of the Caribbean countries in the CCRIF portfolio affects the PML and thus the risk pooling benefit. A robust approach would have been to compute all possible combinations and then average them. However, given the huge number of possible combinations, only a random set of combinations was computed and averaged.
4. See Annex 5 for a more detailed discussion on the benefit of additional reserves in the Facility.
5. Additional discussion of the benefit of initial capital is provided in the section titled "Support from Donor Partners."

Low Operating Costs

Design costs for the Facility are being funded by the World Bank together with grant financing from the Government of Japan. Without the benefit of this grant, the Facility would have had to charge higher insurance premium rates to recover its startup costs. Once the Facility is established, the nature of the insurance instrument that the Facility will provide should help keep costs to a minimum; parametric insurance requires neither a costly monitoring process nor a loss adjustment process. The parametric approach depends exclusively on the measurable characteristics of a catastrophic event, or underlying index, as measured by independent agencies. Finally, participating countries will benefit from economies of scale in the cost of the day-to-day operation of the facility, which is expected to remain below 5 percent of the premium collected.[6]

Stability of Premiums

Catastrophe insurance prices are known to be highly volatile, creating particular difficulties in the planning and execution of insurance programs. Figure 5 illustrates this point by providing an analysis of catastrophe insurance pricing in the US financial markets over the last twenty years. The problem became particularly acute after the 2004/2005 hurricanes seasons which led to a 100% increase in the cost of some reinsurance layer for catastrophe risk in the Caribbean.

One of the objectives of CCRIF is to stabilize insurance costs over time. Indeed, catastrophe insurance pools can act as efficient intermediaries between the ultimate consumers and reinsurance markets. If sufficient reserves are accumulated, the pool can smooth the cost of risk transfer, and thus the insurance premiums, by varying the level of local risk retention. As its reserve base grows, the Facility will be able to retain more of the risk and to provide greater stability to participating countries than is available in the commercial market.

Sustainability

Based on the concepts of mutual insurance, the CCRIF aims to achieve a high level of survivability while maximizing long-term sustainability. To do so, it will need to determine a level of financial security that allows it to grow its reserves, while providing sufficient assurance to policyholders that claims will be paid with certainty in any given year (See Box 5).

The main tradeoff faced by the Facility's risk manager is the opposing need for reserve accumulation and survivability. A strategy in which the Facility would transfer most of its risk portfolio to the reinsurance market would ensure a very high surviv-

6. See section on "Structure of the Facility" for a more detailed understanding of the source of operating expenditure of the Facility.

Box 5. Credit Ratings of Commercial Reinsurers

The score that Rating Agencies place on corporations can, in part, be interpreted as an assessment of how long an entity is expected to operate. For example, an AAA-rated corporation is expected to survive over the very long-term. In contrast, a rating of CCC indicates that there is a significant chance that the corporation may not survive the decade (see Annex 9). Typically, commercial insurers and reinsurers set reserves in order to have enough capital to ensure survival of a 1-in-100-year event or, more recently, a 1-in-250-year event. In the commercial market, reinsurance buyers tend to buy protection from companies rated BBB or better and most available reinsurance is at the A-rated level.

ability but compromise its chance to accumulate reserves over time. On the other hand, a strategy under which the Facility would retain a larger part of the risk may jeopardize its survivability in any given year.

The speed at which reserves are accumulated, and the level of survivability of the Facility, would also affect the affordability of insurance coverage provided. The California Earthquake Authority, for example, maintains enough claims-paying capacity to survive a 1-in-800-year-event. As a result it is among the safest insurance programs in the world, but also one of the most expensive. This risk management target is considerably higher than the 1-in-200-year event typically used by BBB-rated private reinsurers. The Turkish Catastrophe Insurance Pool has, six years after its establishment, a claim-paying capacity that enables it to absorb a 1-in-200-year event.

The CCRIF is being designed using international best practice standards. While all insurance ventures carry a probability of default, this annual probability will be maintained below 0.05% at all times. Therefore, the Facility will initially develop a financial

Figure 4. Estimated Rate-on-Line of Hurricane Insurance for Selected Countries for Different Levels of CCRIF Reserves

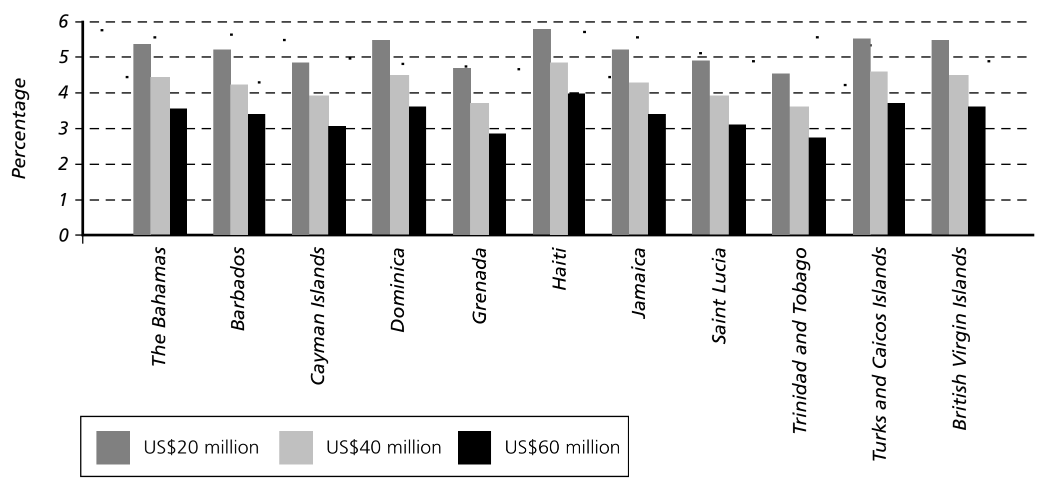
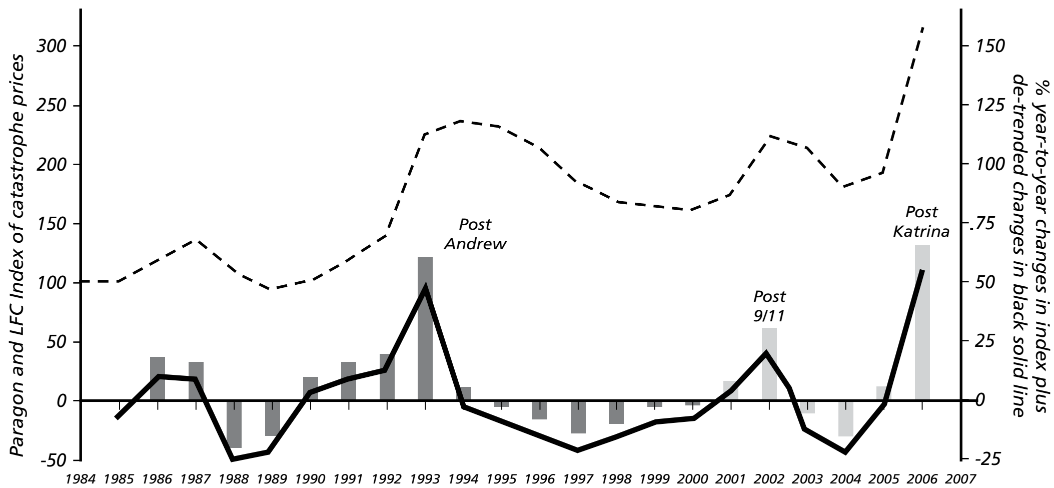


Figure 5. U.S. Catastrophe Reinsurance Price Indexes



Source: Lane Financial L.L.C.

Box 6. Dynamic Financial Analysis

A Dynamic Financial Analysis (DFA) model has been developed as part of the preparation work for the Facility to assist the CCRIF team in designing the most efficient allocation of insurance premiums between purchasing reinsurance and increasing the reserve pool. DFA is a financial tool used by the insurance industry to better understand the effects of risk, and in particular catastrophic risk, on its operational account. This CCRIF DFA model will be used in the in planning and execution of a risk transfer strategy that optimizes the use of available reserves, as well as traditional and non-traditional risk transfer instruments.

strategy that generates a claims-paying capacity for surviving at least a 1-in-200-year event, and seek to reach enough claims-paying capacity for surviving a 1-in-500-year event over the next 5 years. Should the Facility's claims-paying capacity be insufficient to pay all insured losses, claims will be prorated based on the remaining available funds. A reinstatement clause in the reinsurance contract, allowing the Facility to access more reinsurance capacity if the initial reinsurance capacity is exhausted, is being explored for the first years of implementation.

The financial sustainability of the Facility will be heavily influenced by the level of participation as a more diversified portfolio will be less vulnerable to peak exposures. To encourage continuous participation, country members of the CCRIF are required to pay a non-refundable participation fee (see Annex 10). At the same time, it is highly likely that one or more countries participating in the CCRIF will be affected by an insured event during the initial years of operations, and will draw on the insurance coverage provided by the CCRIF. This will confirm the utility of the risk financing instrument.

Proposed Insurance Instrument

Nature of Coverage

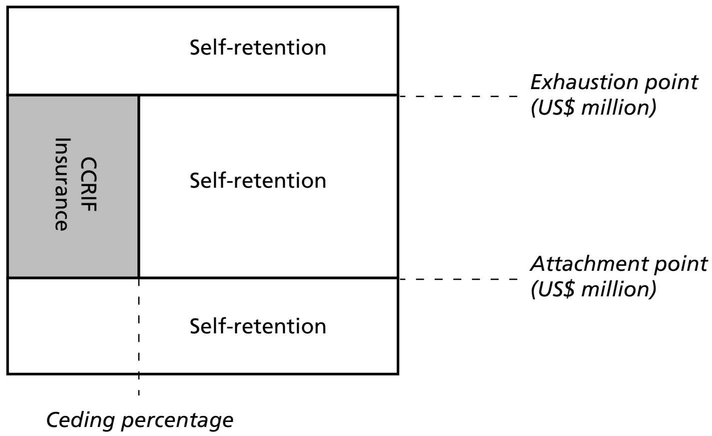
The establishment of the CCRIF will allow participating governments to purchase coverage akin to business interruption insurance against catastrophic events resulting from hurricanes and earthquakes. Under the proposed policies, the amount of funds disbursed would be proportional to the magnitude of the disaster, up to the subscribed limit.

The insurance contract issued by the Facility is "parametric" in nature. Parametric insurance products are insurance contracts that make payments based the intensity of an event (for example, wind speed, earthquake intensity). Unlike traditional insurance settlements that require an assessment of individual losses on the ground, parametric insurance relies on an assessment of losses using a predefined formula that is based on variables that are exogenous to both the individual policyholder and the insurer, but have a strong correlation to individual losses (See Annex 8 for a detailed discussion on the concepts and applications of parametric insurance).

The parametric scale used to calculate wind damage under the CCRIF is based on an index with inputs that would be provided by the U.S. National Hurricane Center. The parametric scale for earthquakes is the Richter scale and will be based on inputs provided by the U.S. Geological Services.[7] In principle, any index can be designed to trigger payment, provided it is agreed in advance, is clear and unambiguous, and is not subject to manipulation by interested parties. Design work produced by a specialized

7. Because they rely on a calculated index, the use of parametric instruments is limited to hazards that can be modeled with a sufficiently high level of confidence. Hurricane and earthquake models have been developed and tested for more than a decade and are under constant improvement (particularly following hurricane Katrina in the United States in 2005), whereas catastrophe risk assessment models for hazards like volcanic eruptions or floods are still under development.

Figure 6. CCRIF Indemnity Structure



risk modeling firm (EQECAT) has established indexes tailored to the needs of each potential participating country in the CCRIF.

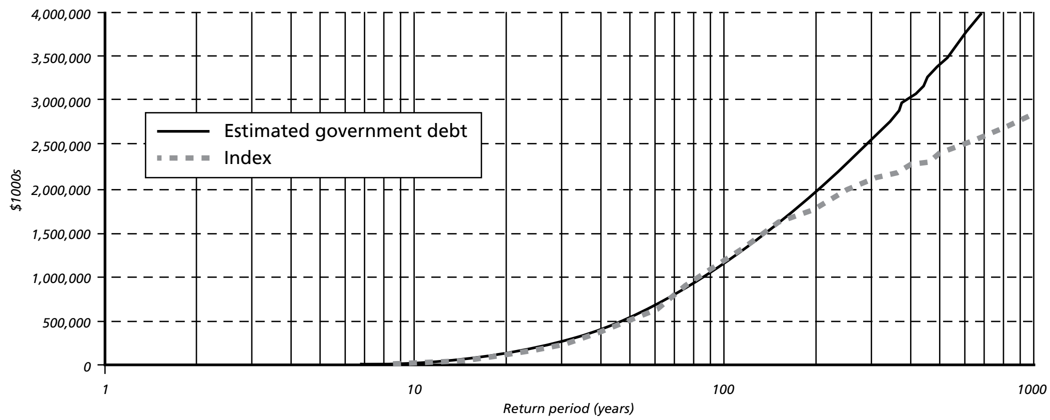
The insurance product covers a portion of estimated government losses (ceding percentage) beyond a pre-determined deductible (attachment point) up to a pre-determined upper limit (exhaustion point), as described in Figure 6. The terms and conditions of the CCRIF insurance policy are described in Annex 11.

