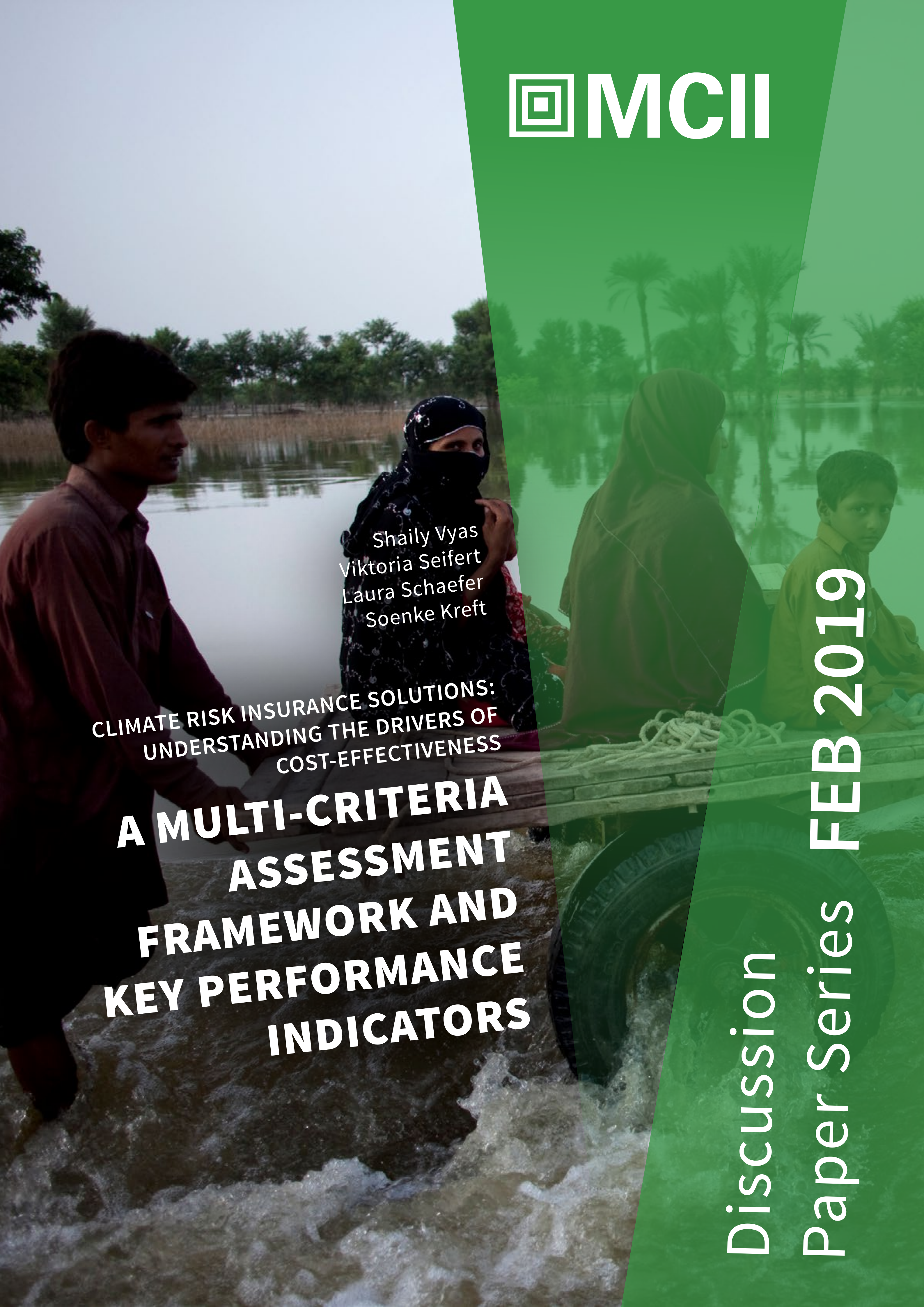

MCII

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CLIMATE RISK INSURANCE SOLUTIONS: UNDERSTANDING THE DRIVERS OF COST-EFFECTIVENESS

A MULTI-CRITERIA ASSESSMENT FRAMEWORK AND KEY PERFORMANCE INDICATORS

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Contents

Abbreviations list

ADC	Aggregated Deductible Cover
ARC	African Risk Capacity
CARICOM	Caribbean Community
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CCRIF	CCRIF-SPC (formerly the Caribbean Catastrophe Risk Insurance Facility)
CDRF	Climate and Disaster Risk Finance
COSEFIN	Council of Ministers of Finance of Central America, Panama and the Dominican Republic
DRFI	Pacific Disaster Risk Financing and Insurance
HARITA	Horn of Africa Risk Transfer for Adaptation
IFA	Insurance for Assets
KPI	Key Performance Indicators
MCCEA	Multi Criteria Cost Effectiveness Analysis
MCII	Munich Climate Insurance Initiative
PCRAFI	Pacific Catastrophe Risk Assessment and Financing Initiative
PCRIF	Pacific Catastrophe Risk Insurance Foundation
PICs	Pacific Islands Countries

Executive Summary

Building on a Multi Criteria Cost Effectiveness Analysis (MCCEA), this paper aims to develop an assessment framework that facilitates the comprehensive understanding of cost-effective climate risk insurance (CRI) approaches for vulnerable populations. MCCEA helps compare and select risk financing instruments based on their costs and overall effectiveness: Instead of taking a one-dimensional approach that only compares costs per unit of effectiveness, MCCEA conceptualizes cost-effectiveness more holistically. It integrates the assessment of efficiency and effectiveness into one framework, including criteria for parameters that cannot be reflected in traditional cost-benefit analysis (CBA) and/or cost-effectiveness analysis (CEA), such as the speed of disbursement and risk assessments. In this context, this paper defines cost-effectiveness as the product of the three overarching determinants of:

- ***Effectiveness***: The degree to which the need of the final consumer is met in an adequate, reliable and consistent way
- ***Cost-efficiency***: The costs incurred in producing and attaining the benefits of insurance
- ***Speed of disbursement:*** The time taken for processing claims and payout turnaround time

Based on these three key determinants, this paper identifies their respective drivers as well as their corresponding key performance indicators (KPIs) that discern and measure their strength and impact. Ultimately, this exercise results in a comprehensive assessment framework based on which information on the cost-effectiveness of CRI for the vulnerable can be inferred. The framework will then be applied illustratively to analyze four different insurance schemes: The African Risk Capacity (ARC), CCRIF SPC (formerly the Caribbean Catastrophe Risk Insurance Facility), the Pacific Risk Assessment and Financing Initiative (PCRAFI), and the R4 Rural Resilience Initiative (R4).

Pillar	Driver	Key Performance Indicator (KPI)
1. **Effectiveness**	Benefit of Insurance	1.1 Cumulative claim payout(macro) or Payout per capita(micro) 1.2 Adequacy ratio - Ratio of claim payout to immediate liquidity needed 1.3 Loss ratio - Claims received/ Premium paid *100
	Basis Risk – correlation of modeled and actual loss	1.4 Probability of catastrophic basis risk 1.5 Catastrophic performance ratio
	Persistency	1.6 Renewal rate percentage
2. **Cost-Efficiency**	Cost of Insurance	2.1 Aggregate policy premium (macro) Premium per capita (micro)

	Premium Multiple	2.2 Ratio of premium paid to claims received
	Premium Rate	2.3 Average of ∑ Aggregate premium t(i)/ average coverage limit t(i)
	Policyholder Expense Ratio	2.4 Expenses incurred/ aggregate coverage limit * 100) / n
	Insurance Penetration	2.5 Percentage of participating policyholders to potential policyholders or Percentage of participating countries to eligible countries
3. **Speed of Disbursement**	Claim Processing Time	3.1 Time taken for insurance provider to make payment
	Payout Turnaround Time	3.2 Total time taken for payout to reach final beneficiary.

In doing so, this paper strives to meet the following needs:

(1) Create a common understanding of the components of CRI cost-effectiveness and an assessment framework to help focus future discussions;

(2) Allow for decision- and policymakers to assess the cost-effectiveness performance across *comparable* CRI schemes, while having to accommodate sometimes conflicting decision-making criteria;

(3) Illustrate the application of the developed framework for four prominent CRI schemes;

(4) Based on (3), provide illustrative recommendations on the schemes' performance and the thereof derived needs for further action, innovation, and research.

The developed framework, however, does not necessarily lend itself to comparing different insurance schemes. The differences between insurance schemes arise due to a variety of factors, such as different objectives (e.g. immediate financial liquidity for governments vs. payouts to governments intended for further transfer to beneficiaries on the ground), different eligibility requirements, the therewith associated provision of different intangible and hence often incomparable wellbeing benefits, and coverage of different perils as well as different risk layers within the severity-frequency continuum associated with such perils. The framework is also limited regarding its usability for the direct comparison with other Climate and Disaster Risk Financing (CDRF) instruments. The assessment of other CDRF instruments, such as contingent credit lines, will build on different KPIs for performance measurement, e.g. KPIs focusing on loan installments, payback periods and corresponding opportunity costs, eligibility requirements, usage of loan, etc. Singular KPIs from this framework can, however, be selected for drawing parallels to the performance of other CDRF instruments to understand the differences of advantages offered.

Based on the illustrative application of the MCCEA framework, this paper finds that the cost-effectiveness performance of the analyzed CRI schemes is largely within reasonable bounds. Even though the schemes may not have proven to be constantly cost effective – especially during their initial years when they were still building financial and operational capacity – the schemes seem to become increasingly stable when maturing over time. While this shows the principal viability of CRI as a risk financing solution, additional efforts need to be brought underway to make insurance protection more accessible and more valuable to vulnerable people and countries.

Going forward, public institutions, businesses and civil society organizations should therefore work to further improve the cost-effectiveness of CRI by:

- **Addressing remaining stumbling blocks** to increase the cost-effectiveness of CRI through integrative disaster risk management and insurance solutions, holistic coverage for micro schemes, income-friendly product pricing, regulatory frameworks and technology advancements.
- **Strengthening product innovation** through innovative risk models (including residual risk layering and risk pooling), inter-regional risk pooling (including the harmonization of financial services regulations across borders) and peer-to-peer insurance
- **Promoting research** that drives discussions forward to enhance cost-effectiveness, including the evaluation and integration of intangible, non-monetary benefits, the measurement of basis risk, the development of tracking tools for payout utilization, additional financial performance integrators, as well as integration and expansion of existing assessment frameworks to allow for the comparison across different combinations of CDRF instruments and insurance.

1. Climate risk insurance: The need for a cost-effectiveness assessment framework

Moving into the 21st century, the risk of climate induced loss and damage keeps rising across the globe, thereby subjecting developing countries to grave danger. Thus, it is imperative to increase the resilience of the affected individuals and states by strengthening their anticipatory, absorptive and adaptive capacities in the face of climate impacts. This needs to be achieved through comprehensive risk management, including using risk management tools like risk transfer. The cost-effective use of such specific climate and disaster risk financing (CDRF) instruments will, in turn, also depend on the frequency and severity inherent to the risk from which protection is needed. Tropical storms, for example, as well as other climate impacts that occur with low to medium frequency (e.g. 1 in 30, 50 or 100 years) and lead to medium or high damages, might be better managed by only retaining some of the risk while transferring other risk portions onto third parties. Climate risk insurance solutions for the micro, meso and macro level represent important approaches to do so. In this context, direct insurance schemes like the R4 Rural Resilience Initiative (R4) as well as regional risk pools such as CCRIF SPC (formerly the Caribbean Catastrophe Risk Insurance Facility) or African Risk Capacity (ARC) are met with heightened interest by the affected states, donor countries and civil society organizations with increasing attention around the issue of cost-effectiveness.

To a large extent, this growing interest has been set off by the launch of the G7 InsuResilience Initiative in 2015, as well as the announcement of the G20/V20 led InsuResilience Global Partnership in 2017;[1] both of which are promoting the design and implementation of climate risk transfer solutions to build resilience. In light of the associated commitments of technical and financial assistance, as well as developing countries' own resources, several stakeholders have critiqued these proceedings as going forward without proof of impact, thereby highlighting the need for accessible approaches to evaluate the cost-effectiveness of risk transfer solutions.

Against this background, this paper aims to develop an assessment framework that facilitates a comprehensive understanding of the cost-effectiveness of CRI approaches from an insurance perspective. In doing so, it is intended to structure ongoing debates around the feasibility of different CDRF instruments with particular focus on the performance of CRI approaches. The framework is not meant as a tool for comparing cost-effectiveness across different CDRF tools; nevertheless this paper aims to meet the following needs:

(1) Create a common understanding of the components of CRI cost-effectiveness and an assessment framework to help focus future discussions;
(2) Allow for decision- and policy-makers to assess the cost-effectiveness performance across *comparable* CRI schemes;
(3) Illustrate the application of the developed framework for four schemes supported by the InsuResilience Initiative;
(4) Based on (3), provide illustrative recommendations on the schemes' performance and the derived needs for further action, innovation, and research thereof.

