

Terms of Reference

Peer Review of the Actuarial Soundness of CCRIF SPC's Loss Assessment Models for Central America and the Caribbean (i) Earthquake and Tropical Cyclone Loss Assessment Model (SPHERA) (ii) Excess Rainfall Loss Assessment Model (XSR 2.0) and (iii) Drought Loss Assessment Model (Drought 1.0)

1. Background

In 2007, the Caribbean Catastrophe Risk Insurance Facility (CCRIF SPC) was formed as the first multi-country risk pool in the world and was the first insurance instrument to successfully develop parametric policies backed by both traditional and capital markets. It was initially designed as a regional catastrophe fund for Caribbean governments to limit the financial impact of devastating hurricanes and earthquakes by quickly providing financial liquidity when a policy is triggered. CCRIF was developed under the technical leadership of the World Bank and with a grant from the Government of Japan. It was capitalized through contributions to a multi-donor Trust Fund by the Government of Canada, the European Union, the World Bank, the governments of the United Kingdom and France, the Caribbean Development Bank and the governments of Ireland and Bermuda, as well as through membership fees paid by participating governments.

In 2014, the facility was restructured into a segregated portfolio company (SPC) to facilitate expansion into new products and geographic areas and is now named CCRIF SPC. The new structure, in which products are offered through a number of segregated portfolios, allows for total segregation of risk. In April 2015, CCRIF SPC signed an MOU with COSEFIN - the Council of Ministers of Finance of Central America, Panama and the Dominican Republic - to enable Central American countries to formally join the facility. The expansion to Central America and the Caribbean is supported through the World Bank administer. The Central America and Caribbean Catastrophe Risk Insurance Program (Program) Multi-Donor Trust Fund (MDTF) established for that purpose. The MDTF channels resources from various donors, including: Canada, through the Department of Foreign Affairs, Trade and Development, the United States, through the Department of the Treasury; the European Union, through the European Commission, and Germany through the Federal Ministry for Economic Cooperation and Development.

Funding under the Program has been allocated to: (i) expand the services and membership of CCRIF SPC through a recipient-executed Project implemented by CCRIF SPC. The Central America and Caribbean Catastrophe Risk Insurance Project (P149670) was approved by the Regional Vice President for Latin America and the Caribbean on June 30, 2015. The Project is implemented by CCRIF SPC (CCRIF Segregated Portfolio Company, formerly the Caribbean Catastrophe Risk Insurance Facility). The Project development objective is to improve affordability of high quality sovereign catastrophe risk transfer associated with earthquakes and climate-related events for CCRIF participating countries. The expansion of membership into Central America has the potential to diversify the risk portfolio, improve access to reinsurance markets hence reduce the cost of risk transfer, allowing these benefits to be passed on to its members. The peer review of the actuarial soundness of CCRIF SPC's loss assessment models for Central America and the Caribbean will be financed with grant funding from the Central America and Caribbean Catastrophe Risk Insurance Project (P149670).

CCRIF SPC is registered in the Cayman Islands with a board of directors which is responsible for governance and the strategic direction of the company and a chief executive officer with responsibility for managing the company on a day to day basis. It operates as a virtual organization, supported by a network of service providers covering

the areas of risk management, risk modelling, captive management, reinsurance, reinsurance brokerage, asset management, technical assistance, and corporate communications and information technology. CCRIF SPC offers earthquake, tropical cyclone and excess rainfall policies to Caribbean and Central American governments. CCRIF SPC helps to mitigate the short-term cash flow problems small developing economies suffer after major natural disasters. CCRIF SPC's parametric insurance mechanism allows it to provide rapid payouts to help members finance their initial disaster response and maintain basic government functions after a catastrophic event.

Sixteen Caribbean governments are currently members of the facility: Anguilla, Antigua & Barbuda, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Dominica, Grenada, Haiti, Jamaica, St. Kitts & Nevis, Saint Lucia, St. Vincent & the Grenadines, Trinidad & Tobago and Turks & Caicos Islands. Nicaragua is the first Central American government to become a CCRIF SPC member.

CCRIF SPC's sustainability relies on certain key factors:

- Continuing operations with the capacity to fund payouts, within the agreed timeframe, while maintaining adequate capital and reserves
- Ability to attract members by offering relevant products with competitive pricing while at all times reinforcing the objectives and limitations of parametric insurance coverage
- Supporting the membership with technical assistance and ensuring a close working relationship with members that value the need for parametric insurance coverage in light of more frequent and severe natural disasters.