Parametric insurance allows for quick payment of claims to the Treasury of the affected country and for reduced operating expenditures. However, parametric insurance faces several challenges. One of them is basis risk, which emerges when the insurance payout does not exactly match the actual loss. By definition, the index used in a parametric contract is a proxy for the real loss, and thus one cannot exclude the possibility that the parametric insurance indemnity may underestimate (or overestimate) the actual loss. To address this issue, a regional earthquake risk model and a regional hurricane risk model have been developed for the Caribbean Basin using state-of-the art catastrophic risk modeling techniques. Parametric indices have been carefully designed to minimize this basis risk. Figure 7 depicts the loss exeedance curve of the estimated government loss deficit and of the deficit index used in the parametric hurricane insurance policy in Jamaica. Both curves fit very well for hurricane events with return periods between 10 years and 150 years, meaning that the basis risk is low for this set of events.

Cost of Coverage

A detailed risk model has been developed to assess individual risk exposure of each client country. The insurance premiums will be calculated based on the estimated risk

Figure 7. Estimated Government Loss Deficit vs. Deficit Index, Jamaica Hurricane



faced by each individual country. This process will ensure that cross-subsidization will be kept to a minimum and remain negligible when compared with the benefits provided by the pooled portfolio.

The cost of coverage is calculated based on the country-specific average annual insured loss, the catastrophe load (including the cost of reserves to be secured by the Facility and the cost of reinsurance), and the operating costs. The components of the insurance premium depend on the terms and conditions of the catastrophe insurance policy selected by the participating countries (attachment point or deductible, limit, and so forth). The insurance premium also depends on the structure of the CCRIF insurance portfolio (the number of countries participating and the terms and conditions of their policy), which will impact the reserve requirements of the Facility and its reinsurance cost.

Box 7 shows the estimated insurance premiums for hurricane coverage offered by the Facility in the hypothetical case where 18 CARICOM members and associate members participate. The estimated hurricane insurance premium varies from US$0.2 million (Montserrat) to US$4.4 million (Jamaica). Of course, these numbers are subject to change depending on individual country decisions regarding the level of premium, and the final structure of the Facility's insurance portfolio and price of the reinsurance products.

Box 7. Hypothetical CCRIF Insurance Portfolio

A portfolio risk model has been developed to estimate the financial benefits of the Facility to the participating countries. A hypothetical portfolio of 18 Caribbean states is considered. The table below shows the estimated coverage (with lower and upper bounds) for hurricane and earthquake insurance with an estimated 1-in-30 year attachment point and a 1-in-150 year exhaustion point.

Estimated Hurricane and Earthquake Coverage Levels and Premium

Country (US$ million)	*Total annual premium*	*Hurricane coverage*		*Earthquake coverage*	
		Lower	*Higher*	*Lower*	*Upper*
Anguilla	0.20	2.1	2.9	0.9	1.2
Antigua and Barbuda	0.30	3.7	5.0	1.1	1.5
The Bahamas	0.95	16.7	22.9	n/a	n/a
Barbados	0.73	6.8	9.3	4.5	6.2
Belize	0.48	7.6	10.5	0.8	1.2
Bermuda	0.49	8.3	11.4	n/a	n/a
Cayman Islands	1.49	18.4	25.4	7.2	9.9
Dominica	1.29	19.9	27.4	1.9	2.6
Grenada	1.29	23.0	31.6	2.4	3.3
Haiti	2.57	34.8	47.8	3.8	5.2
Jamaica	4.14	46.7	50.0	17.9	24.6
Montserrat	0.20	1.7	2.4	1.2	1.6
St. Kitts and Nevis	0.17	3.0	4.2	n/a	n/a
Saint Lucia	1.29	21.2	29.1	2.9	4.0
St. Vincent and the Grenadines	0.20	2.9	4.0	0.5	0.7
Trinidad and Tobago	2.49	13.9	19.1	22.6	31.0
Turks and Caicos Islands	0.94	13.8	19.0	1.6	2.2
British Virgin Islands	1.10	10.6	14.5	6.4	8.8

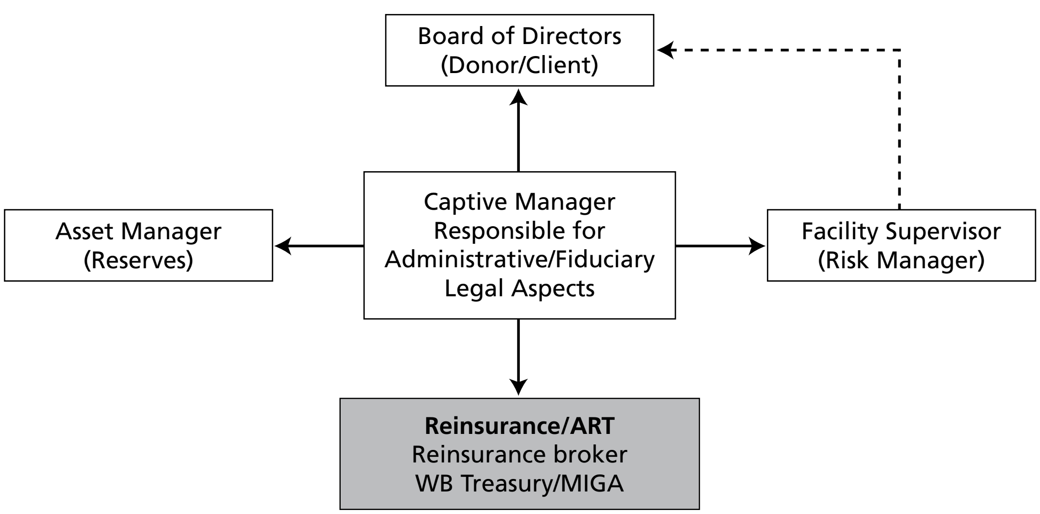
Note: Estimated insurance coverage is subject to change based on countries' participation, donors' contribution, and reinsurance costs.

Operating Structure of the CCRIF

The CCRIF will be managed by a Captive Manager under the supervision of a Board of Directors composed of representatives from the participating donors and client countries. This Board will be supported with the technical advice of a specialized Facility Supervisor. Figure 8 presents the principal elements in the organizational structure of the Caribbean Catastrophe Risk Insurance Facility.

The operational structure of the facility and the roles and responsibilities of each party are:

Figure 8. Operating Structure of the Facility



- *Board of Directors:* The CCRIF will be governed by a Board of Directors responsible for making strategic decisions, such as the purchase of reinsurance, under the advice of the Facility Supervisor. Any variation in the Facility's operating procedures will require Board approval. It is expected that the Board will include representatives from the donors and from the participating countries. The Board will also include one or two recognized insurance experts. The Board will meet on a regular basis to review the performance of the specialized firms responsible for the Facility's day-to-day operations.
- *Captive Manager:* The Captive Manager will act as the Facility's corporate secretary, and manage general day-to-day operations of the Facility under the supervision of the Board of Directors. It will execute and confirm all transactions on behalf of the Facility according to the operational manual, provide internal accounting and fiduciary services, and submit regular reports to the Board and Facility Supervisor. The Captive Manager will also ensure adequate systems of internal control, including the supervision of annual audits. Finally, the Captive Manager will convene meetings of the Board and act as its secretary.[8]
- *Facility Supervisor:* The main function of the Facility Supervisor will be to monitor the risk structure of the Facility and to advise the Board on risk transfer strategies. As such, it will provide regular financial and operational reporting based on the accounting data provided by the Captive Manager. The Facility Supervisor will also monitor potential triggering events, run trigger index models with data input from reporting agencies, and inform the Board on payments to be processed.
- *Asset Manager:* The Facility will subcontract its asset management function to a specialized agency. The Asset Manager will be responsible for the prudent investing of the Facility's reserve.
- *Placement of Reinsurance:* The Facility will be required to purchase reinsurance on an annual basis. To do so, the Facility will recruit a reinsurance broker who will manage the reinsurance claims processed on behalf of the Facility, including verification of outputs from the parametric index models when they are triggered.
- *World Bank Treasury:* Work is ongoing to assess whether the World Bank Treasury could assist the Facility to swap the risk in the international financial markets. This transaction would greatly reduce the cost of risk capital to the Facility.

8. A tender is underway to recruit the Captive Manager to assist the World Bank team in the registration of the Facility and to act as its manager over the first three years of operation.

Legal Structure of the Facility

The CCRIF will be created as an independent legal entity, registered as a fully capitalized Captive Special Purpose Vehicle (SPV) in the Cayman Islands.[9] The Captive SPV will be owned by a commercial trust (the CCRIF Trust) also registered in the Cayman Islands.

The Captive SPV

A trustee of the CCRIF Trust (the CCRIF Trustee) will establish the Captive SPV. The Captive SPV will be a limited liability company whose main purpose will be to sell insurance coverage to participating countries. This Captive SPV will have its own risk management strategy, which will include the purchase of reinsurance. The Captive SPV will have a Board of Directors composed of representatives of the donors,[10] representatives of the participating countries, and one or more insurance specialists.

CCRIF Trust

The sole purpose of the CCRIF Trust will be to establish and own the Captive SPV. When the CCRIF Trust is operational, its only function will be to own 100 percent of the Captive SPV. The beneficiaries of the CCRIF Trust will be the participating coun-

9. A Special Purpose vehicle (SPV) is a body corporate (usually a limited company of some type or, sometimes, a limited partnership) created to fulfill narrow, specific or temporary objectives, primarily to isolate financial risk.
10. Although the International Bank for Reconstruction and Development (IBRD) is expected to be a minority donor, the World Bank will not hold a seat on the Captive SPV's board.

tries that buy insurance policies from the Captive SPV. The CCRIF Trustee will be an entity in the CCRIF Trust's jurisdiction that routinely provides trustee services.

Funding of the Facility

In order to participate in the CCRIF, participating countries must contribute an entry fee to the Captive SPV. For each country, the respective entry fee will be at least equivalent to the level of their insurance premium.

To support to the CCRIF, donors will be invited to contribute either directly to the Captive SPV, or through the CCRIF Multidonor Trust Fund. The World Bank and the Captive SPV will enter into a grant agreement that will set forth the terms and conditions under which the World Bank will disburse funds from the CCRIF Multidonor Trust Fund.

In case of dissolution of the CCRIF, assets held by the Captive SPV will revert to the CCRIF Trust (as 100 percent owner of the Captive SPV). Upon dissolution of the CCRIF Trust, these trust assets will be distributed among the beneficiaries of the CCRIF Trust (that is, the participating countries). Funds remaining in the CCRIF Multidonor Trust Fund will be returned to Donors (pursuant to the Trust Fund Administration Agreement entered into between the World Bank and each Donor).

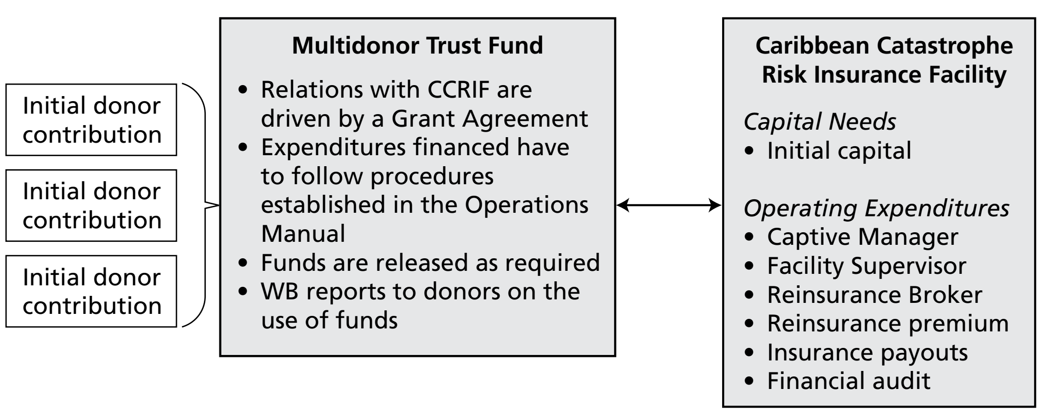
Since the Captive SPV will be a limited liability company wholly owned by the CCRIF Trust, residual risk will be borne by the CCRIF Trust, and will be limited to the amount the Captive SPVs paid in capital. Residual benefits will also accrue directly to the CCRIF Trust, and indirectly to the trust beneficiaries (that is, on the participating countries).

Support from Donor Partners

Preparatory studies for the establishment of the CCRIF are being funded through a grant from the Government of Japan and with support from the World Bank's own resources. These include the development of hurricane and earthquake models used to assess the potential monetary impacts to the Caribbean countries, the structuring of a risk financing strategy, and the design of the legal and organization structure for the Facility.

A donor conference is scheduled to take place on February 26, 2007, to seek support in providing funds for the initial costs of establishing the CCRIF and the financing of the first few years of operations. To facilitate the channeling of funds between Donor Agencies and the Facility, the World Bank is establishing a Multi-Donor Trust Fund (see Figure 9). The World Bank and the Captive SPV will enter into a Grant

Figure 9. Flow of Funds Contributed by Donor Partners



Box 8. Why Is Initial Support so Important?