Box 1: What is insurance?

Insurance serves as a vehicle to transfer risk from individually affected entities in order to diversify it by pooling the associated losses across multiple policyholders. The transferred risk can be retained within the group or ceded to a third party which may be an insurance company, reinsurer or risk pool. Insurance operates on and stems from the probability theory in statistics called the Law of Large Numbers,[2] meaning that the observed average loss per policy gets closer to the statistically expected loss per policy as the size of the insured population increases. This is valid when a large number of small independent risks is involved, such as is the case for automobiles or mortality.

The risk of climate change is not easily diversifiable[3] because usually, large numbers of policyholders are affected in the same areas at the same time; thus, the individual risks are no longer independent. Insurers also have to maintain risk capacity provisions beyond average annual expected losses to ensure they will be able to disburse large indemnity payouts after a catastrophic event. Climate risk insurance achieves economies of scale only with time, and if it diversifies across geographies/region and perils. In order to add financial capacity as well as further diversify risk across geographies, insurers often purchase reinsurance. Small policyholders can also pool resources and self-insure themselves, but this is not effective for very high severity risk.

Traditional Indemnity Insurance

As for indemnity based insurance, claims are paid on the basis of an assessment of the actual losses incurred. Compared to parametric insurance, products are advantageous in so far that there is no basis risk. Yet, the need for individual loss assessments not only results in higher premiums, but also in higher time taken to payout a claim, thus making such products unsuitable for subsistence or small marginal farmers and herders.

Parametric insurance (Explained using the example of crop insurance)

Index-based insurance products make payouts based on a predetermined trigger. Index insurance offers several advantages over traditional indemnity insurance, such as quicker payouts, lower administrative costs, as well as reduced moral hazard and adverse selection, but comes with the challenge of basis risk. Currently there are two types of Index insurance:

- *Area yield index insurance*: Here, the payout is made whenever the crop yields for an area in aggregate are less than a pre-specified threshold, regardless of the actual yield on the policyholder's farm.
- *Climate-related index insurance*: Here, the payout is based on the realization of specific weather parameters measured over a pre-specified period of time, at a particular weather station or as captured by satellite. A payout is made whenever the realized value of the index exceeds a pre-specified threshold (for example, when protecting against excessive rainfall), or when the index is less than the threshold (for example, when protecting against insufficient rainfall).

Alternative Risk Transfer Instruments (as currently under consideration in the context of climate risks)

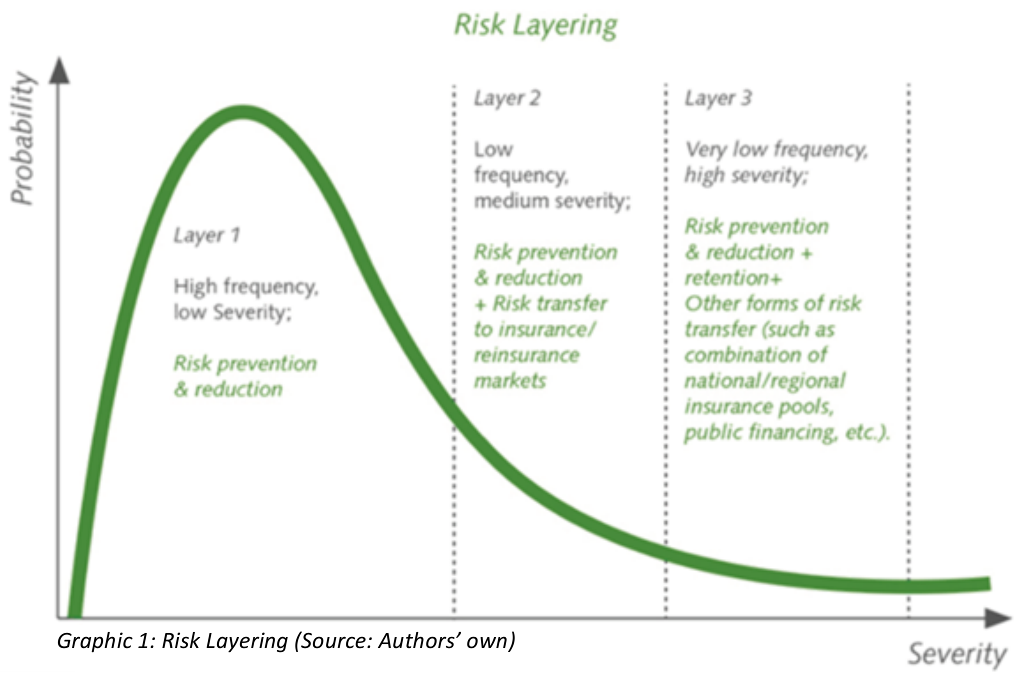
These are mostly event linked bonds which trigger payments on the occurrence of a specified event such as a hurricane, earthquake etc. (e.g. catastrophe (CAT) bonds and other securitized instruments).

Reinsurance

Insurance companies further insure or cede their portfolio to reinsurance companies for financial capacity or risk diversification; this reduces insolvency risk.

The paper was prepared using a desk study approach, encompassing research conducted by MCII and the review of scientific literature, as well as annual and financial reports of insurance schemes. The paper proceeds as follows: Chapter two will set the stage by introducing the approach used to elaborate the framework. Subsequently, a comprehensive cost-effectiveness framework for CRI schemes will be developed. Specifically, this chapter will (1) determine three key determinants substantiating the cost-effectiveness of CRI, (2) dissect these three determinants into their respective drivers and (3) identify a set of key performance indicators (KPIs) to discern and measure the strength and impact of these drivers. Building on this, chapter three will then apply the framework and analyze four different insurance schemes: African Risk Capacity (ARC), CCRIF SPC (formerly the Caribbean Catastrophe Risk Insurance Facility), Pacific Risk Assessment and Financing Initiative (PCRAFI), and the R4 Rural Resilience Initiative (R4). In this context, it is important to mention that the assessment of these schemes is only to illustrate the use of the developed framework and not meant to compare the schemes with each other. Based on these illustrative assessments, chapter four concludes by outlining recommendations regarding the respective schemes' performance and remaining stumbling blocks, as well as specifying innovation and research needs to be met by public institutions, businesses and civil society organizations.

Box 2: A risk layering approach



Graphic 1: Risk Layering (Source: Authors' own)

Risk layering is a key component of comprehensive risk management, since it provides an integrated approach to understanding climate-related disaster risk and developing the corresponding response measures. Climate-induced disaster risks, for example those associated with floods or cyclones, can be segregated into different risk layers due to the differences in frequency and severity by which they materialize – a 1-in-50 years flood event resulting in two meters of flooding, differs from a 1-in-100 years flood event resulting in ten meters of flooding. They, in turn lead to different damages and thus require different risk reduction, adaptation and – potentially – risk financing measures. Segregating climate-induced disaster risks into such different layers to select the appropriately corresponding response measures is called a 'risk layering' approach.

Accordingly, financial instruments, in combination with adaptation and risk reduction measures should be selected based on the frequency and severity of disasters. Flood events that occur often and usually produce low to medium damage, could constitute one such risk layer. As such an event appears almost with yearly certainty, insurance, for instance, would not constitute an appropriately cost-effective response. Instead, reducing the severity of impacts through disaster risk reduction and adaptation measures, while setting aside contingency funds for the risk of impacts that remain even after such risk mitigation measures, may be more sensible. For other flood events occurring less often but producing higher damages, however, it might be advisable to retain only some of the risk that remains after implementing risk reduction measures, while transferring other portions to private and public markets.

2. Multi criteria cost effectiveness for climate risk insurance – An analytical framework

The Multi Criteria Cost Effectiveness Analysis (MCCEA) framework is a tool developed to help compare and select risk financing instruments based on their costs and overall effectiveness. Instead of taking a one-dimensional approach that only compares costs per unit of effectiveness, MCCEA frames cost-effectiveness more holistically. Based on the concept of Multi-criteria analysis (MCA), it integrates the assessment of efficiency and effectiveness into one framework, including criteria for parameters that cannot be reflected in traditional cost-benefit analysis (CBA) and/or cost-effectiveness analysis (CEA),[4] such as the speed of disbursement and risk assessments. For this purpose, MCCEA explicitly evaluates multiple conflicting criteria that occur within decision-making processes. Dealing with conflicting decision-making criteria is typical when evaluating policy options. While the costs/efficiency associated with distinct (policy) options, as well the benefits or effectiveness, for example individual risk financing instruments, usually function as the main assessment criteria, they often also strongly conflict with one another. In purchasing risk-financing instruments, costs, benefits and speed of disbursement are the most important criteria – it is however unusual that the cheapest/easiest risk financing instrument possesses the highest effectiveness. MCCEA is not an attempt to reconcile this conflict completely, but to structure complex decision-making problems into comparable formats, allowing the breakdown of efficiency and effectiveness into sub-ordinated requirements, and to decide amongst them across different (policy) options depending on the context-specific preferences of decision-makers.

This chapter develops an MCCEA framework for the assessment of the cost-effectiveness of climate risk insurance instruments for the vulnerable/modest income populations, and focuses specifically on the weather index insurance schemes currently emerging in developing economies. The subsequent chapter will then demonstrate the benefits of using such a framework as a decision-making support tool by employing it for the assessment of the cost-effectiveness of the three regional risk pools CCRIF, ARC and PCRAFI and the micro scheme R4.

Cost-effectiveness for the vulnerable in the context of CRI: A definition

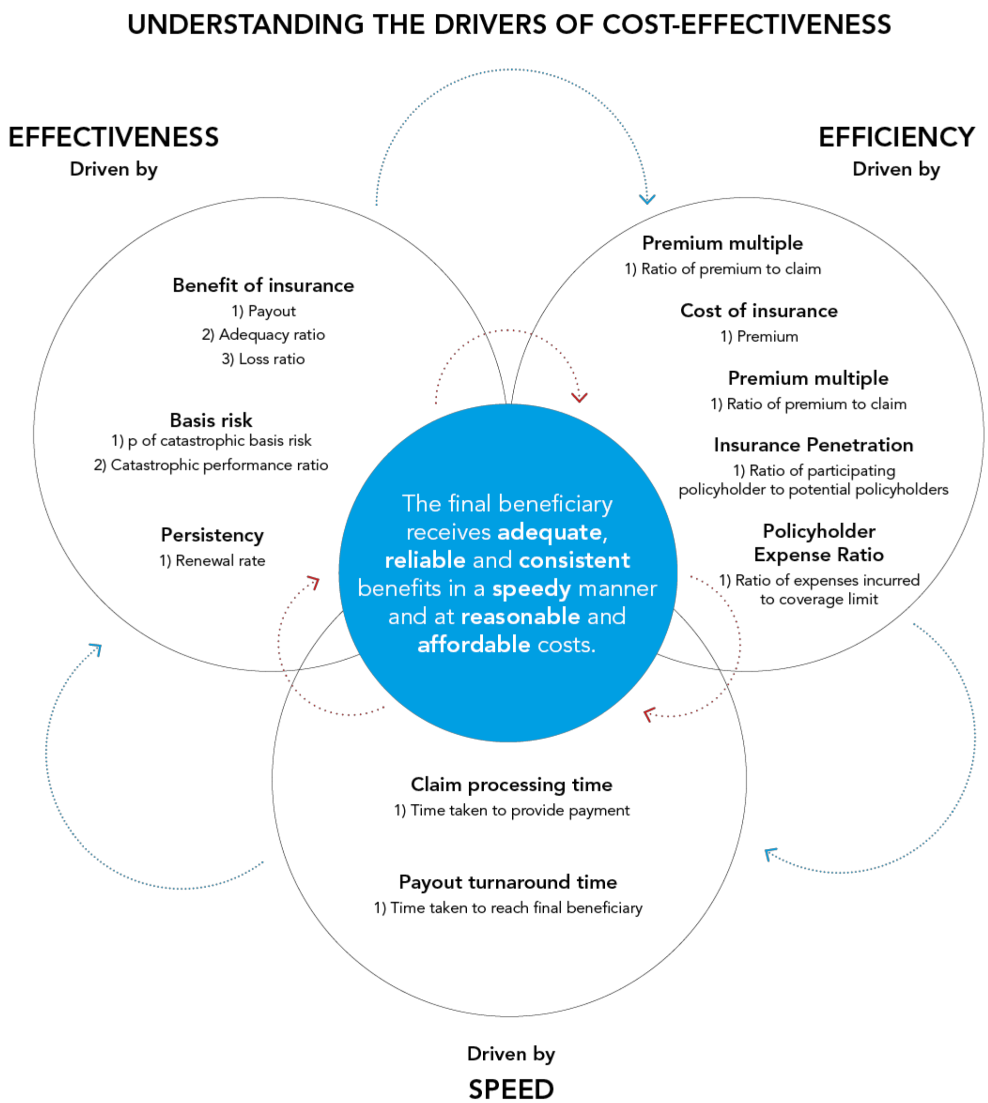
To build a basis for establishing the framework, let us briefly reconstruct and define what we understand by cost-effectiveness in the context of CRI for the vulnerable. Most essentially, a cost-effective CRI product would provide its clients with maximum benefits at least possible costs, meaning that the product would simultaneously fulfill the requirements of effectiveness and efficiency.