On an ongoing basis, membership tend to measure affordability and quality of CCRIF SPC's products based on the perception of whether the insurance payout generally matched the actual loss to the extent of the policy parameters selected, with an anticipated level of over or underestimation. This requires careful design of the policy terms and conditions as well as precise and robust models.

CCRIF SPC owns and utilizes the following models:

- **SPHERA:** This multi-module system, developed for CCRIF SPC by the ERN-RED consortium, is used by CCRIF SPC to estimate loss probabilities caused by Tropical Storms (TCs) and Earthquakes (EQs) to individual countries in the Caribbean and Central America. This model is used for, pricing contracts and for estimating hazard levels and losses for specific events during the contract period. This model is used to assess the tropical cyclone (wind and storm surge only) and earthquake (ground motion) hazards. For the estimation of losses for specific events, data from the US National Hurricane Center and the US Geological Service are used. The model is comprised of the following modules: i) hazard module: defines the frequency and severity of an event for a specific location; ii) exposure module: estimates the exposure values of the assets at risk and its location; iii) vulnerability module: quantifies the damage caused to each asset class by the intensity of a given event at a site; iv) loss module: transforms the damage computed in the vulnerability module to monetary losses given the asset value.
- **Excess Rainfall (XSR) 2.0:** Multi-module system, developed for CCRIF SPC by ERN-RED, to estimate loss probabilities caused by Excess Rainfall (XSR) Events of any origin to individual countries in the Caribbean and Central America. This model is used for pricing contracts and for estimating hazard levels and losses for specific events during the contract period. For estimation of losses of specific events it uses data from the Global Forecasting System produced by the US National Centers for Environmental Protection and data from the Climate Prediction center of NOAA. The XSR 2.0 model includes an exposure module, a

rainfall estimation module, a loss estimation module, and an insurance module that calculates policy payouts for specific events by processing the information provided by the loss module.

- **Drought 1.0:** Developed for CCRIF by ERN-RED, this model uses data from the Climate Prediction center of NOAA and satellite imagery to assess the agricultural losses in the member islands related to drought. For purposes of conducting said assessment, the model is comprised of the same modules of the XSR 2.0 model.
- **Dynamic Financial Analysis (DFA):** Is a MS Excel® spreadsheet-based stochastic simulation model which generates key metrics for the CCRIF over a ten-year time horizon. The model generates premiums by country and peril, can test alternate reinsurance structures, and projects underwriting income and balance sheet position. Additionally, the model calculates key performance measures such as the probability of survival and the loss due to insolvency. The main input of the DFA consists of the Loss Exceedance Curves (LEC), which contain 10,000 points providing losses at each .01% increment and are a representation of the full loss distribution modeled for each Segregated Portfolio. The DFA model simulates the potential losses in a given year by randomly drawing a loss from the LEC and adjusting this loss +/-10%. With the simulated losses, the DFA then computes a projected underwriting result and equity for a 10-year period. The complete process consists of 100,000 simulations. With the result of the simulations, several metrics are produced for each point in the 10-year period: average capital by SP, probability of default, extra capital needed to ensure solvency, amongst others. The MS Excel Add-In @Risk from Palisade Corporation is used to perform the stochastic simulations, therefore it is highly desirable that the Peer Reviewer has access to that Add-In, so he/she can execute the stochastic simulations.

CCRIF SPC is searching for a Consultant qualified on the subject to perform the actuarial review of the adequacy and robustness of the loss assessment models (“Peer Reviewer”).

2. Objectives

As a risk management strategy, an independent actuarial peer review of the model is being commissioned to obtain independent and comprehensive understanding of the models used to inform the CCRIF Board regarding the adequacy of the reinsurance structures, of the pricing of the direct insurance policies, and the overall solvency and capital adequacy.

The reviewer will answer the following questions:

- (i) Does the methodology used to obtain the aggregated curves by peril and SP correctly reflect the insurance risk assumed, including the tail risk, for each SP?
- (ii) Are the prices used in the DFA, per country and per peril, fully consistent with the real prices being quoted, offered and contracted?
- (iii) Do the reinsurance structures, as modelled by the DFA, provide a sound decision making framework regarding the execution of risk transfer strategies consistent with the financial security policy?
- (iv) Is the DFA model a reasonable tool to inform and monitor the capital and solvency position of each SP and the CCRIF SPC as a whole?
- (v) Do the solvency parameters stated in the DFA reports convey all the relevant information for decision makers?