Donors' support will help the Facility to build up its own reserves at an accelerated pace. These reserves are essential for two reasons. First, the Facility will be required to have a minimum amount of reserves in order to to be able to access the reinsurance market. Indeed, whether reinsurers provide risk capital through proportional or excess-of-loss treaties, they require that the primary insurer (in this case, the Facility) retains at least some of the risk. More important, a critical level of initial reserves will be essential to ensure the long-term sustainability of the Facility. These reserves will allow the Facility to retain some of the risk and dedicate a limited portion of the premium collected toward the purchase of reinsurance, giving it the opportunity to grow its reserves over time.

Agreement that will establish the terms and conditions upon which the World Bank will disburse funds from the Multi-Donor Trust Fund. Disbursements from the World Bank Mulitdonor Trust Fund will be made to the Captive SPV, as needed, to finance operating expenses and insurance payouts as they are incurred by the Facility.

On the other hand, with limited initial reserves, the Facility would not be able to retain any of its risk. In this case, most of the insurance premium will have to be used to buy reinsurance. Without the ability to retain a portion of the premium, the Facility would not be able to grow its reserves over time and would probably depend heavily on the reinsurance market. Chronic overdependence on reinsurance is neither desirable nor sustainable over a long period of time. In this scenario, the Facility would be highly exposed to reinsurance price cycles and would likely reach a time when it could no longer provide the proposed insurance service at a reasonable price. Insurance experts typically suggest that reserves should range between one-third and one-half of the total risk capital needed by the Facility.

The risk financing strategy and the insurance premiums will be set so the Facility can absorb a 1-in-200-year event in any given year (that is, the annual probability of survivability is 99.50 percent). Should the initial reserves increase, this would allow the Facility to further increase its expected survivability and/or to reduce the insurance premiums.

Donor Agencies interested in supporting the CCRIF are invited to contact the World Bank Caribbean Country Unit through:

Caroline Anstey
Country Director
Caribbean Country Unit
1818 H Street, NW
Washington, D.C. 20433
Tel: 202-473-1800
Fax: 202-676-1494
canstey@worldbank.org

Participation from Client Countries

Benefits resulting from economies of scale/risk pooling can only be achieved if a sufficiently large number of countries participate. As of January 30, 2007, sixteen countries had expressed interest in joining the CCRIF (see Box 9). A key decision to be taken by participating countries upon entry into the Facility will be the level of coverage they wish to purchase. This choice will be based both on their exposure to risk and on their capacity to pay. Countries interested in purchasing coverage through the CCRIF are invited to contact the CCRIF through their designated country contact listed in Annex 1 to discuss options and costs.

Box 9. Status of Client Country Participation (as of January 31, 2006)*

Countries that have confirmed interest in CCRIF	*Countries for which a response is pending*
Anguilla	Antigua and Barbuda
The Bahamas	Trinidad and Tobago
Barbados	
Belize	
Bermuda	
British Virgin Islands	
Cayman Islands	
Dominica	
Grenada	
Haiti	
Jamaica	
Montserrat	
Saint Lucia	
St. Kitts	
St. Vincent and the Grenadines	
Turks and Caicos Islands	

* Coverage provided by the CCRIF is not relevant to two CARICOM members, Guyana and Suriname, which are not affected by either hurricane or earthquake.

Annex 1. The CCRIF Team

CCRIF Core Team	
World Bank	**Caroline Anstey** Country Director canstey@worldbank.org Tel: 202-473-1800
	Francis Ghesquiere Team Leader (LCSFU) fghesquiere@worldbank.org Tel: 202-458-1964
	Olivier Mahul Senior Insurance Specialist (OPD) omahul@worldbank.org Tel: 202-458-8955
	Atsuko Okubo Senior Counsel (LEGCF) aokubo@worldbank.org Tel: 202-458-5985
	Marc Forni Finance Specialist mforni@worldbank.org Tel: 202-458-9534
	John Pollner Operations Advisor (OPCS) jpollner@wortldbank.org Tel: 202-473-0079
	Olga Jonas Economic Adviser ojonas@worldbank.org Tel: 202-473-7655

MIGA	**Judith Pearce** Lead Operations Officer jpearce@worldbank.org Tel: 202-473-4332
Jamaican Social Investment Fund (JSIF)	**Ms. Scarelette Gillings** Managing Director sgilling@jsif.org Tel. 876-906-2871 **Andrea Garcia** Project Manager agarcia@jsif.org Tel: 876-926-2825 **Paulette Cooper** pcooper@jsif.org Tel: 876-968-4545
EQECAT	**Dennis E. Kuzak** Senior Vice President EQECAT dkuzak@absconsulting.com Tel: 510-817-3108
CGM Consortium	**Simon Young** President, GeoSY Ltd simon@geosy.com Tel: 202-465-4301 **Matthew Pragnell** CEO, CGM Group matthewpragnell@iibre.com Tel: 876-906-0348 **Jan Vermeiren** Kinetic Analysis Corporation (KAC) jcvermeiren@kinanco.com Tel: 240-821-1202

CCRIF Country Contacts	
Jamaica	**Joseph Matalon** Chairman and CEO ICD Group Ltd joseph@icdgroup.net Tel: 876-922-6670
Barbados	**William Tomlin** CGM Group, Barbados wtomlin@cgm.com.bb Tel: 246 426 1442
Trinidad and Tobago	**Peter Melhado** ICD Group Ltd peter.melhado@icdgroup.net Tel: 876-922-6670

Grenada, St. Kitts and Nevis, Antigua and Barbuda, Belize	**Jan Vermeiren and Steven Stichter** Kinetic Analysis Corporation jcvermeiren@kinanco.com sstichter@mail.methaz.net Tel: 240-821-1202
Dominica, Saint Lucia, St. Vincent and the Grenadines	**William Tomlin and Martin Goddard** CGM Group, Barbados wtomlin@cgm.com.bb mgoddard@cgm.com.bb Tel: 246 434 2200
Cayman Islands, Bermuda	**Saundra Bailey** Director Reinsurance and Risk Management International Insurance Brokers Ltd (IIB Re) saundrabailey@iibre.com Tel: 876-906-0348
(regulatory issues)	**Vikram Dhiman** Chief Financial Officer ICD Group Ltd vikramd@icdgroup.net Tel: 876-922-6670
Montserrat, British Virgin Islands, Turks and Caicos Islands, Anguilla	**Paul Rousseau** Vice President, Financial Risk GeoSY Ltd paul@geosy.com Tel: 876-383-4698
Bahamas, Guyana, Suriname	**Eberle (Bobby) Dawes** Senior Account Administrator International Insurance Brokers Ltd (IIB Re) eberledawes@iibre.com Tel: 876-906-0348
Haiti	**Clive Myers** General Manager International Insurance Brokers Ltd (IIB Re) clivemyers@iibre.com Tel: 876-906-0348

Annex 2. CCRIF Logical Framework

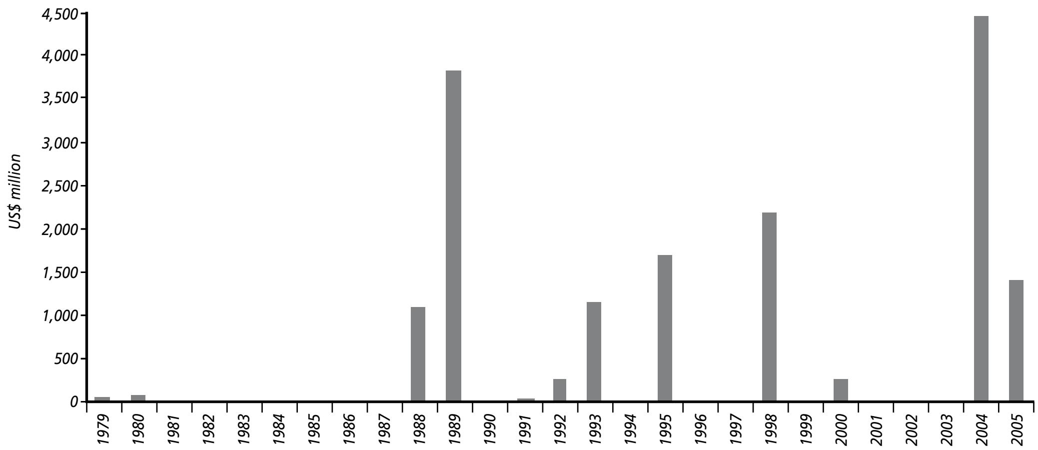
Objectives	*Project outcome indicators*	*Reporting*	*Critical assumptions*
1. Project Development Objective • To reduce Caribbean countries' financial vulnerability to natural disasters	• Country is eligible for insurance payment and has received payment in case of an insured event.	• Reports on disaster response • IMF Report on Country Finances	• The response capacity of participating countries will be improved by the immediate access to liquidity, allowing governments to more effectively respond to the needs of the poor resulting from these events.
2. Specific Objective • Provide access to financial coverage against earthquake and hurricane risks	• Catastrophe insurance coverage provided by the CCRIF (number of participating countries, total sum insured) • The CCRIF maintains enough claims paying capacity to survive at least a 1-in-200 year event.	• CCRIF Annual Report	• CCRIF financial viability such that the CCRIF can cover insured losses caused by a 1-in-200 year event.
3. Outcomes • CCRIF is created as a sustainable Facility. • Catastrophe insurance coverage available for the Caribbean countries	• Incorporation of the insurance captive • Total claims paying capacity • Number of catastrophe insurance policies sold	• First CCRIF Annual Report	• At least 8 countries participating • Minimum initial reserves of US$ 30 million by June 2007 • Successful placement of the CCRIF insurance portfolio on the reinsurance market.

4. Means • Funding of the CCRIF's initial reserves (including funds released for reinsurance payment and insurance payout) • Funding of the CCRIF operational expenses (excluding reinsurance and payouts)	• USD30 million • 5% of gross premium volume	• Quarterly report of the World Bank (if funds are transferred through the multidonor Trust Fund managed by the World) • Annual CCRIF report • Annual report of the financial audit of the CCRIF	

Annex 3. Main Natural Disasters in the Caribbean (1979–2005)

Year	*Country (hazard type)*	*People Affected*	*Damage USD (000's)*
1979	Dominica (David and Frederick)	72,100	44,650
1980	St. Lucia (Allen)	80,000	87,990
1988	Dominican Republic (Flood)	1,191,150	
1988	Haiti (Gilbert)	870,000	91,286
1988	Jamaica (Gilbert)	810,000	1,000,000
1989	Montserrat (Hugo)	12,040	240,000
1989	Antigua, St. Kitts/Nevis, Tortolla (Hugo)	33,790	3,579,000
1991	Jamaica (Flood)	551,340	30,000
1992	Bahamas (Andrew)	1,700	250,000
1993	Cuba (Storm)	149,775	1,000,000
1993	Cuba (Flood)	532,000	140,000
1994	Haiti (Storm)	1,587,000	
1995	St. Kitts and Nevis (Luis)	1,800	197,000
1995	U.S. Virgin Islands (Marilyn)	10,000	1,500,000
1998	Dominican Republic (Georges)	975,595	2,193,400
2000	Antigua/Barbuda, Dominica, Grenada, St. Lucia (Lenny)		268,000
2001	Cuba (Michelle)	5,900,012	87,000
2004	Cuba, Jamaica, Cayman Islands (Charley)	202,620	1,000,000
2004	Bahamas, Dominican Republic, Puerto Rico, Turks and Caicos (Frances)	8,450	
2004	Cayman Islands, Grenada, Jamaica, St. Vincent, Cuba, Barbados, Trinidad and Tobago, Haiti (Ivan)	419,805	3,431,564
2004	Haiti, Puerto Rico, Bahamas (Jeanne)	303,426	21,000
2005	Cuba, Haiti, Jamaica (Dennis)	2,523,000	1,400,000
2005	Cuba, Haiti, Jamaica, Bahamas (Wilma)	101,600	

Figure A3.1. Damage Due to Natural Disasters in the Caribbean Region



Annex 4. Indebtedness of Selected CARICOM States (Public and Publicly Guaranteed External Debt As a Percentage of GNI)

	2001 (%)	*2002 (%)*	*2003 (%)*	*Change 2000–03 (%)*
Barbados	29	29	29	7
Belize	82	93	110	39
Dominica	79	86	89	27
Grenada	49	78	74	26
Guyana	168	172	175	4
Jamaica	56	59	60	11
St. Kitts and Nevis	71	85	103	52
St. Lucia	27	33	37	10
St. Vincent and the Grenadines	50	51	55	3
Trinidad and Tobago	20	20	17	-6
Average Small States				
Africa	125	135	127	3
Asia	41	47	44	6
Caribbean	63	71	75	17
All Small States	82	89	86	7
Memo:				
All developing countries	23	23	22	–2
Low income	36	36	34	–5
Lower-middle income	25	24	21	–6
Upper-middle income	15	17	17	2
Middle income	21	21	20	–2

GNI = Gross national income
Source: Global Development Finance 2006.

Annex 5. The CCRIF as a Complement to IMF Contingent Facilities

The IMF offers two "facilities" specifically designed to meet financing needs associated with natural disasters, and four other facilities to help members meet balance of payment needs in general. Unlike the CCRIF all of these facilities are loans, some with relatively short maturities.