In this paper, we understand the requirement of 'effectiveness' as a combination of several characteristics, namely the *reliable* and *persistent* provision of *adequate* benefits to meet clients' financial needs in time of disaster. The efficiency requirement is broken down into two separate, efficiency-related requirements: attaining efficiency in terms of costs *and* time. The cost-efficiency requirement relates to the processes involved in 'producing' CRI and its benefits and mandates that this is done at minimum possible costs. Its fulfillment is not only critical for maintaining affordability, but also signifies the efficiency and sustainability of the underlying business processes. The requirement of time efficiency relates only to payouts: Timely payouts are of crucial importance, especially for lower income groups. Time efficiency is therefore understood as attaining efficiency in terms of speed of disbursement.

In the context of this paper, we therefore understand the cost-effectiveness of insurance for the vulnerable to be defined by the following overarching determinants, subsequently referred to as the 'pillars' of cost-effectiveness:

- ***Effectiveness*: The degree to which the need of final consumer is met in an adequate, reliable and consistent way**
- ***Cost-efficiency*: The costs incurred in producing and attaining the benefits of insurance**
- ***Speed of disbursement:* The time taken for processing claims and payout turnaround time**

Against this background, the following section will analyze each of these three pillars in more depth by first, discerning the respective sets of key drivers which influence effectiveness, cost-efficiency and speed of disbursement, and second, by identifying specific key performance indicators (KPIs) based on which the strength of these drivers can be measured. Ultimately, this exercise will result in a comprehensive assessment framework based on which information on the cost-effectiveness of CRI for the vulnerable can be inferred. In doing so, we also acknowledge the limitations of this framework and briefly note suggestions of how this could be resolved by expanding it accordingly.



Graphic 2: Overview of the pillars, key drivers and respective KPIs to determine CRI cost-effectiveness (Source: Authors' own)

2.1 Effectiveness

In the context of index schemes, the requirement of providing adequate benefits in a consistent and reliable manner can be determined by looking at the key drivers influencing the three factors. Hereby, the concrete benefits of CRI are expressed as a function of the (in) adequacy of benefits and benefit received per unit of cost[5]; while the reliability of receiving the benefits of CRI can be seen to be reflected by the probability with which the basis risk created in the context of parametric insurance materializes[6]. Moreover, persistency mirrors the utility of the product for the policyholder[7]. Accordingly, this paper understands the benefits provided by insurance, as well as the respective basis risk and persistency as the key drivers of effectiveness.

- *Adequate benefit of insurance: Adequacy of payouts*

Formally, an insurance contract entails the contractual obligation of providing a claims payout as per the amount previously agreed to within the insurance contract[8]. However, a CRI product that provides adequate benefits would be a product which produces benefits, including payouts, sufficient to meet the needs of the beneficiary. Since CRI and regional climate risk pools have not been created with the objective of covering the entirety of losses incurred during a disaster, but to provide immediate liquidity, this means that payouts should cover the *immediate* financial needs of the end customers[9]. For macroinsurance, such immediate financial needs relate to emergency relief and repair work. In case of microinsurance, payouts should be appropriately proportional to the total losses incurred by the policyholder and commensurate with food, clothing or shelter requirements, or the costs of restarting a business, preventing distress sales of other assets or with mitigating reductions in consumption. Contrary, however, policyholders often tend to buy coverage in correspondence to the premium they can afford rather than the coverage needed[10]. Therefore, the adequacy of the payout is also an indicator for the need for smart premium support as well as for other, cheaper risk financing strategies that would be needed to complement the protection provided by insurance so as to cover the residual risk. In order to determine the adequacy of payouts, and hence the adequacy of the benefits provided through insurance, two KPIs: can be determined and measured: the (1.1) aggregate claims payout or the payout per capita and the (1.2) adequacy ratio, meaning the ratio of claim payout to immediate liquidity needed.

- *Adequate benefit of insurance: Long term benefit to cost ratio (Long term loss ratio)*

For the beneficiary, the benefit to cost ratio represents the unit of benefit received for each unit of premium paid, thus signifying the value for money in return for the costs incurred. In industry terms, the ratio is commonly interpreted in reverse and referred to as the loss ratio, signifying the total of losses paid in claims by the insurer (i.e. the benefits for the insured) in relationship to the premiums received from the policyholder (i.e. the costs incurred by the beneficiary). It serves as an indication of whether it is cheaper to transfer or retain risk (When long-term losses are significantly higher than the premiums received in turn, part of the risk should be transferred, e.g. to the re-insurance market, so as to reduce the height of overall losses to be covered by the insurer). A loss ratio of 80 per cent, for example, shows that on average US$ 0.80 is paid in claims for every US$ 1of premium received. A high loss ratio, or "benefit-to-cost ratio", is thus favorable to the customer and signifies that the majority of the premium paid is utilized for covering claims. Contrarily, a low loss ratio implies a substantial underwriting profit, indicating that only a relatively small part of the premium paid is needed to cover the losses of the policyholder, while the rest remains as profit with the insurer. Underwriting profit, however, is of course also crucial, especially during the first few years of operations, for building the reserves necessary for a sustainable insurance pool. Yet, as per the principles of mutual insurance, once reserves are built, any major underwriting profit should be returned back to the policyholders. Nevertheless, it should be noted that due to the volatility of actual losses, the loss ratio can be an unreliable metric to track and compare year by year, since insurance will appear very expensive for years in which there are no extreme weather events and hence no payouts, while very cheap for years, in which major events materialize. It is therefore advisable to use a long term loss ratio (10-15 year) that can be compared across available insurance products to select a product with better on average return of claims, i.e. benefits. Hence, where appropriate, this paper uses the (1.3) long term loss ratio/long-term benefit-to-cost ratio as the second KPI to receive information on effectiveness.

The value proposition CRI can offer to its consumers goes beyond a claims payout (see Box 3), but the benefits included in such proposition cannot be quantified easily, and discerning as well as evaluating those is an expensive, elaborate exercise. Current work in this field is being done in the context of some impact evaluations, including one conducted by MCII, and should be available for study within the next year[11]. Doing so for this framework would go beyond the scope of this paper, but we hope this framework constitutes a good starting point to integrate quantitative KPIs for less tangible effectiveness drivers, once the respective research becomes available. For now, the KPIs used to determine the adequacy of the benefits provided by insurance will therefore be (1.1) the aggregate claims payout or the payout per capita, (1.2) the adequacy ratio and (1.3) the loss ratio.

Box 3: The value proposition of climate risk insurance beyond quantifiably benefits:

- Insurance can catalyze risk assessments and thereby strengthen the anticipatory capacities of climate resilience; assessments constitute a precondition for calculating premium levels. In this context, insurance can act as a catalyst for regional and international data analysis by establishing data repositories, standards and methods.
- Insurance can act as a safety net that prevents people from applying destructive coping strategies and slipping or falling deeper into poverty. Timely finance after a disaster can help individuals to cover losses and damages, stabilize their income, purchase food and other necessities, and avoid costly asset depletion[12]. For governments, insurance can help to avoid fiscal deficits and costly post-disaster loans.
- Insurance can help reduce the financial repercussions of volatility and create a space of certainty within which savings and investment planning can be undertaken.
- In the case of macroinsurance, the certainty of post disaster support can change investment behavior with the uptake of e.g. governmental investments in relevant risk reducing infrastructure projects. For microinsurance, climate resilient investments in relevant farming/livestock practices can reduce the need for smoothing income through non-core supplementary activities during or after natural disasters and thereby help to maintain and increase farm productivity in the long term[13].
- Having insurance as collateral should also open the doors for credit access to lower income groups. If implemented adequately, insurance against aggregate losses may protect lenders by reducing default rates and thus unlocking access to credit for low income farmers before shocks occur (Karlan, 2012).
- The insurance industry can also contribute towards disaster risk reduction by awareness raising campaigns, sharing of risk data and risk expertise, lobbying for public policy, and building standards and regulations as well as through investing in resilience building projects like infrastructure or flood defense[14]. Insurance can incentivize risk reduction practices by moving towards risk based pricing as well as through the terms and conditions of the insurance policy[15].
- In the context of disaster risk reduction, the insurance features and payoffs should result in long term risk reduction and not promote high risk taking and profit seeking behavior. The insurance payouts should be successively utilized for risk reduction activities instead of business as usual practices, resulting in net risk reduction[16].

- *Reliable insurance benefits: Basis Risk*

The reliability and hence the effectiveness of index insurance furthermore depends on basis risk. Basis risk[17]arises in the context of parametric insurance and most essentially represents the risk of mismatch between the payout as measured by the index and the actual loss incurred by the policyholder. It may thus happen that index insurance provides claim payments in years when there are no losses, and no claim payments in years when there are losses[6]. Insurance benefits can thus be defined as reliable when there is no mismatch between losses as measured by index and on ground losses incurred by policyholders.

Box 4: Different types of basis risk

The different types of basis risk prevalent in weather index insurance are:

Product basis risk: The difficulty of correlating the index (intended as a proxy for yield losses) well with the weather variable (e.g. rainfall) due to complex crop growth patterns, susceptibility to dry spells, soil type and degradation.

Contract design basis risk: Arises when contract parameters are incorrectly set or if there is difficulty in setting contract parameters in situations where there are major 'constraints' limiting yields.

Spatial basis risk: The discrepancy in the amount of rainfall recorded by the rain gauge or satellite, and received in different villages or different parts of a village.

Temporal basis risk*:* Caused due to the variation during the start of the season, individual farmer planting decisions and short/long cycle crop types.

An additional form of basis risk that can arise is yield loss due to uninsured perils (e.g. pests); losses that could be mitigated by farmers through better practice response to perils; or losses below the "deductible" of insurance etc. Furthermore, basis risk could also develop as a consequence of lacking reliable historical weather data for catastrophic events (above 1 in 75 year) and the tendency of data calculators/insurers to adjust trigger levels to make products more attractive for target audiences and pricing. When introducing a new product, for example, insurers tend to keep the trigger at a lower level to install frequent (but lower) payouts in the initial years for the purpose of building product trust. While frequency of payouts can help to build trust, the attractiveness and affordability of pricing for parametric products can be increased mainly in two ways: Either by reducing the payout levels when installing frequent payouts via lower trigger (and hence lower risk) thresholds or by reducing the (higher level) payouts by setting the trigger at a higher level, as both ways translate into favorable pricing effects.

Overall, the basis risk in the context of parametric weather insurance can be considerably reduced by improving the accuracy of hazard data collection systems, increasing the openness and centralization of historical data and better quality risk assessments.

Before considering parametric insurance, it is vital to analyze and compare different potential indexes with different levels of basis risk with regard to their costs and benefits. In *area yield index insurance* for example, the basis risk is higher than for indemnity-based products. And while it is lower than for weather index insurance products, the basis risk for large areas, where localized and independent losses are not accounted for, can still be substantial. For *weather index insurance*, the basis risk is the highest. Here, building on an accurate index and precise weather assessment data is quintessential for the products to be dependable and successful.

To capture the reliability of index insurance, especially in the case of catastrophic losses, Morsink, Clarke and Mapfumo devised two indicators[6]: the probability of catastrophic basis risk, that is, the probability of not receiving a claim payment when a farmer incurs catastrophic losses; and the catastrophic performance ratio, represented by the ratio of the average payouts for cases of catastrophic losses in relation to the premiums paid. For catastrophic losses, it provides more accurate information than the loss ratio/benefit-to-cost ratio, which highlights the relationship between the payout received and the premium paid, and thus indicates the average amount of benefits received, but disregards the intensity of loss.

A catastrophic performance ratio of 110 per cent for example signifies that a farmer receives US$ 1.1 per US$ 1 premium paid in the case of catastrophic loss. For farmers who mainly care about worst case scenarios, such outcome would be considered insufficient and strengthen the belief that CRI provides unreliable benefits. Yet, claims about the reliability of an insurance scheme should not only be based on singular instance of basis risk and how these are being dealt with. Rather, to reach valid conclusions, such instances should be considered in the wider context of the scheme's long-term reliability as indicated by the loss ratio: Considering a combination of indicators like a loss ratio of 80 per cent and a catastrophic performance ratio of 400 per cent may indicate a valuable product in terms of benefit for US$ 1 of premium paid.