3. Scope of the Assignment

The peer review is a technical review of the document explaining the probabilistic methodology for performing DFA that is based, among other inputs, on the country-specific risk profiles computed by the catastrophe risk models (SPHERA, XSR 2.0 and Drought 1.0). The soundness of the country-specific risk profiles and of the methodology that was used to produce them has been assessed elsewhere and does not concern this review. The scope of works involves:

- (i) The technical soundness of the methodology that uses the country-specific risk profiles from the catastrophe risk models (SPHERA, Drought 1.0 and XSR 2.0) to estimate the multi-country risk profile and, therefore, the risk for the SPC.;
- (ii) the structure of CCRIF SPC's earthquake, tropical cyclone, drought and excess rainfall policies, specifically whether the policies adequately reflect the model;
- (iii) the soundness of the DFA that CCRIF SPC uses to help determine the pricing of the policies; and finally
- (iv) whether such pricing is actuarially consistent with CCRIF SPC's solvency and long-term survivability.

4. Services

The expected services from a successful Peer Reviewer are the following:

- (i) **Read the Documentation and evaluate the related deliverables.** CCRIF SPC will provide the Peer Reviewer information necessary for the peer review. The documentation may consist of, but is not limited to, the following items:
 - a. A description of the assumptions, justifications and methodology followed for the loss computation for the earthquake, tropical cyclone, drought and excess rainfall perils.
 - b. All DFA reports, board reports, MS Excel spreadsheet, and the user documentation.Before receiving any such material, the Peer Reviewer will be required to sign a Non-Disclosure Agreement with ERN RED (Model Developer) and CCRIF SPC.
- (ii) **Interaction with the Model Developer.** The Peer Reviewer is expected to interact with the Model Developer via electronic mail, webex and other means for clarifications. If the interactions occur via electronic mail, the Peer Reviewer will carbon copy a designated contact person at CCRIF SPC. If the interactions occur via phone, the designated CCRIF SPC contact person will be notified so that he/she can participate in the call, if needed. CCRIF SPC will provide the Peer Reviewer with the point of contact of the Model Developer to address any such request.
- (iii) **Interaction with CCRIF SPC.** The Peer Reviewer is expected to interact with the designated person at CCRIF SPC regarding the Peer Review. Although the Peer Reviewer will not have direct access neither to the Developer's catastrophe model nor to the DFA model, he/she may ask the CCRIF SPC designated person to carry out specific analyses with the Developer's model and to report back the model output, if appropriate. The CCRIF SPC designated person may also provide the Peer Reviewer with comments about the peer review findings.
- (iv) **Reporting.** The Peer Reviewer is expected to deliver the following reports:
 - a. Interim Reports after the review of the material specified in section 3

- b. A Final Report for internal use of CCRIF SPC, if possible, where all the findings are reported at the level of detail necessary for the implementation of ameliorating actions in the successive releases of the catastrophe risk model by the developer. This report will not be shared by CCRIF SPC with any third party with the exception of the Developer.

5. Requirements

- A qualified Actuary with a degree or certification in Actuarial Sciences or an equivalent and suitable qualification;
- Experience in developing and Peer Reviewing catastrophe risk estimation models;
- At least 10 years of proven experience as a reviewer of catastrophe risk estimation models;
- Excellent analytical skills, and ability to prepare professional narrative reports summarizing observations and conclusions;
- Good oral and written communication abilities in English are required and
- Experience and knowledge of the Central America and the Caribbean context.

6. Time Schedule and proposed Fees

The assignment is expected to commence in December 2017 upon execution of the contract and the expected level of effort (LOE) is no more than 10 days over a two-month period, for *each* segregated portfolio as follows:

- **Caribbean EQ-TC SP:** Providing Earthquake and Tropical Cyclone Policies for Caribbean Governments
- **Caribbean XSR SP:** Providing Excess Rainfall Policies for Caribbean Governments.
- **Central America SP:** Providing Earthquake, Tropical Cyclone, Excess Rainfall and Drought Policies for Central American Governments.

The specific dates for deliverables will be agreed by contract. Delays are justified if caused by the proven tardiness in receiving the requested information or the results of the model runs by either the Model Developer or CCRIF SPC.