Fees charged by the IMF can be significantly lower than the CCRIF insurance premium. However, with the exception of Emergency Natural Disaster Assistance (ENDA), IMF support is typically not intended to be quick-disbursing and entails program conditionality and regular performance reviews. Yet approval of Fund arrangements or augmentation of resources available under existing arrangements may be sped up in exceptional circumstances. Conversely, the CCRIF disbursement is conditional only on a) prior participation to the facility through an insurance contract and b) confirmation of a pre-determined parametric trigger measuring the level of hazard.

Below is a brief description of each IMF facility, starting with the two specifically designed for natural disaster situations:

1. *Emergency Natural Disaster Assistance (ENDA)*. This facility is specifically designed to help countries with urgent balance of payment financing needs in the wake of natural disasters. ENDA loans are designed to be rapidly disbursed and do not involve adherence to performance criteria and only require the country to describe future economic policies in broad terms. ENDA loans are non-concessional although PRGF eligible countries (see below) can receive subsidization upon request and pay an interest rate of 0.5% per year. ENDA loans have to be repaid within 3 1/4 to 5 years and are generally limited to 25 percent of the member's quota in the IMF.
2. *Exogenous Shocks Facility (ESF)*. Introduced in 2006, the ESF provides policy support and concessional financing to PRGF eligible low-income countries that

do not have a PRGF-arrangement in place and are facing exogenous shocks, including natural disasters. ESF-supported programs focus on an adjustment to the underlying shock, with less emphasis on the broad structural adjustment that often characterizes other IMF programs (including PRGF programs). For countries that wish to exit, or "graduate", from continuous engagement in PRGF-supported programs, the ESF can serve as a safety net. In the event of a shock, an on-track Policy Support Instrument (PSI)—another new facility that establishes a policy framework but without Fund financing—would facilitate access under the ESF because it would reduce the time normally required to design an appropriate program. ESF programs are one or two years in length and require that a poverty reduction strategy be in place (or launched during the program). Access is generally limited to 25 percent of the member's quota in the Fund. Similar to the PRGF, ESF loans carry an annual interest rate of 0.5%, with semi-annual repayments, beginning at 5.5 years and ending at 10 years after disbursement.

3. *Stand-By Arrangement (SBA).* The SBAs make resources available to members to help meet actual or potential balance of payments difficulties of any kind, including those arising from natural disasters. This is a non-concessional facility with market-related interest rates, plus a "surcharge" when countries exceed their borrowing limits. Financing levels (or "access") are determined on the basis of need and the strength of the member's program, and can be augmented in the event of additional need. Purchases under SBAs are quarterly and involve quarterly or semi-annual reviews. SBAs are mainly used by middle-income countries. The length of SBAs is typically 12 to 18 months, and cannot exceed three years. Repayment obligations are over a period of 3 1/4 to 5 years.
4. *Poverty Reduction Growth Facility (PRGF).* The PGRF is the Fund's main facility for providing financial assistance to low-income countries facing a protracted balance of payment problem regardless of cause, including because of natural disasters. PRGF loans are concessional (interest rate of 0.5 percent), and loans are repaid over a period of 10 years (with 5½ years' grace). Access is determined on the basis of need and the strength of the member's program. Access can be augmented in the event of additional need. Disbursements are generally based on semi-annual reviews. Given their focus on poverty reduction PRGF arrangements require a poverty reduction strategy to be in place..
5. *Extended Fund Facility (EFF).* Extended arrangements provide financing to address relatively long-term balance of payments difficulties which require a strong structural reform program to deal with the embedded institutional or economic weaknesses. The length of extended arrangements is typically three years, with a possibility of extension for a fourth year. EFF loans carry the same financial costs as SBA ones, and repayments obligations are over a period of 4 ½ – 10 years.
6. *Compensatory Financing Facility (CFF).* The CFF was created to help finance balance of payments needs resulting from a temporary decline in export earnings or increase in cereal import costs attributable to factors largely beyond the control of the authorities. CFF loans have the same financial terms as SBA ones except for the surcharges. This facility has not been used since the late 1990s.

Annex 6. Country Risk Profile

The government deficit loss due to natural hazard includes the following components:

- Damage to government buildings
- Reduction of annual tax revenue due to loss of commercial facilities, business interruption, loss of import taxes, and tourism taxes
- Damage to infrastructures
- Government relief expenditures

The government loss for each country will be calculated through the losses from the damage to government buildings and infrastructure, reduction of tax revenue caused from the loss function of commercial facilities or business interruption, and the government relief expenditures. Each of these loss components will be estimated first, and then combined, to find the overall government loss for a country:

- *Loss due to damage to government buildings*. Direct damage to government buildings
- *Reduction of national tax revenue due to loss of commercial facilities, business interruption, loss of import taxes, and tourism taxes*. The reduction of tax revenue is estimated from the damage degree of commercial buildings in the country using the relationship of annual national tax reduction, with the damage ratio of commercial buildings shown in Figure A.6.1. The annual tax revenue values for each country are the total national tax revenue less the property tax, summarized in Table 6.1.
- *Loss due to damage to infrastructure (bridges, roads, pipelines, hospitals)*. The damage to infrastructure is estimated based on the total damage to the residential buildings in the same area. From the damage information of past hurricanes in

Figure A6.1. Relationship of Annual Tax Reduction and Commercial Building Damage

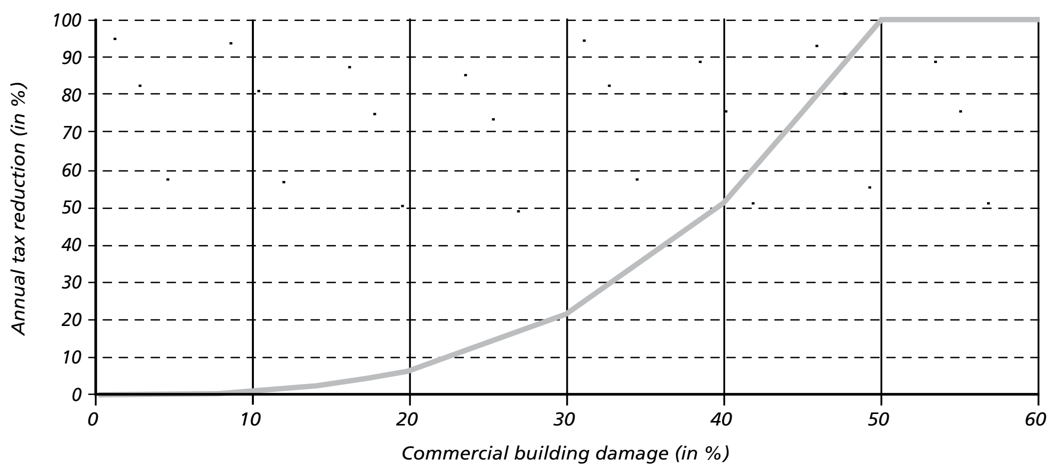


Table A6.1. Tax Revenue by Country

Country	*Population*	*GDP ($1000)*	*GDP/Cap ($)*	*Annual tax revenue ($1000)*
Barbados	12,200	108,885	8,925	46,770
Antigua and Barbuda	69,108	818,999	11,851	178,940
The Bahamas	303,611	6,043,073	19,904	1,100,000
Barbados	271,600	2,168,998	7,986	479,772
Belize	273,700	1,190,585	4,350	271,636
Bermuda	61,900	3,022,825	48,834	296,396
British Virgin Islands	23,098	953,231	41,269	287,000
Cayman Islands	42,500	1,937,490	45,588	345,102
Dominica	71,200	270,987	3,806	91,930
Grenada	104,800	350,766	3,347	95,448
Haiti	8,373,750	309,829	37	317,910
Jamaica	2,635,400	7,416,016	2,814	2,264,852
Montserrat	9,439	33,895	3,591	12,308
St. Kitts and Nevis	47,300	369,413	7,810	154,830
St. Lucia	160,600	591,972	3,686	211,730
St. Vincent and the Grenadines	106,700	309,750	2,903	65,048
Trinidad and Tobago	1,294,494	14,449,142	11,162	4,446,900
Turks and Caicos	30,600	298,993	9,771	158,490

Table A6.2. Ratio of Infrastructure Loss to Residential Building Loss (percent)

Country	*Hurricane*	*Earthquake*
Anguilla	35	20
Antigua and Barbuda	35	20
The Bahamas	50	20
Barbados	35	20
Belize	35	20
Bermuda	35	20
British Virgin Islands	35	20
Cayman Islands	29	20
Dominica	35	20
Grenada	15	20
Haiti	15	10
Jamaica	50	20
Montserrat	35	20
St. Kitts and Nevis	35	20
St. Lucia	35	20
St. Vincent and the Grenadines	35	20
Trinidad and Tobago	35	20
Turks and Caicos	35	20

Caribbean countries — four reports from the Economic Commission for Latin America and the Caribbean (ECLAC) and the United Nations Development Program (UNDP) — the loss amount from the damage to infrastructure ranges from 15% to 129% of the residential buildings (Grenada 15%, Cayman Island 29%, Jamaica 62%, and Bahamas 129%). The following assumption on the ratio of infrastructure loss to residential building loss is made accordingly, as summarized in Table A.6.2.

- *Government relief expenditure*. By referring the information from ECLAC reports, the government relief expenditure after natural disasters is assumed to be 1% of the total damage to the residential buildings in the same area.

Table A6.3. Government Deficit Losses, Earthquake

	AAL		*Probable no loss*		*PML (USD millions) by return period (years)*						
Country	*USD millions*	*% GDP*	*CV (%)*	*%*	*20*	*30*	*50*	*100*	*200*	*250*	*500*
Anguilla	0.4	0.31	678	88	2.3	3.6	5.1	8.0	14.9	16.0	29.7
Antigua and Barbuda	4.2	0.46	480	80	22.0	37.0	47.6	70.6	133.4	144.9	264.3
The Bahamas	0.1	0.00	779	74	0.2	0.5	1.0	2.1	3.5	4.1	7.6
Barbados	8.5	0.30	592	90	49.5	79.5	126.0	202.7	298.2	326.8	471.4
Belize	2.8	0.25	583	92	13.1	26.5	40.0	73.8	104.6	110.5	151.3
Bermuda	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cayman Islands	1.2	0.08	840	90	1.4	6.5	12.8	34.0	68.6	68.6	126.2
Dominica	0.6	0.21	681	90	2.6	5.0	7.2	12.2	19.3	21.6	38.3
Grenada	1.6	0.39	690	92	7.0	15.7	23.8	40.7	67.4	78.7	107.4
Haiti	7.2	0.21	731	79	27.9	48.3	64.6	146.2	287.8	366.4	571.0
Jamaica	61.9	0.70	475	81	286.1	480.7	681.0	1,122.7	1,782.1	1,817.9	2,979.4
Montserrat	0.5	1.68	565	87	2.3	4.1	6.0	9.6	14.0	18.2	28.0
St. Kitts and Nevis	1.3	0.32	518	87	6.7	12.7	19.5	27.8	46.1	54.9	81.5
Saint Lucia	2.5	0.31	475	88	14.2	24.2	36.9	53.6	71.3	86.2	113.5
St. Vincent and the Grenadines	1.2	0.30	554	87	6.1	12.8	18.3	35.4	45.5	49.5	69.7
Trinidad and Tobago	47.1	0.38	523	79	252.8	396.5	572.9	834.5	1,596.2	1,989.0	2,991.5
Turks and Caicos Islands	0.1	0.05	976	96	—	0.5	1.5	4.3	7.0	9.3	15.0
British Virgin Islands	1.8	0.07	630	86	7.5	14.5	25.9	42.6	86.5	102.1	140.5

AAL = Average annual loss
PML = Probable maximum loss
CV = Coefficient of variation
Source: EQECAT

Table A6.4. Government Deficit Losses, Hurricane

	AAL		Probable no loss		PML (USD millions) by return period (years)						
Country	USD millions	% GDP	CV (%)	%	20	30	50	100	200	250	500
Anguilla	1.3	1.05	552	77	3.4	10.6	18.1	41.1	54.4	57.5	68.1
Antigua and Barbuda	7.7	0.86	521	67	27.9	66.8	114.3	247.6	327.9	372.1	415.1
The Bahamas	44.6	0.84	403	31	227.9	376.5	606.4	894.4	1,354.5	1,512.9	1,900.8
Barbados	20.9	0.75	685	91	17.5	124.9	325.9	849.2	1,167.3	1,216.2	1,389.4
Belize	9.1	0.83	620	91	17.4	62.5	134.7	246.0	391.9	423.6	602.4
Bermuda	18.0	0.40	521	73	103.9	172.4	248.9	397.0	805.3	882.6	1,054.6
Cayman Islands	37.4	2.69	703	62	79.2	246.5	393.1	1,291.6	2,431.2	2,753.9	3,500.4
Dominica	3.3	1.08	545	79	8.8	27.2	46.1	110.8	135.3	144.7	175.7
Grenada	3.5	0.87	793	91	1.6	10.3	28.2	113.8	255.0	270.1	341.1
Haiti	28.2	0.80	499	61	115.3	257.2	392.9	671.6	953.4	1,020.3	1,303.8
Jamaica	79.6	0.89	591	76	225.7	592.6	1,093.9	2,586.8	3,805.7	4,056.7	4,956.8
Montserrat	0.6	2.17	524	77	2.1	6.1	12.0	20.1	26.8	28.4	31.3
St. Kitts and Nevis	4.7	1.17	504	74	18.6	37.8	94.2	148.6	199.8	213.8	232.1
Saint Lucia	6.0	0.75	605	88	9.7	40.8	94.3	220.6	280.1	300.6	331.0
St. Vincent and the Grenadines	3.6	0.91	671	87	4.8	20.1	50.2	166.0	221.5	232.7	256.7
Trinidad and Tobago	7.6	0.06	1,020	95	0.1	9.3	46.9	181.2	437.7	784.8	1,301.3
Turks and Caicos Islands	4.4	1.90	657	79	12.3	25.1	45.2	117.4	171.2	188.8	315.2
British Virgin Islands	5.9	0.24	563	68	16.6	47.6	85.8	182.8	251.3	287.6	322.3