Accordingly, the KPIs used by this paper to measure the basis risk, and hence the reliability of CRI will be (1.4) the probability of catastrophic basis risk and (1.5) the catastrophic performance ratio. To allow for a comprehensive reliability assessment, these will be further contextualized through use of a further KPI, namely (1.3) the loss ratio.

- *Persistent insurance benefits: Renewal rate*

An insurance product, which would be repurchased by policyholders on a continuous basis, could be considered as satisfying the consistency requirement of effectiveness mentioned at the outset of this paper. In the context of CRI, the continuous uptake and hence consistency of insurance can be measured by its persistence, and more specifically by computing the renewal rate for an insurance scheme. Usually, a high renewal rate for an insurance product is an indicator for the effectiveness of a climate risk insurance instrument, as well as customer satisfaction[18]. For macroinsurance, it thus implies that governments prefer insurance over other risk financing instruments, such as risk retention and ex-post budget re-allocation, to cover certain residual risks. For new insurance schemes, it would furthermore serve as an indicator of the long-term sustainability of the insurance scheme, because it means that the pool of policyholders could continue leveraging the benefits of risk pooling. Hence, for an insurance scheme with a relatively small customer base, low renewal rates would be disadvantageous since the remaining policyholders would lose the benefits of risk pooling and the sustainability of the insurance scheme would reduce.

For this framework, persistency is considered a key indicator of cost effectiveness and therefore we use the (1.6) renewal rate as the last KPI to elicit the overall effectiveness of a CRI product. The table below provides a brief overview of the effectiveness drivers and the respective KPIs that have been discussed in this section (see Table 1).

Table 1: Drivers and KPIs substantiating the effectiveness of CRI

Pillar	Driver	Key performance indicator
1. **Effectiveness**	Benefit of insurance	1.1 Cumulative claim payout or payout per capita 1.2 Adequacy ratio - Ratio of claim payout to immediate liquidity needed. 1.3 Benefit to cost ratio (Loss ratio) - claims received/premium paid
	Basis risk - correlation of modeled and actual loss	1.4 Probability of catastrophic basis risk 1.5 Catastrophic performance ratio
	Persistency	1.6 Renewal rate percentage

2.2. Cost efficiency

As stated before, achieving cost efficiency entails providing benefits to clients at minimum possible cost, and signifies the efficiency of managing a business. In order to achieve cost efficiency, the cost of insurance needs to be minimized as much as possible. The drivers listed below provide an overview of the factors contributing to the costs of insurance. Optimizing these drivers is necessary to cost-efficiency in the context of CRI products.

- *Cost of Insurance*

Generally, the cost of insurance can be divided into the direct and indirect costs that arise for policyholders[16]. The major direct cost components are constituted of the premium paid and the deductible. In general, the premium is derived from three different elements and can be considered as the sum of the costs of the expected loss, the risk loading costs and all administrative costs related to providing insurance[19] (see Box 5). The premium deductible[20] represents the costs of a loss to be incurred by the insured because they fall below a pre-agreed threshold above which the insurer has agreed to make claim payments. The insurer deducts this amount from the loss before paying up to its policy limits, and the remaining costs are carried by the policy holder (see Box 6). Yet, to simplify our analysis, the (2.1) premium paid is considered the only KPI used to measure the cost of insurance, even though in reality, the deductible as well as the indirect costs (covered later under the policyholder expense ratio) should also be considered. Nevertheless, the framework lends itself to being expanded accordingly within future work and with the help of further research.

Box 5: Pricing of climate risk insurance solutions - setting the premium charge[19]

When establishing the price for an insurance instrument, providers will take into consideration their own risk appetite, business imperatives, and operational costs. While there are a variety of methodologies for pricing, in general the pricing for all contracts will contain an element of expected loss, plus some risk loading as well as administrative costs. Generally, the premium charge for a contract can therefore be broken down as follows:

Price = Expected Loss + Loading Costs + Administrative Costs

Expected Loss

Insurers conduct extensive risk assessments to evaluate the risk profile of prospective policyholders. Based on the expected loss frequency (the expected number of events per year) and the expected loss severity (the average value of each loss), the 'average annual expected losses' and 'probable maximum loss' are determined. The average annual loss is the expected loss per year (estimated loss frequency multiplied by estimated loss severity, summed up for all exposures), averaged over many years. The probable maximum loss is the largest potential loss for a given exposure, often defined in terms of a specific exceedance probability. Thus, effective preventive measures and risk reduction practices play a big role in driving down the insurance premium by reducing the expected annual loss and probable maximum loss, which are the primary determinants of a policyholder's risk profile and in turn determine the premium of an insurance policy. Depending on the type of insurance product, namely indemnity based yield, revenue or weather index insurance, the values of the expected loss and the risk loading are established based on the historical yield, revenue or weather data.

Administrative costs

Administrative costs are essentially the costs the provider incurs in the context of running its business, including operational expenses, underwriting costs, marketing and delivery costs, claim adjustments expenses, charges for data, office costs, taxes, re-insurance and brokerage charges. For setting up a new line of insurance business, these costs can be significant as they would include the development costs for establishing an administrative apparatus, build a database, and develop or purchase sophisticated catastrophe models to assess its risk profile. All these expenses are recovered as administrative costs charged through the premium.

Risk loading costs

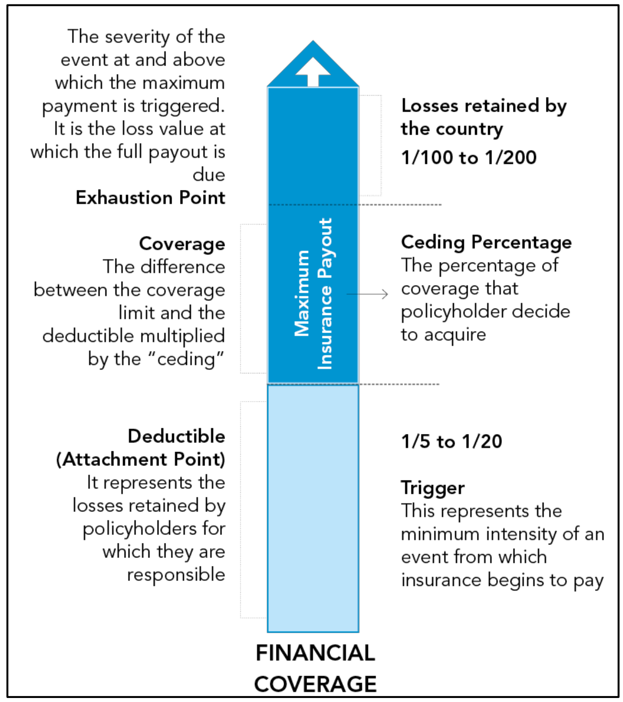
The providers charge a risk margin due to the fact that in some years, when extreme events happen, payouts in excess of the average can occur and the risk-taker must be compensated for this uncertainty. Catastrophic loads are included especially when insuring very high risk or correlated risk based on the recognition that substantial losses may occur before significant reserve funds could be accumulated. In order to have ready access to capital and add capacity, insurers (more so in developing countries) often need to buy reinsurance to meet their financial needs. These *costs of buying reinsurance or risk transfer* are also added to the premium. In case of high uncertainty, *the ambiguity or uncertainty load* margin is used to compensate the insurer for limited information or uncertainties in the data, such as trends or missing values associated with writing specific lines of insurance like extreme weather risk events. For insurance covering large, infrequent events (but sometimes even more frequent events) in countries where the quality of data is poor, the uncertainty load can be a significant part of premium. The risk margin corresponds to a capital reserve charge required to underwrite the risk at a target level for the business. The associated cost of capital can be viewed as opportunity cost and compensates the insurer for placing their capital at risk in the insurance business.

- *Premium rate (premium to coverage limit ratio):*

The premium rate signifies the relation between the cost of insurance and the risk covered, i.e. the insurance coverage limit offered. It represents the ratio of the premium paid to the coverage limit and signifies the percentage of the premium charged per unit of coverage. A premium rate of 5 per cent signifies a US$ 5 premium charged for a US$ 100 coverage limit. A high premium rate implies an expensive insurance plan. For an insurance scheme designed for vulnerable populations, the premium rate should thus be on the lower side, i.e. within 3-10 per cent[a]. In the context of determining cost-efficient solutions for the vulnerable, we thus define the (2.2) premium rate as the second KPI for cost-efficiency.

Box 6: Pricing of climate risk insurance solutions – the influence of policy conditions on premium pricing

The policy conditions lay down the perils covered, insured losses, as well as the inclusions and exclusions that will be covered by an insurance contract. They therefore also regulate the premium price of a given policy. The three key determinants to be considered by policyholders during coverage selection – the attachment point, exhaustion point and ceding percentage–¬ in-turn, decide the kinds of losses insured by an insurance policy.



Graphic 3: Pricing of CRI adapted from CCRIF (2015)

Deductible/ attachment point: The attachment point can be described as the loss event's minimum severity at which payments are made and therefore equal the modelled loss value at which the policy contract is triggered. The attachment point therefore functions like the deductible in a standard insurance policy. While policyholders generally select the attachment point as a return period (for example, 15 years representing a 1-in-15 year tropical cyclone), the policy states the equivalent dollar value of the loss the return period represents in the country's risk profile. It is a vital component as it encourages risk reduction behavior, keeps the premium low and also helps to check moral hazard. Furthermore, in order to optimize the deductible cost, the theory of deductibles states that claim payments should

[a] In this context, index-based products seem more feasible, since indemnity-based insurance comes with a higher premium rate due to loss adjustment charges and higher admin expenses.

not be made very frequently. Instead, insurance should only make big payments for the times of severe disaster to be effective on the deductible cost.

Exhaustion point: The exhaustion point refers to the severity of the event loss at or above which the maximum payment is triggered. As with the attachment point, the return period selected as the exhaustion point is converted into the equivalent dollar value of the loss for that return period for inclusion in the policy.

Ceding Percentage: The ceding percentage is the portion of the losses that the insurer will cover under the policy. More specifically, it is the fraction of the risk between the attachment and exhaustion points that the policyholder is transferring to the insurance company. Once the attachment and exhaustion points are chosen, there is a one-to-one relationship between the amount of premium paid and the ceding percentage – a higher ceding percentage means a higher premium.

Coverage limit: The coverage limit is the maximum amount that can be paid out under the contract in any one year for any one peril. It reflects the difference between the attachment and exhaustion points (exhaustion minus attachment) multiplied by the ceding percentage.

- *Cost of insurance per unit of benefit (Premium multiple)*

Another important indicator of the cost efficiency provided by insurance is the relationship between the costs incurred for, and benefits provided through CRI. The relationship between the benefits and costs of insurance is depicted by the premium multiple[21], which is calculated as the ratio of premium paid to claims received. Accordingly, a premium multiple of 1.25, for example, signifies that US$ 1.25 premium is spent for every US$ 1 of benefit. Thus, a high premium multiple implies that high costs have to be incurred to obtain insurance benefits. Similarly, to the loss ratio,, which is the inverse of the premium multiple, tracing the premium multiple year on year can also be considered undependable as losses are volatile due to the occurrence of major loss events during the year. However, when tracing the premium multiple over the longer term (for 10-15 years), it can serve as a signifier of the overall costs of insurance (see Box 7). Hence, the (2.3) premium multiple is our third KPI for the cost-efficiency of CRI products.

Box 7: Comparing the cost multiplier of insurance with other CDRF instruments[22]

Additionally, the premium multiple can also be understood as cost multiplier and hence function as a reliable indicator for comparing the cost of insurance vis-a-vis other risk financing instruments. The aforementioned study also calculates the cost multiplier (premium multiple) of different risk financing tools (findings in table below) and shows that while insurance can be a powerful tool for risk management, it is also an expensive one for governments that otherwise have access to sufficient sovereign financing. It concludes that insurance can be beneficial specifically for small states that lack sufficient capacity to build reserves and have restricted access to credit.

Table 2: Cost multipliers of climate risk transfer and other CDRF instruments based on Ghesquiere and Mahul (2010).