AAL = Average annual loss
PML = Probable maximum loss
CV = Coefficient of variation
Source: EQECAT

Table A6.5. Government Deficit Losses, Earthquake, Spearman Correlation Index

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
1	Anguilla	1	**0.38**	0.04	0.05	0.02	0.01	0.20	0.03	0.03	0.01	0.37	0.55	0.07	0.03	0.05	0.02	0.49
2	Antigua and Barbuda		1	0.00	**0.07**	0.03	0.04	**0.40**	0.04	0.01	0.04	**0.86**	**0.72**	**0.15**	0.04	0.05	0.04	0.06
3	The Bahamas			1	**0.06**	0.03	0.05	0.01	0.04	**0.34**	**0.12**	0.01	0.03	0.01	0.03	0.06	**0.39**	0.01
4	Barbados				1	0.04	0.01	**0.30**	**0.31**	0.00	0.01	**0.14**	0.03	**0.66**	**0.57**	0.06	0.04	0.05
5	Belize					1	0.02	0.02	0.00	0.03	0.02	0.02	0.01	0.00	0.02	0.01	0.01	0.02
6	Cayman Islands						1	0.02	0.05	0.03	**0.20**	0.03	0.02	0.00	0.01	0.09	0.01	0.00
7	Dominica							1	0.03	0.01	0.02	**0.46**	**0.30**	**0.43**	**0.16**	0.06	0.00	0.06
8	Grenada								1	0.05	0.00	0.00	0.04	**0.31**	**0.72**	**0.63**	0.04	0.01
9	Haiti									1	**0.20**	0.01	0.01	0.04	0.05	0.06	**0.33**	0.00
10	Jamaica										1	0.03	0.02	0.01	0.01	0.02	0.02	0.02
11	Montserrat											1	**0.79**	**0.21**	0.07	0.03	0.02	**0.11**
12	St. Kitts and Nevis												1	**0.11**	0.04	0.04	0.01	**0.22**
13	Saint Lucia													1	**0.67**	0.09	0.00	0.06
14	St. Vincent and the Grenadines														1	**0.38**	0.04	0.03
15	Trinidad and Tobago															1	0.08	0.03
16	Turks and Caicos Islands																1	0.01
17	British Virgin Islands																	1

Note: Bold values indicate statistical significance at the 95 percent level.

Table A6.6. Government Deficit Losses, Hurricane, Spearman Correlation Index

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
1	Anguilla	1.00	**0.77**	**0.20**	**0.17**	**0.07**	**0.06**	**0.09**	**0.32**	**0.10**	**0.30**	**0.12**	**0.56**	**0.67**	**0.16**	**0.15**	**0.06**	**0.31**	**0.84**
2	Antigua and Barbuda		1.00	**0.17**	**0.18**	**0.07**	0.05	**0.13**	**0.41**	**0.09**	**0.37**	**0.22**	**0.77**	**0.89**	**0.18**	**0.15**	**0.07**	**0.25**	**0.69**
3	The Bahamas			1.00	**0.12**	0.02	**0.10**	**0.09**	**0.13**	**0.09**	**0.15**	**0.07**	**0.15**	**0.15**	**0.15**	**0.13**	**0.06**	**0.43**	**0.20**
4	Barbados				1.00	0.00	**0.14**	**0.11**	**0.42**	**0.47**	**0.23**	**0.16**	**0.23**	**0.22**	**0.83**	**0.87**	**0.18**	**0.13**	**0.23**
5	Belize					1.00	**0.05**	0.02	0.01	0.02	0.02	0.02	**0.09**	**0.08**	0.01	0.02	0.03	**0.07**	0.05
6	Bermuda						1.00	**0.06**	**0.06**	**0.07**	0.04	0.01	**0.05**	0.05	**0.12**	**0.13**	0.05	0.04	**0.11**
7	Cayman Islands							1.00	**0.12**	**0.11**	**0.29**	**0.44**	**0.09**	**0.12**	**0.11**	**0.09**	**0.08**	0.02	**0.09**
8	Dominica								1.00	**0.16**	**0.35**	**0.27**	**0.61**	**0.50**	**0.50**	**0.32**	**0.09**	**0.17**	**0.40**
9	Grenada									1.00	**0.15**	**0.27**	**0.10**	**0.11**	**0.36**	**0.63**	**0.55**	**0.06**	**0.13**
10	Haiti										1.00	**0.39**	**0.34**	**0.35**	**0.27**	**0.23**	**0.08**	**0.13**	**0.33**
11	Jamaica											1.00	**0.22**	**0.23**	**0.17**	**0.21**	**0.12**	**0.02**	**0.14**
12	Montserrat												1.00	**0.88**	**0.27**	**0.17**	**0.08**	**0.23**	**0.62**
13	St. Kitts and Nevis													1.00	**0.23**	**0.17**	**0.09**	**0.23**	**0.69**
14	Saint Lucia														1.00	**0.73**	**0.14**	**0.16**	**0.23**
15	St. Vincent and the Grenadines															1.00	**0.26**	**0.13**	**0.19**
16	Trinidad and Tobago																1.00	**0.04**	**0.07**
17	Turks and Caicos Islands																	1.00	**0.33**
18	British Virgin Islands																		1.00

Note: Bold values indicate statistical significance at the 95 percent level.

Annex 7. Economic and Financial Analysis

CAVEAT: Figures presented in this annex for illustrative purpose only and are subject to change.

The catastrophe premium formula provides a good snapshot of the main drivers behind the determination of the price of catastrophe insurance.

$$\textit{Technical Premium} = \textit{Pure Premium} + \textit{Catastrophe Load} + \textit{Expense Load} + \textit{Return on Equity}$$

Key components that affect the pricing of such insurance follow.

The *Pure Premium* is equal to the average annual loss (that is, expected loss per year when averaged over a long period) divided by the replacement value of the asset, usually expressed as a percentage of monetary value.

Losses from natural disasters can be catastrophically high. In addition, as opposed to traditional insurance, where risks are (almost) independent, catastrophic risks are highly correlated geographically, as the occurrence of a catastrophic event (for example, the passage of a hurricane) affects many people simultaneously. As a result of these potentially very large losses, insurance companies need to set aside a high level of funds in reserve to be able to pay indemnities (which largely differ from expected losses), should a catastrophic event occur. The *catastrophe load* is the cost of capital associated with the reserves the insurer must set aside in order to pay unexpected losses, with a predefined degree of confidence. This cost depends on the *amount of risk capital* and the *cost of risk capital*.

Catastrophe insurers need to secure risk capital to support the underwritten risks, and to ensure that they will be able to pay indemnities in full (with a given level of confidence), should a catastrophe occur. These catastrophe reserves usually follow regulatory requirements. They can be estimated using the concept of Probable Maximum Loss (PML), defined as the largest likely loss from a specific catastrophic event, for a given return period.[11] The catastrophe risk financing strategy, which includes catastrophe reserves and catastrophe risk transfers (for example, reinsurance), is devised to optimize the relationship among premium levels, insurance coverage, and creditworthiness. For example, suppose an insurer wants to be able to cover a 1-in-200-year event without becoming insolvent, which corresponds to an implied rating BBB+ (S&P rating system). They must secure an amount of risk capital equal to the PML with a 200-year return period. Box A7.1 shows how this risk capital (per policy) is driven by the variance of individual losses, the correlation among individual losses, and the level of solvency.

Once the amount of risk capital (per policy and for the entire insurance portfolio) is estimated, the insurer needs to secure this capital through a variety of risk financing instruments: reserves, reinsurance, insurance-like securities (for example, catastrophe bonds), and so forth. The optimal risk financing strategy is driven by economic considerations and regulatory requirements and should ultimately be driven by the (marginal) opportunity cost of capital.

The *expense load* includes development costs (which can be quite high when a new line of business is developed), underwriting costs, delivery costs, loss adjustment costs, monitoring costs (which are reduced with index-based insurance), and so forth.

The *Return on Equity* (ROE) is the rate of return (profit) by the shareholders of the insurance company. This profit is usually paid as a form of dividend. Under the proposed CCRIF, all profit will be reinvested to build up reserves and no dividends will be paid.

One of the objectives of the CCRIF is to offer competitive catastrophe insurance to the CARICOM states. The potential benefits of (a) pooling country risks, and (b) establishing the initial capital of the facility with donor contributions is discussed using a simple but robust simulation model. A pool of eight CARICOM member states and associate members is considered: Barbados, Bermuda, Dominica, Grenada, Jamaica, St. Kitts and Nevis, Saint Lucia, and Saint Vincent.

The Pool (CCRIF) offers parametric hurricane insurance and parametric earthquake insurance to its members. These financial instruments aim at providing immediate budget support should a hurricane and/or an earthquake hit the islands. Budget deficits resulting from the passage of such hurricanes were estimated through a catastrophe risk model developed by the risk modeling firm EQECAT. These losses include damage to government buildings and infrastructure, reduction of annual tax revenue (import taxes, tourism taxes, and so forth), and government relief expenditures. Note that these numbers are only an approximation of expected short-term government losses caused by a hurricane.

A simple but robust insurance portfolio model is developed to assess the benefits of the CCRIF on the pricing of catastrophe insurance. The first step is to define a pricing

11. Expected loss for a given return period from a set of stochastic events.

Box A7.1. Amount of Risk Capital: Concepts

The adequate amount of risk capital can be discussed by considering a simple model of a risk pool. The role of the insurer is to serve as recipient of individual risks and to aggregate/diversify risk by pooling the losses among policyholders. Consider a series of random individual losses ($\tilde{x}_2, \tilde{x}_2, \ldots \tilde{x}_N$) from a probability distribution with mean μ and variance σ^2. The law of large numbers then states that the sample mean

$$\tilde{X} = \frac{1}{N}\sum_{i=1}^{N} \tilde{x}_i$$

tends to the population mean μ as the sample size increases:

$$\lim_{N\to\infty} \Pr[\tilde{X} - \mu| < \varepsilon] = 1, \text{ for } \varepsilon > 0.$$

Thus the insurer's average loss (per policy) is highly predictable in a sufficiently large sample. The ability to accurately predict average loss is clearly evident in the case of automobile insurance where thousands of cars are insured.

The central limit theorem can then be used to specify the amount of risk capital (per policy) needed by the insurer for a given level of insolvency probability, α. Insolvency probabilities are usually driven by regulatory constraints. For example, the regulator may impose a rule that the insurance company must survive a 1-in-250-year event, meaning that the insolvency probability is 0.04 percent. This insolvency probability cannot be driven to zero because of the cost of holding capital (agency costs, regulatory costs, accounting rules, and so forth), as explained below.

The amount of risk capital per policy to cover any deviations from the expected loss (population mean) is thus calibrated to satisfy the insolvency constraint:

$$\Pr[\tilde{X} - \mu \le k] = 1 - \alpha$$

Assuming that the correlation between any pair of losses is ρ and, for the sake of simplicity, the individual losses are identically normally distributed, one can easily show that the amount of risk capital per policy as N tends to infinity (or at least is very large) is:

$$k - z_\alpha \sigma \sqrt{\rho},$$

where z_α is the value from the standard normal distribution such that $\Pr[\tilde{z} < z_\alpha] = 1 - \alpha$.

The above formula allows for an interesting discussion. Risk capital per policy is zero if individual random losses are not correlated ($\rho = 0$). In the case of automobile insurance for example, the average loss per policy tends to be very close to the expected loss and thus catastrophe reserves are not necessary (in addition to technical reserves). The higher the degree of correlation among individual losses, the higher the risk capital per policy. Risk capital also increases with the variability of individual losses. Finally, risk capital increases with the degree of solvency; the lower the accepted level of insolvency, the higher is the risk capital.

formula. The catastrophe reinsurance market is not a transparent market and catastrophe reinsurance quotes are not easily disclosed. It is thus very difficult, or even almost impossible, to derive any pricing formula. An alternative is to gather pricing data from the catastrophe bond market where many deals are disclosed and, with this information, develop a pricing formula from a statistical analysis. Several statistical pricing formulas have been estimated from past catastrophe bond deals (see, for example, Lane 2004).[12]

The approach adopted here relies on an economic analysis, rather than a statistical analysis. Following our previous discussion on the decomposition of the catastrophe insurance premium, we assume that the price of a given catastrophe insurance product is driven by the annual expected payout and the catastrophe load (which is equal to the PML for a given return period times the cost of capital). The return of equity is assumed to be imbedded in the cost of capital. Operating costs are omitted for the sake of simplicity, although this assumption is conservative because these operating costs are expected to be lower under the Facility (given that the development costs were covered through donor's grants) than under a commercial entity. Finally, the risk financing strategy of CCRIF is devised to sustain a 1-in-200 year event. (This risk financing strategy relies on reserves and excess-of-loss [XL] reinsurance because XL reinsurance is widely used on the catastrophe reinsurance market). In this static model, reinsurance and catastrophe bonds would generate the same payout. While profit is not the motive of the Facility, because it aims at being an independent entity, it must generate increasing reserves to grow its coverage. It must therefore charge a cost of internal capital, although it is lower than the cost of capital on the commercial reinsurance market. Formally, the commercial insurance premium is:

Technical Risk Loaded Catastrophe Insurance Premium = *AAL* + *PML*capital cost,*

where the capital cost is 5.5 percent for CCRIF internal capital (reserves) and 15 percent for external capital (that is, reinsurance).

The insurance coverage offered by the CCRIF has a 1-in-30 year attachment point and a 1-in-150 year exhaustion point.

The price of such a coverage offered by the CCRIF is estimated through a portfolio risk analysis coupled with a pricing model. It is compared with the hypothetical insurance price if it were offered individually by direct insurers. Such catastrophe insurance coverage is currently *not* available for the Caribbean countries. Hypothetical individual insurance premiums are derived through a basic pricing equation based on the estimated annual average loss, the 200-year probable maximum loss and the opportunity cost of capital (set at 12 percent).

The estimated CCRIF insurance premium is also compared with the cost of self-retention if the country had to retain this risk (because insurance markets were not available) through reserves. Should the country be risk neutral, the cost of self-retention would be estimated through the annual average loss over a long period. This assumption is consistent with the Arrow-Lind Public Investment Theorem (Arrow and Lind 1970),[13] which states that governments should be risk neutral toward natural disasters

12. "How High is Up? The 2006 Review of the Insurance Securitization Market," Morton N. Lane and Roger Beckwith, *Trade Notes*, April 21, 2006.
13. Arrow, K., and R. Lind, "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review*, 60(3)364–78, 1970.

Table A7.1. CCRIF Estimated Hurricane and Earthquake Coverage Levels and Premium

Country	Total annual premium (US$ million)	Hurricane coverage		Earthquake coverage	
		Lower	Higher	Lower	Higher
Anguilla	0.19	2.1	2.9	0.9	1.2
Antigua and Barbuda	0.30	3.7	5.0	1.1	1.5
The Bahamas	0.95	16.7	22.9	n/a	n/a
Barbados	0.73	6.8	9.3	4.5	6.2
Belize	0.48	7.6	10.5	0.8	1.2
Bermuda	0.49	8.3	11.4	n/a	n/a
Cayman Islands	1.49	18.4	25.4	7.2	9.9
Dominica	1.29	19.9	27.4	1.9	2.6
Grenada	1.29	23.0	31.6	2.4	3.3
Haiti	2.57	34.8	47.8	3.8	5.2
Jamaica	4.14	46.7	50.0	17.9	24.6
Montserrat	0.20	1.7	2.4	1.2	1.6
St. Kitts and Nevis	0.17	3.0	4.2	n/a	n/a
St. Lucia	1.29	21.2	29.1	2.9	4.0
St. Vincent and the Grenadines	0.20	2.9	4.0	0.5	0.7
Trinidad and Tobago	2.49	13.9	19.1	22.6	31.0
Turks and Caicos Islands	0.94	13.8	19.0	1.6	2.2
British Virgin Islands	1.10	10.6	14.5	6.4	8.8

Note: Estimated insurance coverage is subject to change based on countries' participation, donors' contribution, and reinsurance costs.

and thus they should not invest in any risk financing strategies that are more expensive than the expected losses caused by a natural disaster. This theory is in fact implemented by a number of large developed countries that rely on post-disaster financing (including budget reallocation and tax increases) to finance catastrophic losses. However, this theory fails in the case of small and highly indebted countries like the Caribbean countries, because they can spread the risk neither across space (geographic spread) nor across time (intertemporal spread). Therefore, the cost of self-retention is assumed to be equal to the annual average loss plus the opportunity cost of reserves. The opportunity cost of reserves is equal to the amount of reserves necessary to survive a 1-in-200-year event, multiplied by the marginal opportunity cost of capital (set at 12 percent).

As shown in Table A7.2, the CCRIF hurricane insurance is estimated to be, on average, approximately 52 percent less expensive than individual hurricane insurance, and approximately 68 percent less expensive than the cost of country's self-retention. CCRIF earthquake insurance is estimated to be, on average, 45 percent cheaper than individual earthquake insurance and 51 percent less expensive than self-retention. This is a direct consequence of risk diversification.

Table A7.2. Estimated Hurricane and Earthquake Insurance Premiums

	Hurricane coverage			*Earthquake coverage*		
		% reduction compared to			*% reduction compared to*	
Country	*ROL*	*Individual coverage*	*Self-retention*	*ROL*	*Individual coverage*	*Self-retention*
Anguilla	4.8	-50	-66	6.3	-46	-52
Antigua and Barbuda	4.6	-51	-67	6.2	-46	-53
The Bahamas	4.5	-51	-67	n/a	n/a	n/a
Barbados	4.4	-52	-68	6.3	-46	-52
Belize	4.3	-52	-68	6.6	-45	-51
Bermuda	4.7	-50	-66	n/a	n/a	n/a
Cayman Islands	4.0	-54	-70	6.3	-46	-52
Dominica	4.6	-51	-67	7.0	-44	-50
Grenada	3.8	-55	-71	7.0	-44	-50
Haiti	5.0	-49	-65	7.3	-43	-49
Jamaica	4.4	-52	-68	7.0	-43	-49
Montserrat	5.1	-48	-65	6.2	-46	-53
St. Kitts and Nevis	4.5	-52	-67	n/a	n/a	n/a
Saint Lucia	4.1	-54	-70	6.9	-44	-50
St. Vincent and the Grenadines	4.1	-54	-69	6.7	-45	-51
Trinidad and Tobago	3.7	-56	-71	6.5	-45	-51
Turks and Caicos Islands	4.7	-51	-66	6.3	-46	-52
British Virgin Islands	4.6	-51	-67	6.1	-47	-53
Simple average	4.4	-52	-68	6.6	-45	-51

Note: ROL = Rate-on-Line

A reinsurance broker will be hired to help the facility to place its reinsurance program on the market. The broker will provide inputs in the design of the reinsurance strategy based on the market environment. Initial discussions with the key reinsurance players show that non-proportional reinsurance may be the cost-effective strategy. Figure A7.1 below depicts the risk financing strategy using excess-of-loss reinsurance, where the hurricane insurance portfolio and the earthquake insurance portfolio are reinsured separately.

Table A7.3 and Figure A7.2 summarize the financial impact of the reinsurance program. Operating expenses represent 5% of the gross premium income. Reinsurance costs capture 48% of the gross premium. The Facility would face a net underwriting loss once every 30 years. This means that it will use its initial reserves to cover catastrophic events with a higher return period. For example, the Facility would finance a 1-in-200 year losses through reinsurance and initial reserves (US$5.6 million). Should

Figure A7.1. Hypothetical CCRIF Reinsurance Strategy

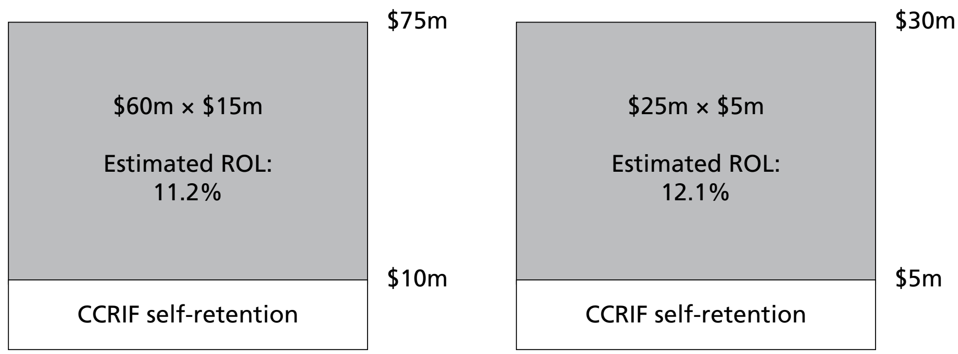
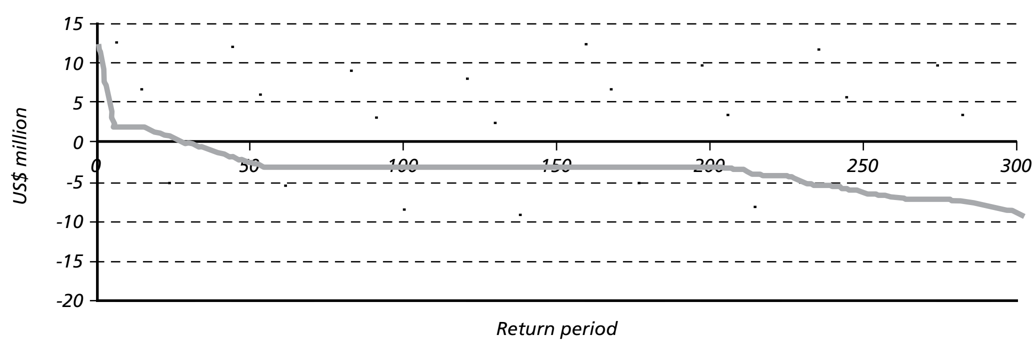


Table A7.3. Average Underwriting Results (US$ millions)

	Gross	*Reinsurance*	*Net*
Premium	20.3	9.7	10.6
Claims	-6.8	-3.6	-3.2
Expenses	-1.0	—	-1.0
Total	12.5	5.3	6.4

Figure A7.2. Net Underwriting Results — Loss Exceedance Curve



the Facility have less initial reserves resulting in self-retention lower by one third, this would result in an increase of the insurance premiums allocated to reinsurance costs from 40% to 55% (the insurance premiums remaining unchanged).

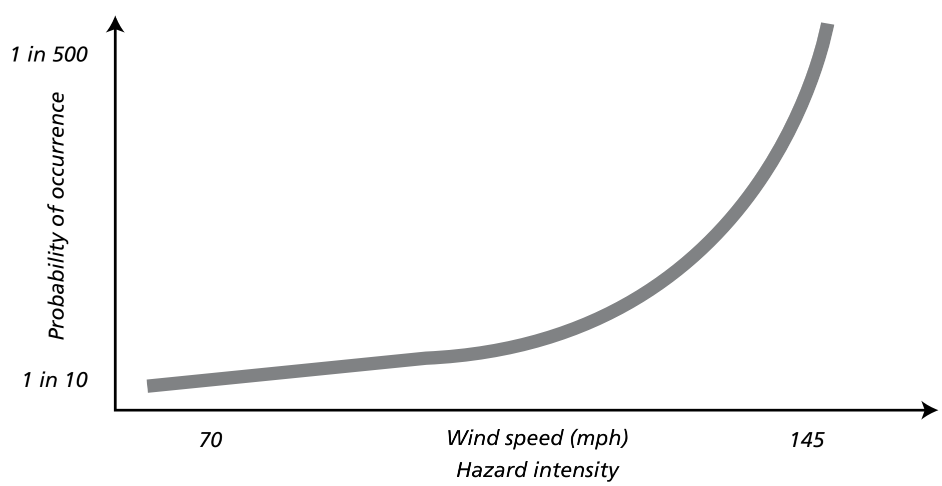
Annex 8. Parametric Insurance: Concepts and Applications

Creation of a Parametric Insurance Contract

1. Hazard Modeling

A thorough assessment of the underlying hazard forms the basis of all parametric insurance contracts under the Caribbean Catastrophe Risk Insurance Facility (CCRIF). This hazard assessment was conducted specifically for the CCRIF and is intended to accurately reflect the hazard history and expected impacts in the Caribbean. The char-

Figure A8.1. Wind Exceedence Curve



acter of the hazard (its frequency and intensity) in a specific territory is the primary factor in determining the cost of coverage within the CCRIF.

Using robust, stochastic models of tropical storm (hurricane) and earthquake hazards, the frequency (probability) with which the hazard occurs at different levels of intensity is determined. For the hurricane hazard, intensity is expressed in wind speed, and for earthquakes, in ground acceleration. As a result of this analysis, hazard exceedence curves are produced for each location of interest. Hazard exceedence curves (see Figure A8.1) depict the relationship between the intensity of the hazard and the probability of that hazard intensity being exceeded at a specific point.

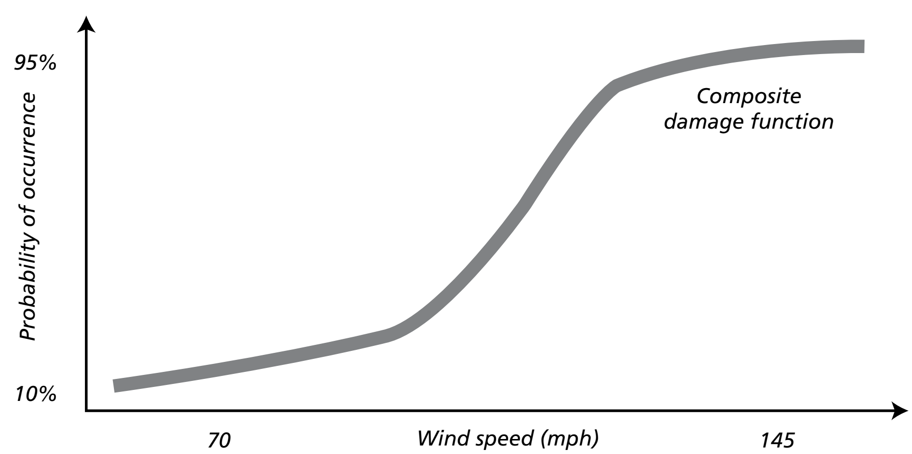
The CCRIF hazard model generates this type of hazard information for all hazard measurement points (see below) as a basis for loss estimation.