Instruments	Indicative Cost Multiplier	Disbursement (months)	Size of funds potentially available
Donor support (humanitarian relief)	0-1	1-6	Uncertain
Donor support (recovery and recollection)	0-2	4-9	Uncertain
Budget reallocations	1-2	0-9	Small
Domestic credit (bond issue)	1-2	3-9	Medium
External credit (e.g. emergency loans, bond issue)	1-2	3-6	Large
Budget Contingencies	1-2	0-2	Small
Reserves	1-2	0-1	Small
Contingent credit	1-2	0-1	Medium
Parametric insurance	1.3 and up	0-2	Large
Alternative Risk Transfer (e.g. CAT bonds, weather derivatives)	1.5 and up	1-6	Large
Traditional (indemnity-based) insurance	1.5 and up	2-12	Large

- *Policyholder Expense Ratio*

In addition to the premium and deductible, there are other expenses that a policyholder incurs while purchasing insurance. For macro and meso-insurance, where governments and groups/institutions are the policyholders, these usually don't represent major expenses in comparison to their paying capacity. Yet, for the individual policyholders in the context of microinsurance, these expenses could be substantial, and also the end beneficiary of macro or meso-insurance schemes could have to incur such expenses when the benefits are finally passed on to them. It is these kind of expenses that were previously mentioned as indirect cost components[16], and conventionally entail the costs of transaction, opportunity costs and prevented mitigation costs. Transaction costs describe the monetary resources spent for purchasing an insurance contract. They can be substantial if individuals cannot easily purchase the insurance, which is often the case for microinsurance products in developing countries. Opportunity costs represent the value of the alternative options the resources could have been used for, had the CRI purchase not occurred. The costs of prevented risk mitigation due to buying insurance refer to the value risk reducing measures could have produced, had the respective risk not been transferred through insurance. All these costs can sometimes be substantial in a developing economy and therefore we have our fourth KPI policyholder expense ratio[b] as the ratio of total expenses incurred for purchasing insurance to the aggregate coverage limit. Premium paid and expenses incurred would together formulate the total cost incurred for purchasing insurance. However, as the expenses incurred are difficult to measure, it can be tough to measure the policyholder expense ratio. But it is an important factor to be considered when companies launch a product for the vulnerable population, as a low premium rate but high policyholder expense ratio would still lead to an overall high cost for the customer. Accordingly, the (2.4) policyholder expense ratio represents the fourth KPI via which this framework aims to obtain information on the cost-efficiency of CRI products.

Box 8: Diversification of Losses

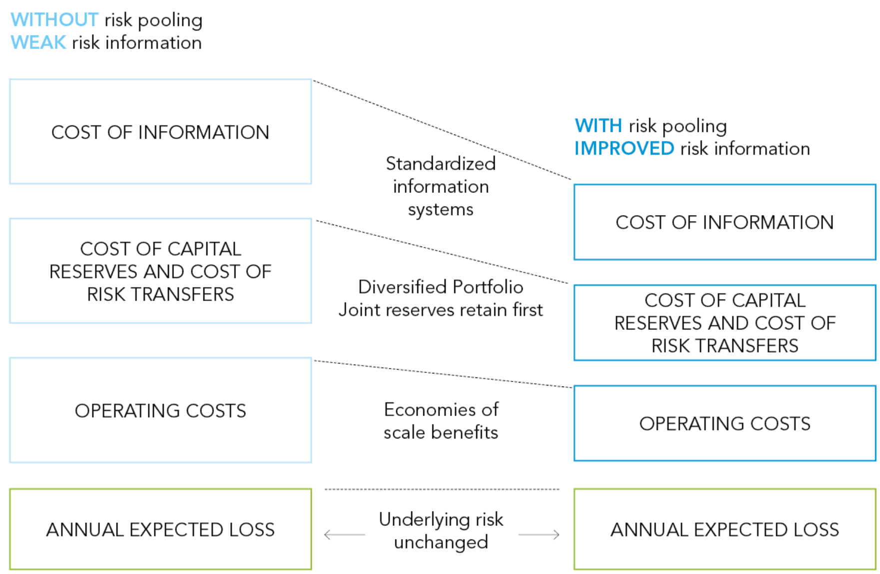
A basic concept underlying insurance and lowering its costs is the concept of loss diversification. This is especially important in the context of climate risk insurance, given that climate risks are usually covariant risks. Covariant risk arises from the circumstance that severe losses will be experienced simultaneously, that is, across all (in our case, all entities participating in the same insurance scheme). The law of large numbers – the basic principle underlying insurance (stating that the larger the number of exposure units independently exposed to loss, the greater the probability that the actual loss experience will equal the expected loss experience) can only be sufficiently applied to climate risks if the risk is diversified both across geographies and multiple perils. The benefits of diversified losses[23] would manifest themselves as a reduction in the catastrophe load that needs to be integrated into the insurance premium as well as in

[b]The expense ratio in the insurance industry is a measure of operational efficiency of the insurance company calculated by dividing the expenses associated with acquiring, underwriting and servicing premiums through the net premiums earned by the insurance company. The expense ratio stated in the paper is from the policyholder's perspective. Even though insurance industry expense ratio does not directly impact the policyholder financially, it is still important to consider since a very high expense ratio over years indicates inefficient operations, which could translate into significant price reductions for the end customer if they were optimized.

the reduced capital needs of the insurer to cover the risks in case of materialization. Thus loss diversification does not reduce the risk (as measured by the annual expected loss), but reduces the capital required to cover the full risk spectrum.

Pooling, that is diversifying risks, also creates larger transactions more attractive to global reinsurance and capital markets, and therefore reduces the cost of reinsurance. Ultimately this translates into a reduction of the premiums paid by the participating countries. Also, achieving economies of scale by sharing the costs of administering the risks of the different participants and a larger reinsurance ticket size (risk transferred to the reinsurer), further reduce the operational costs.[c] Hence loss diversification is a basic principle underlying insurance for achieving cost-efficiency of an insurance product in multiple ways.

Graphic 4: Catastrophe risk insurance premium based on World Bank (2017)



- *Insurance Penetration*

Insurance penetration[24] is defined to be the percentage of potential policyholders that holds the insurance policy. If a country has an insurance enabling environment, a good insurance scheme would eventually reach scale over time and penetrate the insurance market. Insurance penetration can be measured in two ways: (i) the percentage of people/ countries insured in comparison to the entire potential target group/ countries (if data available). Alternatively, or complementarily, penetration can

[c] From the perspective of the insured, a catastrophe risk insurance pool can also be viewed as a joint reserve mechanism, with contribution levels selected by individual participants and a set of rules to ensure that in the long term, each participant will receive payouts relative to the premium (contribution) it has paid. Establishing joint reserves allows the pool to retain more frequent losses and transfers the excess risk to the reinsurance and capital markets. Ultimately this can also reduce the insurance premium paid by countries.

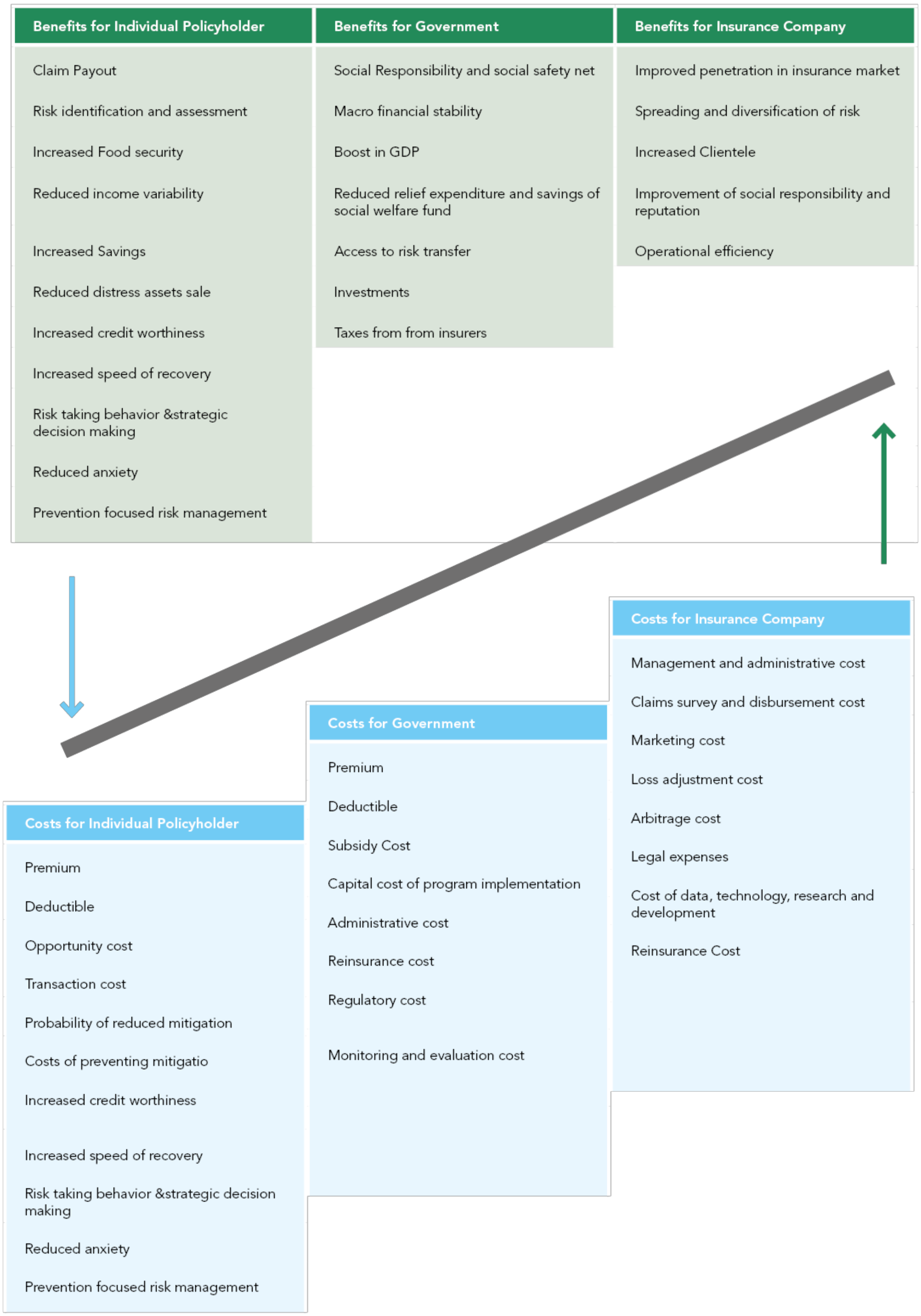
be measured as (ii) the percentage of area covered under insurance in comparison to the total agricultural area (if data available). By upscaling, economies of scale can be reached and the cost of insurance could come down. Henceforth, (2.5) insurance penetration is the fifth KPI used to illuminate cost-efficiency through our framework.

Table 3: Drivers and KPIs substantiating the efficiency of CRI

Pillar	Driver	Key performance indicator
2.Cost efficiency	Cost of insurance	2.1 Aggregate policy premium (macro) or premium per capita (micro)
	Premium rate	2.2 Ratio of premium paid to coverage limit: Average of ∑ Aggregate premium t(i)/ average coverage limit t(i)
	Premium multiple	2.3 Premium paid /claims received
	Policyholder Expense Ratio	2.4 Expenses incurred/ Aggregate coverage limit * 100
	Insurance penetration	2.5 Percentage of participating policyholders to potential policyholders or percentage of participating countries to eligible countries) / n

Based on the discussions above, this framework will thus use the key drivers and respective performance KPIs listed in the table above to assess the cost-efficiency of CRI schemes (see Table 4). As highlighted throughout the past two sections, not all drivers affecting effectiveness or cost-efficiency can be considered in this framework. Before moving on to the final pillar of cost-effectiveness – speed of disbursement– the graphic below provides a visual representation of the multiple factors determining cost-effectiveness, including those left out from our framework.

Graphic 5: Costs and Benefits of CRI based on Prabhakar et al (2017)



2.3. Speed of disbursement

In the insurance industry, standards are developing for the speed with which claims are paid. Even with a loss ratio of 80 per cent i.e. a premium multiple of US$ 1.25, and low basis risk, an index insurance may still be of low value, especially for the vulnerable target groups, if claim payments are made only long after losses are incurred. The significance of faster payouts for preventing adverse consumption behavior, anxious liquidating of assets and school dropouts is well researched and understood. Timely insurance payouts furthermore carry benefits beyond increasing immediate coping capacities by ensuring that farmers have sufficient funds for buying seeds and replanting for the next season. Going forward, the two key drivers signifying the claim processing time and the payout turnaround time will be used to analyze the third pillar of cost-effectiveness. Before this chapter concludes, the following will explain these pillars and indicate the respective KPIs that will be used to characterize them.

- *Claim processing time*

The *claim processing time* signifies the time an insurance company takes to make payments to the policyholder from when index is triggered (index insurance) or from the first notice of loss (indemnity insurance) provided the claims process formalities are completed by the policyholder. The claims process varies for traditional indemnity insurance and parametric products. This is because for traditional indemnity based products, loss assessments need to be performed before the processing of claims. For indemnity insurance, claims processing time would be measured from the time of notice of loss[25]; in effect, processing indemnity related claims takes more time. For area yield index insurance, the claim payouts are relatively faster as well as cheaper, since claims are not paid on the basis of individual loss assessments but on the basis of average yield assessments for an entire area. For area yield insurance, claim processing time would be measured from the time the index is triggered. Weather based parametric products are even faster and similarly cheap, since they make claim payouts whenever an index is triggered and require no loss assessment. Claim processing time for weather based parametric products would also be measured from the time the index is triggered. Reduced costs and increased speed of disbursement therefore make parametric insurance a promising product for lower income groups. So for this framework, the (3.1) *claim processing time* is the first indicator for speed of disbursement and signifies the time taken by an insurance company to pay the claim to the policyholder from when index is triggered or from the first notice of loss.

- *Payout turnaround time*

The *payout turnaround time* indicates the time it takes for the payouts to reach the final beneficiary[d] from the time the index is triggered or from the first notice of loss. In the case of a macro scheme, the policyholder is the government and final beneficiary are the citizens of the country. In the case of meso scheme the group/institution is the policyholder and group members are the final beneficiary. Therefore, the time taken for payout to reach policyholder is different from the time taken for the payout to reach final beneficiary for meso and macroinsurance schemes. Tracking the time needed for the payout to reach the final beneficiary becomes even more important for lower income groups since an inclusive financial environment is still developing, and tracking might help to reveal gaps that need to be addressed. In the case of macroinsurance schemes, "...the operationalization of relief work through safety net programs further facilitates the low cost delivery of robust help to the beneficiaries. In this context, a formalized claims process defined through the respective insurance pools, such as the submission of contingency plans, can also safeguard faster relief work, transparency and the quicker disbursement of claims to the final beneficiaries."[26] Accordingly, the second KPI for our framework is the (3.2) *payout turnaround time*, signifying the time taken for the benefit to reach the final beneficiary. This would be interesting for decision makers to identify and compare the turnaround time taken for the benefits to reach the final beneficiary through different financing mechanisms.

Table 4: Drivers and KPIs substantiating the speed of disbursement

Pillar	Driver	Key performance indicator
3. Speed of disbursement	Claim processing time	3.1 Time taken for insurance provider to make payment
	Payout turnaround time	3.2 Total time taken for payout to reach final beneficiary.

2.4. Applicability and Limits of the Framework

The above described framework, including the stated indicators for each key driver and pillar of cost-effectiveness respectively, can be tailored to individual analyses. **Parametric climate risk insurance can be considered a cost-effective tool for covering residual risk, if these key pillars – effectiveness, cost efficiency and speed of disbursement – along with their key performance indicators are performing**

[d] In case of micro scheme as policyholder and final beneficiary are the same so the claim processing and payout turnaround time will also be the same.

well. While best applied in full, depending on the particular situation and availability of data, selective indicators or combinations can be chosen. Consider the below example as a brief demonstration of how the developed MCCEA framework can help to compare two illustrative insurance schemes:

Table 5: Illustrative insurance schemes (Source: Authors' own)

KPI	Scheme A	Scheme B
Long term loss ratio	50%	70%
Catastrophic performance ratio	120%	140%
Premium Rate	15%	17%
Claim Processing time	10 days	14 days
Policyholder Expense ratio	5%	4%
Renewal Rate	60%	70%
Insurance Penetration	2%	1.5%

In the case shown above, scheme A has a lower premium rate than B, but a higher policyholder expense ratio, which increases the overall price incurred by the policyholder to purchase insurance. Furthermore, scheme A is cheaper than scheme B and provides relatively faster payouts, but the B's loss ratio and catastrophic performance ratio are comparatively better. This implies that even if scheme A is a better marketing proposal, scheme B would pay more benefits to customers over the long term.

Table 6: MCCEA Cost-effectiveness assessment framework: Pillars, drivers and KPIs substantiating cost-effectiveness

Pillar	Driver	Key Performance Indicator (KPI)
1. Effectiveness	Benefit of Insurance	1.1 Cumulative claim payout(macro) or Payout per capita(micro) 1.2 Adequacy ratio - Ratio of claim payout to immediate liquidity needed. 1.3 Loss ratio - Claims received/ Premium paid *100

	Basis risk – correlation of modeled and actual loss	1. 4 Probability of catastrophic basis risk 1.5 Catastrophic performance ratio
	Persistency	1.6 Renewal rate percentage
2. Cost efficiency	Cost of insurance	2.1 Aggregate policy premium (macro) Premium per capita (micro)
	Premium multiple	2.2 Ratio of premium paid to claims received
	Premium rate	2.3 Average of ∑ Aggregate premium t(i)/ average coverage limit t(i)
	Policyholder Expense ratio	2.4 Expenses incurred/ aggregate coverage limit * 100) / n
	Insurance Penetration	2.5 Percentage of participating policyholders to potential policyholders or Percentage of participating countries to eligible countries
3. Speed of disbursement	Claim processing time	3.1 Time taken for insurance provider to make payment
	Payout turnaround time	3.2 Total time taken for payout to reach final beneficiary

It must, however, be mentioned that the developed framework does not necessarily lend itself to comparing different insurance schemes. The differences between insurance schemes arise due to a variety of factors, such as different objectives (e.g. immediate financial liquidity for governments vs. payouts to governments intended for further transfer to beneficiaries on the ground), different eligibility requirements (e.g. disaster risk reduction, contingency plans), the therewith associated provision of different intangible and hence often incomparable well-being (not welfare) benefits, different perils covered (e.g. flood, drought, cyclones) as well as different risk layers within the severity-frequency continuum associated with such perils (e.g. medium frequency/medium severity as is the case for e.g. ARC covering 1:5 year events vs. lower frequency/higher severity as is the case for e.g. CCRIF covering mainly 1:15 and 1:30 year events, disregarding that both facilities cover different perils to start with). Therefore, to be comparable, insurance schemes should play in the same league. Additionally, the here

developed framework would need to be expanded to include more financial stability indicators, since the schemes might have reached different maturity, including different degrees of sophistication affecting operating costs and cost of capital, and are capitalized and rated differently. Since this framework is focusing on assessing the cost-effective performance of insurance schemes, including the respective drivers, not the financial health of these schemes, these indicators have not been further considered.
The framework is also limited regarding its usability for direct comparison with other CDRF instruments. Most basically, insurance should only be compared to other CDRF instruments, if these are planned to be used for the same risk layers. Furthermore, the assessment of other CDRF instruments, such as contingent credit lines, will build on different KPIs for performance measurement, e.g. KPIs focusing on loan installments, payback periods and corresponding opportunity costs, eligibility requirements, usage of loan, etc. Singular KPIs from our framework can, however, be selected for drawing parallels to the performance of other CDRF instruments to understand the differences of advantages offered.

Most essentially, the developed framework can be applied to assess the cost-effective performance of a scheme over a given time and to identify shortcomings as well as successes per which future operations can be adjusted. In doing so, it builds a better understanding of cost-effectiveness drivers amongst policy-makers, NGOs and donors and enables deeper insights into the components crucial to an insurance scheme's cost-effectiveness as well as their various interplays. As such, it allows policy- and decision-makers to reach cost-effective scheme designs via identifying needs for further action, innovation and research, and recognition of remaining gaps that would need coverage by other instruments. The framework can furthermore be modified and expanded to increase the comparability between insurance and other CDRF instruments, given these are applied to the same risk layers. In this regard, it must, however, be mentioned that CDRF instruments should not be used or compared only in isolation from each other, as none of them will be sufficient to protect against the entirety of risk layers associated with climate impacts. Rather, they should be used in combination and according to their individual appropriateness to cover different risk layers. Such combinations should then be compared with each other to identify the most cost-effective mix of CDRF instruments. While this is beyond the scope of this paper, the framework designed presents itself as a good starting point for developing an approach allowing to do so.

Lastly, it should be mentioned that performance assessments often tend to affect support-related decisions and hence contributions from donors (or members, as in the case of regional risk pools) or CSO acceptance and approval. Yet, to allow for just assessments and decisions, different degrees of scheme maturity and different capabilities, e.g. those of governments and institutions implementing CRI-based solutions, should also be considered. While this framework assesses the performance of insurance schemes regardless of the capabilities of the governments and institutions involved, any future performance assessment should take such circumstances into account before reaching definite conclusions on the performance and thus the quality and desirability of the CRI mechanism under consideration.

3. Illustrative Application and Analysis: ARC, CCRIF-SPC, PCRAFI, and R4

In this chapter, we will now turn to applying the above developed framework to four different CRI schemes supported by the InsuResilience Initiative and analyze the respective findings. This includes the three currently existing macroinsurance schemes CCRIF-SPC, ARC and PCRAFI, covering 26 countries in three regions, as well as one well known microinsurance scheme, R4, active in four African countries. Building on our framework and the associated KPIs, the performance of each scheme will be assessed based on data availability from annual reports and displayed individually in the respective boxes 9, 10, 11 and 12 (see Annex). If not specifically stated differently, the data used for analysis is based on what has been available as of the end of 2017. For CCRIF SPC and R4, data available as of mid-2018 has been used. It should, however be mentioned that due to a lack of available data, not all of the KPIs determined previously can be considered in depth. The other part of this chapter will interpret and analyze the findings from the boxes as well as contextualize them to provide deeper insights. In this context, it is important to highlight that firstly, the subsequent analysis is only illustrative of applying the framework and secondly, that even though the KPIs of different schemes are sometimes put in context with each other, this paper does not aim to compare across different schemes.

Box 9: African Risk Capacity (ARC) – Africa (as of 2016/17)[27 – 37]

In 2012, 18 African Countries founded African Risk Capacity (ARC). The scheme is now in its fifth year of operations with a capital reserve of US$ 98.5 million and offers parametric drought insurance policies to the participating African countries (tropical cyclone policies are in development). The eligibility criteria for receiving access to risk coverage is a risk and vulnerability analysis conducted by the Africa Risk View model and an approved contingency plan to be submitted by the participating countries. The premium amount and potential payout level for each member of the risk pool is determined by the policy conditions selected by each country. ARC currently offers a maximum coverage of US$ 30 million per country per season for drought events that occur with a frequency of three to five years, which is commensurate with the high frequency of droughts in many African countries. The trigger levels for cyclone and flood policies are somewhat higher, covering risk in the 1-in-10 to 1-in-100-year return period range.

Countries receiving a parametric payout from ARC are required to develop a final contingency plan for the use of the payout funds, which needs to be certified by a group of experts and peers before the payout is made. While this approach tends to make payouts from ARC occur within a few weeks (this could be faster otherwise), it is valuable for ensuring that the benefits of early action are fully captured and that the most vulnerable are reached and assisted. The use of payouts is audited after implementation to ensure appropriate deployment and enable learning to feed back into updated and improved contingency plans.

Effectiveness

- **Benefit of insurance – Cumulative claim payout, Adequacy ratio and Loss ratio**: In total US$ 34.4 million have been paid out to Mauritania, Niger, Senegal, and Malawi. Payments made were used to enable food and fodder distribution, and conditional cash transfers. The payouts have impacted approximately 2.1 million people and 0.9 million livestock. The long term loss ratio stands at 64.54per cent, which is customer favorable and sufficient for a scheme to operate sustainably.
- **Basis risk**: Basis risk is prevalent and needs to be addressed. For Malawi, initially the model underestimated the impact of drought and no payouts were triggered. Re-investigation of ARC was eventually able to secure a payment after 9 months of emergency, with a payout that should have occurred during the implementation period 2015/16 having been made in 2017. Actual basis risk could not be measured during our research.

- **Persistency**: Kenya and Malawi opted out of the 2016/17 pool, citing lack of trust. In the case of Kenya, had it remained in the pool for 2016/17, it is likely that the country would have received a payout. Current participation (as of 2017) is comparatively low with 6 countries participating, resulting in a renewal rate of 72 per cent for 2016/17.

Cost Efficiency

- **Cost of insurance, premium rate and aggregate coverage limit**: Till date a total of approximately US$ 53.3 million has been paid as premiums by all participating countries. The average aggregate coverage limit offered is US$ 134 million. The premium rate, on average, is 13 per cent of the aggregate coverage limit showing an above average premium rate.
- **Premium multiple**: The long term premium multiple is 1.55.
- **Policyholder expense ratio**: ARC being a macroinsurance scheme, policyholder expenses are not a major cause of concern for governments. However, no information on any expenses transferred to and borne by final beneficiaries could be found during this research.
- **Insurance penetration**: A total of 32 African countries have signed the ARC treaty and until today, 8 countries have participated. As shown by research done by Clarke & Hill (2013)[38], pooling risk across the continent within its diverse rainfall patterns, could save countries up to 50 per cent of the cost of emergency contingency funds, while also decreasing reliance on external aid.