2. Loss Estimation

Damage and loss due to hazard impacts increase exponentially as the intensity of the hazard increases; that is the rate of damage increases more rapidly than does the increase in the intensity of the hazard. Damage functions relate the severity of the hazard to the damage expected. Damage functions are specific to various categories of infrastructure and to the building types in residential and commercial sectors. They are also specific to the actual types of infrastructure and buildings found in a territory, and for each hazard.

Using a set of damage functions appropriate to the territory, in combination with information on the quantity and location of development and infrastructure, a composite damage function (Figure A8.2) can be derived for use with the results of the hazard analysis.

Figure A8.2. Composite Damage Function

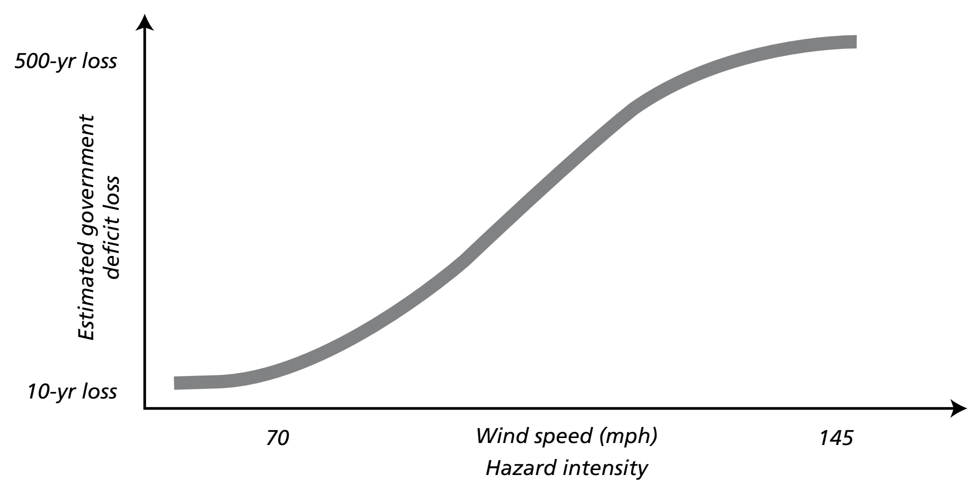


The damage functions incorporated into the CCRIF model are based primarily on data derived from insurance claims and by engineering-based damage modeling.

3. Impact on Government Accounts

The CCRIF is designed to address the immediate liquidity problems that governments face in the aftermath of a significant hazard event. To estimate the short-term impact of expected damage and loss on a government's treasury, shortfalls in tax and other revenues due to business interruption in the economic sectors, and extra expenditures for rehabilitation of government property and for emergency response and relief are estimated based on expected damage.

Figure A8.3. Estimated Loss to Government Accounts



The estimated loss to government accounts (Figure A8.3) is primarily determined by the composite damage function for that location Figure A8.2. However, a country's system of taxation, its primary revenue sources, and the hazard exposure in areas where government property and economic activity are concentrated all affect the character of hazard impacts on government revenues and expenditures—and therefore determine the magnitude of the expected loss and the specific shape of the expected loss function.

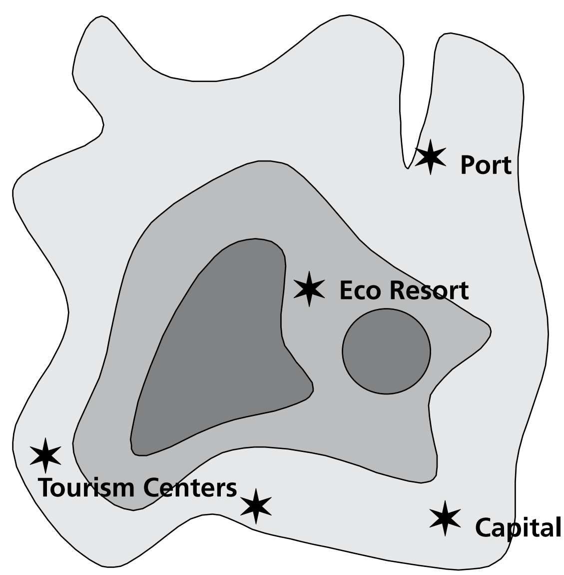
For the CCRIF, government deficit loss was estimated for all eligible member countries. For this assessment, specific information on the makeup of the economy, tax and revenue structures, and expected hazard relief expenditures were collected for each country. Based on this information, the government deficit loss curve was modeled.

4. Creation of Hazard Index

To ensure that the parametric hazard trigger reflects the actual impacts experienced across a member country, specific measurement points are defined across the country, representing the areas of primary economic and hazard vulnerability. The hazard values measured at each of these points during a hazard event are combined, with a predetermined weighting, which reflects the economic loss potential of economic activities surrounding each measurement point.

Subsequent to an actual hazard event, the intensity of the event at each measurement point will be determined (see below). Under the CCRIF, contract payouts for an event are based on the hazard impacts experienced at the measurement points in the member country, not on the maximum intensity of the hazard event outside of the member country.

Figure A8.4. Economic Centers for Sample Country



Measurement locations

Since a single hazard event can have varying impacts at different locations within a country, hazard intensities are measured at multiple significant locations in the country for determining the parametric trigger for the Facility. These measurement points are pre-selected to correspond to key economic activity areas in the country (see Figure A8.4).

Importance factors

To ensure that the hazard index appropriately captures the effects of a hazard event on the local economy, each measurement location is assigned a weight, which represents its importance based on its contribution to government revenues.

To derive the index, hazard intensities and frequencies are taken for each measurement point, using a hazard model. The results of the hazard modeling for the individual measurement points are combined using the individual importance factors.

Sample index function

The resulting index function includes variables for the wind speed and importance factor at each measurement location and other calculated factors to fit the economic loss curve.

Equation 1. Sample Hurricane Index Function

$$\alpha \times \sum_{\text{calcPoint}, i} [weight_i \times (\max(0, (WS_i - 50))^{\beta}]$$

Where,
$weight_i$ = weight at calculation point, i
WS_i = peak gust wind speed at calculation point, i, in mph

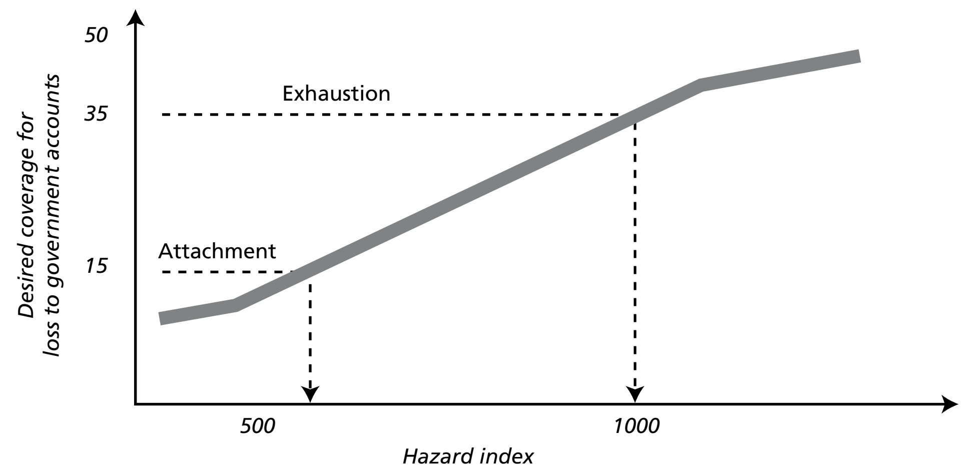
5. Selection of Contract Attachment and Exhaustion Points

All CCRIF contracts include attachment and exhaustion points. The attachment point is the hazard index value at which the contract is triggered, and functions like a deductible in a standard insurance policy. Payouts are made on the policy when the hazard index for an event in a member country equals or exceeds the attachment point specified in the contract. The policyholder covers all losses for events that generate a hazard index below the attachment point.

Unlike standard insurance policies, the attachment point applies equally to all storms. There is no accumulation of attachments (deductible) from storms for which the calculated hazard index was less than the attachment point.

As the hazard index increases above the attachment point, the corresponding payout increases up to the *exhaustion point* selected by the member country. The *policy limit* is the difference between the attachment and exhaustion points (exhaustion – attachment) and is the maximum amount to be paid out under the contract. Payouts for events that have in-country hazard indexes that exceed the exhaustion point will be paid at the policy limit.

Figure A8.5. Fitting the Index Curve



The policy limit applies to the full term (one year) of the contract; the total amount paid out under the contract during the one-year period will not exceed the policy limit, whether that limit is reached due to payout from one large event or multiple smaller events that each trigger payments under the contract.

Selection of the Attachment and Exhaustion Points

Since the CCRIF is designed to address the liquidity problems caused by impacts from catastrophic hazard events, it is expected that attachment points for country contracts will be selected such that payouts are triggered only by low-frequency, high-impact events (for example, 1-in-50-year events) rather than recurrent events.

When developing a parametric contract with the CCRIF, a member country will identify a level of financial impact on the government treasury, beyond which it would want to receive an immediate cash injection; this value is an appropriate starting point for identifying an attachment point for the contract. Once an attachment point has been selected, the exhaustion point can be set based on the cost of the contract and the maximum amount that the country is interested in paying for the CCRIF catastrophic coverage. The frequency with which the hazard index exceeds the attachment point (as identified by the member country-specific hazard curve) and the range between attachment and exhaustion point (that is, the policy limit) are primary determinants of the premium cost to a member country.

Based on an index curve derived for a specific member country, it is possible to identify the hazard index value that corresponds to a specific payout amount. In the example shown in Figure A8.5, a contract attachment point of US$15 million is selected;

based on this country's index curve, this corresponds to a hazard index value of 550. An exhaustion point of US$35 million corresponds to a hazard index of 980 on this same curve. The selection of these two points results in a policy limit of US$20 million (US$35 million – US$15 million).

In the initial years of the CCRIF, maximum policy limits may be implemented, in function of the reserves available to the Facility.

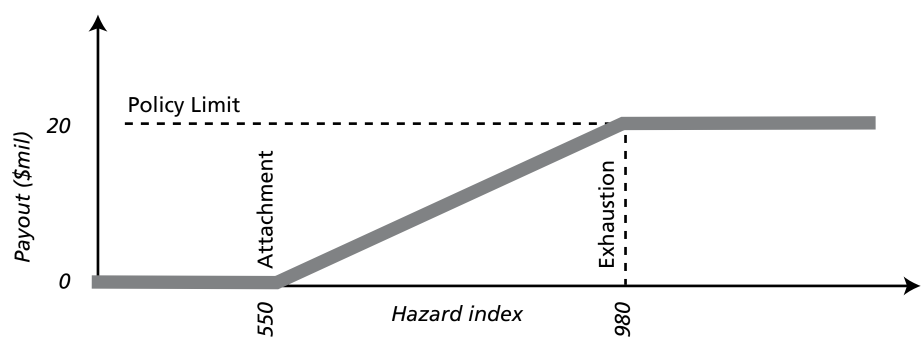
6. Final Parametric Payout Curve

The final payout curve for one hazard for a member country is defined by the following, all of which will be explicitly included in the parametric contract:

- Equation for calculating the hazard index (including country-specific measurement points and importance factors [weights]);
- Equation for the payout curve; and
- Attachment and exhaustion points.

Each CCRIF contract will include parametric payout curves for both hurricane and earthquake hazards (see Figure A8.6).

Figure A8.6. Final Contract Payout Curve



Contract Costing

The cost of the final CCRIF contract will be based on a pure premium charge derived directly from the final payout curve, plus an administrative load to cover Facility costs, such as reserve development, reinsurance costs, and administration.