Speed of Disbursement

- **Claims processing time**: No data could be found for the time taken for ARC to make the payments to governments.
- **Payout turnaround time**: ARC promises to make payouts to the final beneficiary within 120 days of a triggered event. However, as per research conducted by Clarke & Hill (2013)[38] in 3 years of operation, the payout turnaround time of 120 days has been missed for 3 out of 4 payouts. This is a major detriment to the potential benefits ARC could have realized. As per the same research, US$ 1.00 spent on early intervention through ARC saves US$ 4.40 spent after a crisis unfolds, as a result of reduced response times and risk pooling. This is valid only if the payout reaches the final beneficiary within 120 days, the premium multiple is assumed to be 1.2 and safety nets are used for disbursement. Currently ARC's premium multiple is around 1.55, and none of the payouts have reached final beneficiaries within 120 days.

3.1 Effectiveness

- *Adequacy of insurance benefits: Adequacy of payouts*

As stated before, individual insurance payouts are not meant to cover the entire disaster response costs, but should be adequate to meet immediate liquidity requirements. In this respect, our research indicated repeatedly that the insurance coverage presently purchased by countries stands in no proportion to their immediate liquidity needs, but rather depends purely on their premium paying capacity[10].

In turn, this has led to countries receiving insufficient payouts during disasters. For microinsurance schemes, such as R4, the case is similar – In Ethiopia, the average farmer only purchases insurance cover for 15 per cent to 20 per cent of his cultivated area with an average insured sum of about US$ 60-80 per farmer, while the immediate financial needs to sustain themselves in case of disaster usually relate to their entire farming grounds. Over the past eight years, 40 per cent of farmers have received a payout with an average of US$ 12.9 per benefitting farmer. This shows not only those farmers in Ethiopia are severely underinsured, but also indicates that even for those that are insured; the tiny average payouts they receive would be insufficient to ensure the purchase of seeds and fertilizers for the next season (paper forthcoming). In terms of adequacy of benefits, this therefore signals the need for smart premium support for catastrophic losses and cheaper alternative financing mechanisms for non-catastrophic losses, since current conditions show that policyholders (both micro and macro) are incapable of buying adequate insurance coverage due to affordability issues.

- *Adequacy of insurance benefits: Benefit to cost ratio (Long term loss ratio)*

The long term loss ratios for ARC and CCRIF stand favorable to the customer at 65 per cent and 56 per cent respectively. The long term loss ratio of PCRAFI is 33 per cent, indicating that the insurance pool is priced expensively, not sufficiently diversified and not operating with good underwriting profits. The R4 microinsurance scheme is making an underwriting profit with a loss ratio of 72 per cent.

As all of these pools are relatively new and working on mutual principles; the underwriting profit is used to build the capital reserves necessary to also cover catastrophic risks and provide claim payouts during major disasters. In addition, the building of capital reserves is crucial for the pools to pay back the loans taken out from donor countries. Eventually, once the capital reserves have reached sufficient levels and all policyholders are paying for themselves, the mutual schemes should pay back any long term underwriting profit to their policyholders, for example in the forms of dividends or discounts. Over time, this helps to decrease the costs of insurance, while the benefits – ceteris paribus – remain constant, thereby increasing the countries' (clients) benefit to cost ratio, making the benefits increasingly adequate.

- *Reliable insurance benefits: Basis risk*

While basis risk is inherent in index insurance products, all of the assessed schemes have adopted measures to reduce it. Basis risk arises due to several reasons such as product and contract design or basis and spatial criteria. Responses to some of those difficulties include, for instance, the Aggregate Deductible Cover (ADC) by CCRIF SPC, the recalculation mechanism by PCRAFI, the Basis Risk Fund by R4 and the continuous improvement of indices by ARC, as well as by all other schemes. Further developing these measures, as well as increasing the accessibility of better resolution satellite data are necessary steps to refine index insurance products and further increase the reliability of benefits. At the same time, however, more research is needed on measuring basis risk and the extent to which it can be reduced with the help of such approaches. Further technology advancements in artificial intelligence and data science could be an additional avenue to reach reduced levels of basis risk.

Additionally, it is plausible to assume that insurers also tend to slightly modify the payout and trigger level selection to achieve better pricing and increase product acceptance, which can further impact basis risk. This could be done to increase the competitiveness of the product, for example by selecting trigger levels in a way that ensures frequent payouts, for instance once a year, which could lead to basis risk in terms of a mismatch between the payout and the losses incurred. For such instances it would be advisable to limit the range of modifications of ideal scenarios to 20 per cent deviations from the actual trigger level in order to maintain the reliability of adequate benefits.

- *Persistency*

All analyzed macroinsurance schemes depict a high renewal rate, which shows the overall utility derived from CRI for transferring the residual risk. Remaining issues associated with the dissatisfaction of countries that had to suffer losses without receiving payouts, either because the trigger threshold was not reached or the cause of loss was not part of the coverage, can be successively resolved by improving product design like CCRIF-SPC has been doing with regards to its Aggregate Deductible Cover (ADC). For R4 no information on the renewal rate could be gathered.

Box 10: Caribbean Catastrophe Risk Insurance Facility (CCRIF SPC) – Caribbean (as of 2017/18)[39-54]

In 2007, Caribbean Catastrophe Risk Insurance Facility (CCRIF) was formed to solve the short-term liquidity problems of Caribbean governments in the aftermath of natural disasters. In 2014, CCRIF was converted into a segregated portfolio company (SPC) and was renamed CCRIF SPC. CCRIF recently expanded to include Central American countries and currently offers parametric earthquake (EQ), tropical cyclone (TC) and excess rainfall (XSR) policies to 17 member countries. CCRIF's coverage is customizable, with pricing partially based on the quantum of risk transferred (measured by expected loss and variability of those losses). CCRIF currently offers coverage limit of approximately US$ 100 million for each insured hazard per country per year for events that occur every five to 10 years or so (While TC and EQ have longer attachment periods, XSR coverage is typically for 1-in-5 year events), and provides larger payouts for larger events up to a limit in the 1-in-100- to 1-in-200-year range. Earthquake policies tend to have less frequent trigger levels, while excess rainfall policies have more frequent trigger levels, though generally transfer a smaller quantum of risk.

In 2015, CCRIF expanded to Central America to provide catastrophe insurance to Central American countries. Nicaragua is the only participating country to date. Due to its recent membership, Nicaragua is not included in the analysis below.[e]

Effectiveness

- **Benefit of insurance: Cumulative claim payout, Adequacy ratio and Loss ratio**: As of mid-2018, the facility has made 34 payouts for hurricanes, earthquakes and excess rainfall totaling almost US$ 128.4 million to 12 member governments. In the past, countries have used CCRIF funds to provide food, shelter and medicines to affected persons; pay government salaries right after an event disrupted normal operations, repair infrastructure, including bridges and roads, supplement the general budget and institute risk reduction measures to increase their countries' resilience. The long-term loss ratio is balanced at 55.8 per cent.
- **Basis risk**: Several times during disaster events, policies did not trigger owing to the policy parameters selected by the insured country. CCRIF SPC has now introduced the Aggregated Deductible Cover (ADC), which can provide a minimum payment for events that are not sufficient to trigger a CCRIF policy, but losses on the ground can be identified. In effect, the ADC intends to reduce

[e] Note that Nicaragua has paid a cumulative premium of US$3.3 million (Considering the aggregation from 2015 to 2017-18) policies and received benefits worth US$1.6 million for two events, within 14 days after the event.

the basis risk inherent in parametric insurance in which some events are missed or not identified. Actual basis risk could not be measured during the research. The ADC is available only for TC and EQ policies for Caribbean members.

- **Persistency**: For the first time, The Bahamas and Bermuda did not participate in the risk pool in 2016, while a total of 14 Caribbean countries participated that year. The renewal rate was 87 per cent for 2016. However, The Bahamas participated in the pool in 2017, bringing the number of participating members to 15 (or 94 per cent of the total Caribbean membership).

Cost Efficiency

- **Cost of insurance, premium rate and aggregate coverage limit**: To date, a total of approximately US$ 233.3 million is paid in the form of premiums by all participating Caribbean countries. The average aggregate coverage limit offered is US$ 630 million. On average, the premium rate is 3.41 per cent of the aggregate coverage limit, thus depicting a low premium rate.
- **Premium multiple**: The long term premium multiple is slightly on the higher side at 1.8 but as CCRIF covers only high severity risks, it is assumed to still be lower than the premium multiple of other adaptation measures that would be needed to address such high risk. CCRIF has also lowered the long-term premium pricing metric and used short-term premium discounting to maintain participation and provide best value to its client countries.
- **Policyholder expense ratio**: This being a macroinsurance scheme, the policyholder expenses are not a major cause of concern for the governments. However, no information on any expenses to be borne by the final beneficiary could be found during the research.
- **Insurance penetration**: A total of 16 Caribbean countries have joined the facility, of which 15 are participating in the pool (as of mid-2018). The participation is adequate to actualize the benefits of pooling. For CCRIF, the premium is reduced by up to half, as compared to what a country would pay for individual insurance. CCRIF is backed by donor funds held by the World Bank in a multi-donor trust fund. When it is efficient to do so, CCRIF utilizes the international reinsurance markets to leverage its own capital to provide much greater aggregate coverage than would be possible.

Speed of Disbursement

- **Claim processing time**: All payouts were transferred to respective governments within 14 days (and in some cases within a week) after the event, thus facilitating immediate liquidity after disaster and fulfilling the goal of CCRIF.

- **Payout turnaround time**: CCRIF SPC directly pays out to the governments for further use. Hence, payout turnaround time cannot be calculated.

3.2. Cost efficiency

- *Long term premium multiple*

In the long term, index insurance should ideally have a premium multiple of 1.3 – 1.6 or lower to be cost efficient in comparison to other risk financing instruments[23]. The long term premium multiple for ARC and CCRIF SPC is optimal at 1.55 and 1.8 respectively, to obtain the insurance benefits at reasonable costs and their cost-effective realization. On the contrary, the premium multiple for PCRAFI stands very high at 3, signaling that it would be cost effective only for very high severity risks for which other risk financing and risk adaptation measures might be even more costly. Given that PCRAFI is still nascent, and that meaningful analysis of the premium multiple or loss ratio requires schemes to be running for at least eight to 12 years, one can, however, plausibly expect that this might improve over time. As stated before, this analysis is just illustrative and no final conclusion for any nascent or younger schemes such as PCRAFI and ARC can or should be drawn from it.

- *Premium rate (here: Premium to coverage limit ratio)*

ARC's premium rate, standing at 13 per cent, is higher than that of the other macro schemes, with CCRIF SPC displaying the lowest premium rate at 3.4 per cent and PCRAFI one of 4.2 per cent. The lower premium rates of CCRIF SPC and PCRAFI indicate that providing risk coverage only for high severity, lower frequency risks and achieving economies of scale through risk diversification (by CCRIF SPC) have enabled lower premium price offerings, which translate into lower premium rates. At the same time, however, the moderate frequency risk coverage provided by ARC justifies the higher premium prices charged by it and hence ARC's higher premium rate. Generally, for a well-diversified risk pool, a premium rate of 5 per cent and lower would be ideal. In this respect, it might be advisable for ARC and PCRAFI to increase their respective risk spreads, while maturing over time to minimize the costs of maximum protection.

In contrast to the macro schemes, R4 shows a substantially high premium rate of 22 per cent. Even in light of the high risk levels micro schemes are often confronted with and the thereof resulting higher pure risk costs, this premium rate is very high. Generally, it is plausible to assume that a premium rate of 10 per cent or higher is very high for a micro scheme such as R4, which is designed for population segments from lower income strata. In light of this, R4's premium rate signals the urgent need for better risk diversification, while taking into account that the options for risk spreading for micro-schemes are more limited than for macro-schemes, so that additional measures to minimize coverage costs, such as premium support or better risk layering, might be essential as well.

- *Policyholder Expense ratio*

Unfortunately, no comprehensive information on policyholder expenses could be found as part of the research for this paper. It was, however, possible to extract pieces of information, for example on the operating efficiency of insurance schemes, which also hints at their cost efficiency. The World Bank estimates the average operating cost of sovereign risk pools to be around 10 per cent of their annual premium income (when in full operation) and higher during the first years of operation (World Bank DFRI, 2017). For ARC, which used 8 per cent of the collected premiums for their administration/operating costs until December 2015, and CCRIF, which continues adhering to its mandate of keeping the recurring administration costs below 5 per cent, this indicates that parts of the risk pools' transaction costs are favorable for a cost-efficient performance. Apart from that, more information on other components of (indirect) policyholder expenses, such as other transaction costs, opportunity costs and prevented mitigation costs, could not be found or was beyond the scope of this paper. For PCRAFI and R4 no information could be found.