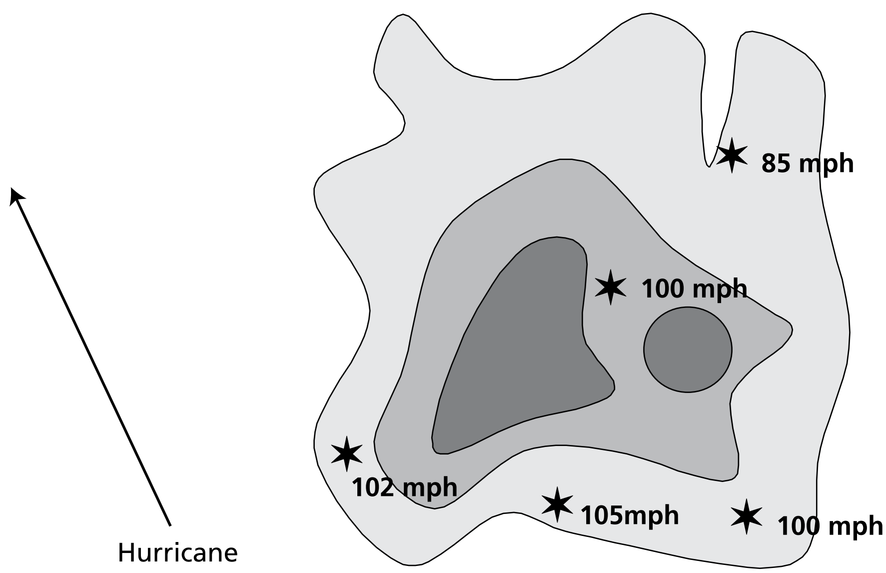
Determination of Contract Payout after a Hazard Event

1. Calculation of Hazard Index

To determine contract payout after a hazard event, a hazard index is calculated for the event for each affected CCRIF member country. Since equipment to measure wind speed does not exist at each calculation location, standard, predetermined models are used to calculate these intensities, using storm information from the official reporting agency. For the hurricane hazard, the official reporting agency used by the CCRIF is the U.S. National Hurricane Center.

Using the calculated hazard values for the measurement locations and importance factors that were defined in the development of the hazard index function, the index value is calculated according to the hazard index formula specified in each country's contract (see Figure A8.7).

Figure A8.7. Wind Speeds Calculated at All Measurement Points



2. Calculation of Payout Amount

Once the hazard index has been calculated for a particular hazard event that affected a member country, the index value is compared to the attachment and exhaustion points for the country. If the hazard index calculated for the event in one country is below the attachment point, no payment is made to that country for the event. If the hazard index for the event exceeds the attachment, the payout amount can be determined directly based on the attachment and exhaustion points and the policy limit, as shown in Equation 2:

Equation 2. Payout Calculation Formula

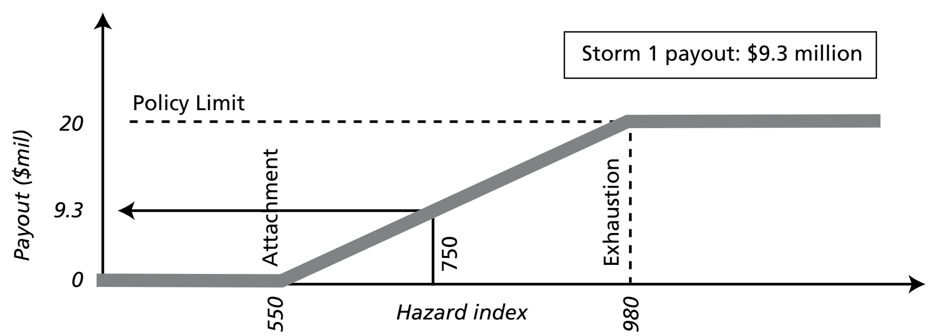
$$\text{Payout} = \frac{(\text{event index} - \text{attachment})}{(\text{exhaustion} - \text{attachment})} * \text{policy limit}$$

The resulting payout amount cannot be less than zero or greater than the policy limit.

The resulting payout amount cannot be less than zero or greater than the policy limit.

In the example shown in Figure A7.8, the hazard index for a specific event was 750. Since this index value is above the attachment value of 550, this event triggers a payment on the parametric contract. The payout for this country for this event would be approximately US$9.3 million.

Figure A8.8. Payout Calculation for First Hazard Event



Equation 3. Payout Calculation for Multiple Hazard Events

$$\text{Payout} = \frac{(750 - 550)}{(980 - 550)} * \$20 \text{ million}$$

$$= \frac{200}{430} * \$20 \text{ million}$$

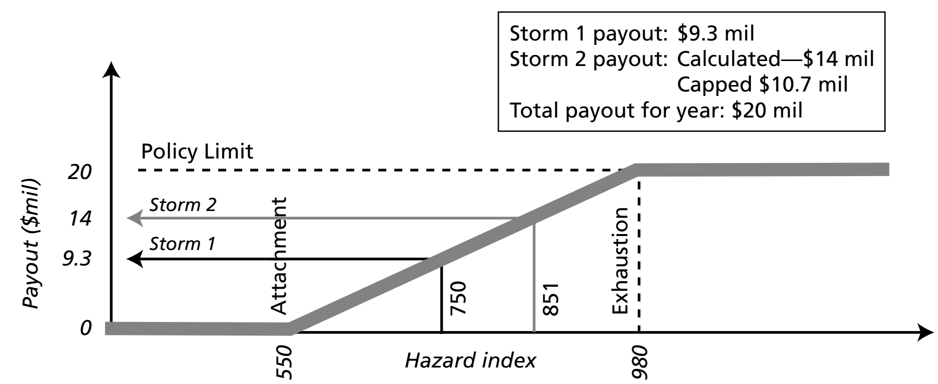
$$= \$9.3 \text{ million}$$

3. Treatment of Multiple Events

The policy limit is an annual loss limit — it is the maximum total payment from the Facility over the course of the contract year, whether from one or multiple events.

In the example shown in Figure A8.9, a payment of US$9.3 million is made for the first storm to trigger the contract. A second storm occurs, with a hazard index of 851, which corresponds to a payout of US$14 million. Since the combined total of the two payments (US$23.3 million) exceeds the policy limit, the second payment is capped at US$10.7 million, so that the total payment for the year is equal to the policy limit of US$20 million.

Figure A8.9. Payout Calculation for Multiple Hazard Events



Reporting Agencies

For hurricanes, the reporting agency of record will be the National Hurricane Center (NHC), which is the World Meteorological Organization (WMO) Regional Centre for Tropical Cyclone Forecasting and Reporting for the Atlantic basin, of which the Caribbean Basin is part. NHC publishes in real time 6-hourly positions, intensity (peak 1- minute sustained wind speed) and radius to maximum winds for the full storm track within 100 nautical miles of any member country of the Facility. These data will be used to compute the hurricane index and the indemnity payment through the payout formula defined in the hurricane insurance policy.

For earthquakes, the reporting agency of record is the U.S. Geological Survey, National Earthquake Information Center (USGS-NEIC). This center provides body wave magnitude, epicenter location, and depth of hypocenter through the recorded Preliminary Determination of Epicenters (PDE) file for the particular event at midday, Coordinated Universal Time on the 28th day after the event. The PDE data will be used to calculate the earthquake index, because final “official” data are not available for a global event for at least two months after the event.

Benefits of Index-based Insurance

- *No moral hazard*. Moral hazard arises when insured parties can alter their behavior to increase the potential likelihood or magnitude of a loss. Parametric insurance policies offered by the CCRIF are exempt from moral hazard because the indexes used in the calculation of the indemnity payouts (for example, wind speed, ground motion) are independent on the individual actions of the governments.
- *No adverse selection*. Adverse selection occurs when the potential insured has better information than the insurer about the potential likelihood or magnitude of a loss, thus using that information to self-select whether or not to purchase insurance. This informational asymmetry problem is eliminated under the CCRIF, as sophisticated country-specific catastrophic risk models are developed to assess the frequency and severity of hurricanes and earthquakes.
- *Lower operating costs*. Unlike traditional insurance, parametric insurance does not require costly monitoring processes (since there is no moral hazard or adverse selection) or loss adjustment processes. Parametric insurance products offered by the CCRIF depend exclusively on the realized value of the underlying index as measured by independent agencies (such as the U.S. National Hurricane Center or the U.S. Geological Survey, National Earthquake Information Center).
- *Transparency*. Parametric insurance contracts are based on independently reported indexes and transparent indemnity formulas. As such, they give little opportunity for litigation between the parties. With payout calculated based on a predefined formula included in the contract, and input data provided by an independent agency, the parties to a contract can calculate the potential impact of a disaster event immediately after it occurs and start processing a claim.
- *No cross-subsidization*. The detailed risk model developed under the CCRIF will permit the individual assessment of the risk exposure of each individual island in the Caribbean Basin. The insurance premium will thus be calculated individually based on the estimated risk faced by each island. This process will ensure that opportunities for cross-subsidization are kept to a minimum and remain negligible when compared to the benefits provided by the pooled portfolio.
- *Immediate disbursement*. Because no loss assessment is required, parametric contracts allow for quick settlement of claims shortly after an event. It is expected that claims under the CCRIF will be settled within four weeks following a disaster, as weather/earthquake information is available on a daily basis. This rapid claim settlement is essential if the affected states are to get access to liquidity to cover emergency and early recovery expenditures.
- *Reinsurance and securitization*. Parametric insurance is a new type of financial product where the underlying asset is a physical index (for example, wind speed, ground motion). Financial markets are interested in these types of products, which are uncorrelated with their asset portfolio and thus allow for further diversification. While they are sometimes reluctant to invest in insurance and reinsurance companies, because they do not fully understand the risks faced by these compa-

nies, parametric instruments are generally event specific, making them more transparent and thus more attractive to investors. This facilitates access to the capital markets through securitization (for example, index-linked securities, including catastrophe bonds).

Challenges of Parametric Insurance

- *Basis risk*. Basis risk emerges when the insurance payout does not exactly match the actual loss. By definition, the index used in a parametric contract is a proxy for the real loss, and thus one cannot exclude that the parametric insurance indemnity may slightly underestimate (or overestimate) the actual loss. Careful design of the terms and conditions of the parametric insurance policy is critical to minimize this basis risk. Recent catastrophe risk modeling techniques allow designing composite indexes that better mimic potential losses. At the same time, it is important to remember that the objective of the Facility is not to cover the entire losses faced by affected states, but to guarantee a minimum liquidity in case of a major adverse natural event.
- *Technical limitations of insurable hazards*. Because parametric instruments rely on a calculated index, their use is limited to hazards that can be modeled with a sufficiently high level of confidence. Hurricane and earthquake models have been developed and tested for more than a decade and are under constant improvement (particularly following hurricane Katrina in the United States in 2005). However, catastrophe risk assessment models for hazards like volcanic eruptions or tsunamis are still under development.
- *Market limitations of insurable hazards.* The existence of a catastrophe risk model developed by an independent agency is a necessary but not sufficient condition to make this risk insurable. Financial investors generally charge an uncertainty load in the premium to accept risks that are new in the market. This uncertainty load can make the premium so high, compared to the expected loss, that the risk becomes uninsurable. This is currently the case for tsunamis and volcanic eruptions.
- *Education.* Parametric insurance is a combination of insurance concepts and financial concepts. Education of policymakers and government agencies will be essential to ensure that the instrument is understood and used appropriately by local authorities.

Annex 9. Probability of Default Among Insurance Companies

Moody's "Idealized" Cumulative Expected Loss Rates (%)

	Year				
Rating	*1*	*2*	*3*	*4*	*5*
A1	0.003	0.020	0.064	0.104	0.144
A2	0.006	0.039	0.122	0.190	0.257
A3	0.021	0.083	0.196	0.297	0.402
Baa1	0.050	0.154	0.308	0.457	0.605
Baa2	0.094	0.259	0.457	0.660	0.869
Baa3	0.231	0.478	0.941	1.309	1.678
Ba1	0.479	1.111	1.722	2.310	2.904
Ba2	0.858	1.909	2.849	3.740	4.626
Ba3	1.546	3.031	4.329	5.385	6.523
B1	2.574	4.609	6.369	7.618	8.866
B2	3.938	6.419	8.553	9.972	11.391
B3	6.391	9.136	11.567	13.222	14.878

Source: Goldman Sachs "Insider" September 2006 presentation.

S&P Cumulative Default Probabilities for Catastrophe Securitizations (%)

	Year				
Rating	*1*	*2*	*3*	*4*	*5*
A+	0.140	0.311	0.512	0.743	1.002
A	0.740	0.324	0.553	0.823	1.130
A-	0.150	0.368	0.647	0.978	1.353
BBB+	0.230	0.541	0.924	1.368	1.861
BBB	0.230	0.648	1.198	1.834	2.523
BBB-	0.540	1.353	2.314	3.343	4.389
BB+	1.670	3.322	4.924	6.448	7.876
BB	2.770	5.262	7.496	9.488	11.255
BB-	2.790	5.664	8.377	10.822	12.970
B+	3.670	7.541	11.086	14.131	16.665
B	8.590	14.508	18.586	21.437	23.479
B-	9.560	16.622	21.560	24.957	27.312

Source: Goldman Sachs "Insider" September 2006 presentation.

Fitch's Castastrophe-linked Bond Rating Curve (Expected Loss) (%)

	Year				
Rating	*1*	*2*	*3*	*4*	*5*
A+	0.071	0.142	0.213	0.284	0.655
A	0.077	0.154	0.213	0.308	0.685
A-	0.121	0.242	0.363	0.484	0.605
BBB+	0.164	0.328	0.492	0.656	0.820
BBB	0.207	0.414	0.621	0.828	1.035
BBB-	0.536	1.076	1.614	2.152	2.690
BB+	0.869	1.738	2.607	3.476	4.345
BB	1.200	2.400	3.600	4.800	6.000
BB-	1.760	3.520	5.280	7.040	8.800
B+	2.320	4.640	6.960	9.280	11.600
B	2.880	5.760	8.640	11.520	14.400
B-	3.775	7.550	11.325	15.100	18.875

Source: Goldman Sachs "Insider" September 2006 presentation.