- *Penetration*

CCRIF SPC has achieved a very good penetration in the region with 17 countries out of 20 participating in the sovereign risk pool (17 countries out of 20 countries that have ratified CCRIF are policyholders). This has also enabled greater risk diversification and hence a lower premium rate. For ARC and PCRAFI, however, penetration is on the lower side, with ARC having six out of 18 countries participating (6 out of 18 countries that have ratified the treaty) and PCRAFI six out of 15 (6 out of 15 countries eligible for PCRAFI coverage). R4 has continuously added members since its inception and expanded to five countries, but the participation is still too low to fully actualize the benefits of risk diversification and pooling. As the example of CCRIF indicates, achieving increased penetration by increased participation along with the thereby improved possibilities to diversify risks across geographies and perils can majorly facilitate attaining cost-efficiency.

Box 11: Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) – Pacific region[23]

The PCRAFI Insurance program was launched on January 17, 2013 and designed to provide the Pacific Island Countries (PICs) with parametric insurance as a mechanism for rapid response financing through immediate injection of cash following a major tropical cyclone and/or earthquake/tsunami. The five PICs currently involved in the Pacific Disaster Risk Financing and Insurance (DRFI) Program, are in the top 30 countries most vulnerable to natural disasters, ranked according to annual expected GDP losses due to natural disasters – the Cook Islands (2 per cent), the Marshall Islands (2.1 per cent), Samoa (1.2 per cent), the Solomon Islands (3.1 per cent), Tonga (4.4 per cent), and Vanuatu (6.6 per cent).

Effectiveness

- **Benefit of insurance, Cumulative claim payout, Adequacy ratio and Loss ratio**: Since its inception the PCRAFI insurance portfolio has made two payouts for an aggregate amount of US$ 3.2 million. The funds were mainly used to bring nurses to the affected areas to provide emergency care and purchase fuel for boats bringing emergency goods to the affected islands. The long-term loss ratio is low at 33.33 per cent. However, PCRAFI also operates on mutual principles with the underwriting benefit being used to accumulate capital to ultimately benefit the premium paying clients.
- **Basis risk**: In order to minimize basis risk, either participating countries or the World Bank can initiate a calculation process after a disaster. Also, due to the dynamic nature of hazards, a recalculation mechanism was built in to capture the updated hazard parameters.
- **Persistency**: The Solomon Islands received no payment after the March 2014 flooding which killed 22 people and left 10,000 homeless, with losses of more than US$ 100 million (9.2 per cent of GDP). This was owed to the circumstance that pure flood events were not part of the coverage. In response, the Solomon Islands government quit the scheme. The five remaining countries have since then renewed their policies yearly, resulting in a renewal rate of 100 per cent for 2016/17.

Cost Efficiency

- **Cost of insurance, premium rate and aggregate coverage limit**: As of 2017, US$ 9.6 million in total have been paid by all the participating countries in the form of premiums; the aggregate coverage limit offered is US$ 47.2 million. On average the premium rate is 4.21 per cent of the aggregate coverage limit, signifying a lower optimal premium.

- **Premium multiple**: The long term premium multiple is somewhat on the higher end, standing at 3, but makes insurance still a feasible instrument for protection from high severity events. This is because in comparison to the smaller-sized emergency reserve provisions of PICs, insurance can deliver larger payments and hence protection in case such events materialize.
- **Policyholder expense ratio**: This being a macroinsurance scheme, policyholder expenses are not a major cause of concern for the governments. However, no information on any expenses to be transferred to and borne by the final beneficiary could be found during the research.
- **Insurance penetration**: In total, 15 PICs are eligible for coverage, of which 6 have participated till date. Yet, until now the participation is too low to fully actualize the cost benefit s of risk pooling.

Speed of Disbursement

- **Claim processing time**: Both payouts were made in a period of 10 days following the event, thus providing governments with immediate liquidity to cover disaster relief expenditure.
- **Payout turnaround time**: PCRAFI directly pays out to the governments for further use. Hence, payout turnaround time cannot be calculated.

3.3 Speed of disbursement

- *Claim processing time*

For CCRIF SPC and PCRAFI, claim payouts are processed within 10 to 15 days after the index is triggered (CCRIF SPC: 14 days, PCRAFI: 10 days), and hence fulfill the objective of providing immediate liquidity to governments post disaster. In the case of these two schemes, this demonstrates the efficiency of index insurance mechanisms in delivering timely claims payouts to beneficiaries. Unfortunately, in the case of ARC this statement cannot be confirmed yet, where three out of four claim payments failed to meet ARC's objective for the payouts to reach beneficiaries (not governments, as is the case for e.g. CCRIF SPC and PCRAFI) over a time period of 120 days post disaster[27]. It is therefore plausible to assume that the impact the insurance payouts could have produced, had they reached the beneficiaries in time, was unfortunately less protective than it could have been. For R4, claim processing time could not be found during research.

- *Payout turnaround time*

The payouts disbursed by CCRIF SPC and PCRAFI are directly utilized by governments for relief work[f], while the ARC payouts made to respective governments are further distributed to end beneficiaries. As stated before within the assessment of CCRIF-SPC and PCRAFI, in contrast to ARC, governments are contractually envisioned as recipients of the payouts, which is why the time taken for CCRIF and PCRAFI payouts to reach the end beneficiaries is not relevant as it is for ARC when considering their respective turnaround times. Yet, while this subject matter is outside the scope of the respective insurance contracts, further research into the time taken for CCRIF-SPC and PCRAFI payouts to reach the final beneficiaries, as well as insights into the utilization of payouts, is a major interest to donor countries and civil society, and could have substantial benefits for increasing the impact and effectiveness of CRI.[55]

Box 12: R4 Initiative – Ethiopia, Senegal, Malawi, Zambia and Kenya[56,57,58]

The R4 Rural Resilience Initiative (R4) was launched in 2011, to enable vulnerable rural households to increase their food and income security in the face of increasing climate risks. R4 builds on the initial success of the Horn of Africa Risk Transfer for Adaptation (HARITA) initiative, pioneered in Ethiopia. Currently, R4 operates in Ethiopia, Senegal, Malawi, Zambia and Kenya, and reaches 57,000 vulnerable farmers and their families with an integrated risk management strategy, combining four risk management components: improved resource management through asset creation (risk reduction), insurance (risk transfer), livelihood diversification and microcredit (prudent risk taking), and savings (risk reserves). Assets are built through risk reduction activities.

R4 is a pioneer in enabling comprehensive climate risk management. In Ethiopia, Malawi and Senegal, Insurance for Assets (IFA) activities have contributed to natural resource rehabilitation and agricultural development. In Zambia, participation in the IFA scheme allows farmers to learn and apply conservation agriculture (CA) techniques to improve their agricultural productivity and sustainability. The R4 Initiative also facilitates access to credit at better rates, with insurance serving as collateral. In 2016, 13,275 people were able to access loans amounting to US$ 318,169 in total. In Ethiopia and Senegal US$ 78,398 have been mobilized under the revolving fund. In Zambia, 2835 farmers accessed input credit from the Vision Fund in the form of seeds and fertilizer. Participants establish small-scale savings, which are used to build risk reserves. Members saved a total of US$ 30,3524 in their respective savings groups and accessed loans amounting to US$ 223,722. To ensure long-term sustainability, R4 contributes to the creation of rural

[f] A small portion of CCRIF funds are provided to direct beneficiaries as well.

financial markets by building local capacity and gradually transitioning farmers to paying insurance premiums in cash.

Effectiveness

- Benefit of insurance, Cumulative claim payout, Adequacy ratio and Loss ratio: Until mid-2018, R4 has made an aggregate insurance payout worth of US$ 2.4 million (for coverage bought for 2017). The long term loss ratio is 72 per cent. In 2017, it went up to 136 per cent, in 2016 to 125 per cent, and to 118 per cent in 2012 respectively, which were extreme loss years.
- Basis risk: To minimize basis risk, R4 has developed a basis risk fund mechanism in each country, which provides payouts in case of discrepancy between actual loss and loss estimates as calculated by indices. In order to avoid distrust among farmers due to basis risk, R4 is also continuously improving the indices, strengthening the risk reserves component as a buffer for non-catastrophic events, and improving farmers' understanding of indices and trade-offs of insurance products.
- Persistency: No information regarding renewals by farmers could be found during the research.

Cost Efficiency

- Cost of insurance, premium rate and aggregate coverage limit: To date, a total of US$ 3.4 million has been paid by all the policyholders in the form of premiums. The average aggregate coverage limit offered is US$ 2.1 million. The average premium rate is high at 22 per cent for a non-commercial scheme, but keeps on gradually decreasing as more farmers and countries participate in the scheme over the years. Participants also have the option to pay insurance premiums through the insurance for assets (IFA) scheme that engages them in risk reduction activities. Assets built, or rehabilitated through these activities (such as water and soil conservation infrastructure), promote resilience by steadily decreasing vulnerability to climate risks.
- Premium multiple: The long term premium multiple is 1.4.
- Policyholder expense ratio: No information on any expenses transferred to and borne by policyholders could be found during the research.
- Insurance penetration: Overall, more than 57000 farmers from five different countries participated directly in R4, while over 200,000 people benefit from its comprehensive risk management approach.

Speed of Disbursement

- Claim processing time and payout turnaround time do not differ for a microinsurance scheme as the policyholder and end beneficiary are same. However, no information for speed of disbursement could be found during the research.

3.4. Summary of framework application

As we have stated throughout this analysis, several components of cost-effectiveness could not be measured exhaustively. For effectiveness, this includes the adequacy of benefits and basis risk. Yet, in conjunction with the loss ratio, which should be monitored on a long-term basis (7-10 years), the performance indicators used so far have provided some early signals on the adequacy, reliability and persistency of insurance payouts, and thus should be monitored on a regular basis. In terms of cost-efficiency, we have demonstrated how the diversification of losses, penetration and policy holder expense ratio, as well as the operational efficiency of an insurance scheme, can be major factors to assess and optimize the premium charge. They too should be monitored on a regular basis to track the cost efficiency of a scheme, while the premium multiple is best monitored on a long term basis (7-10 years). Finally, the claims processing and payout turnaround time should be monitored closely to ensure that benefits reach the beneficiaries in time, so as to realize the fullest potential CRI protection has to offer.

4. Recommendations and Way Forward

The following chapter concludes by outlining some of the recommendations that can be made based on the illustrative application and analysis formulated in the previous chapter. While these recommendations are by no means exhaustive, they can be taken up by multiple stakeholders involved with the design of CRI mechanisms. Going forward, we hope that these recommendations – grouped by the need to address remaining stumbling blocks, product innovation and research –will help to further promote the cost-effectiveness of CRI.

4.1 Performance

The cost effectiveness performance of the analyzed CRI schemes is largely within reasonable bounds. Even though the schemes may not have proven to be constantly cost effective – especially during their initial years when they were still building financial and operational capacity –, the schemes have become increasingly stable while maturing over time. This shows the viability of CRI as a risk financing solution for extreme weather events. Additionally, when reflecting upon the pros and cons of different risk financing options, parametric insurance schemes have the potential to offer several additional as well as unique and non-quantifiable benefits, which (see Box 3) also deserve consideration during decision-making processes.

4.2. Addressing remaining stumbling blocks

Climate risk insurance solutions could attain further cost effectiveness and deliver increased value to clients by:

- **Integrating disaster risk management:** Integrating disaster risk management (DRM) into climate risk insurance contracts could mandate policyholders to implement risk reduction activities beforehand and to reinvest certain percentages of the insurance payouts in risk reduction activities to increase benefits over the long term. This would ensure that the premium spent on insurance as well as on its indirect costs, especially on prevented risk mitigation costs, are well utilized. This also applies for indemnity-based insurance schemes. In order to realize the full potential of integrated DRM, integrating disaster risk management into indemnity based and area yield index insurance is viable as loss/risk assessment are done at the time of a claim. However, more research is needed on how DRM can be aligned with weather index insurance products, where there is no risk assessment prior to purchasing insurance or after a triggered event.
- **Holistic risk coverage for micro schemes:** As microinsurance schemes are designed to directly benefit modest and low income population segments that have limited access to insurance, providing CRI together with additional coverage/extensions for other prominent causes of loss (like pests, diseases, etc. for agriculture insurance or individual health/life insurance) could offer a more reliable and holistic solution. Additionally, it would also help to build resilience across sectors and wellbeing dimensions affected by climate change. Respective governments could consider providing premium support for such holistic solutions to make them affordable for their target groups.

- **Product pricing:** Premium financing is a major concern for modest income countries and vulnerable individuals who are often unable to buy adequate insurance coverage. This circumstance is aggravated especially through climate change, where the pure risk premium per se is already higher for poorer population segments, since these usually live in highly vulnerable regions. Smart premium support is therefore essential for providing affordable CRI solutions.[59] Insurers moreover need to continuously improve products and processes to provide maximum benefits and client value at least possible costs. The client value of a microinsurance product can, for instance, be augmented by ensuring access to credit and providing technical advice.
- **Regulation**: The establishment of and adherence to consumer protection regulations are crucial for building a trustworthy and long lasting insurance environment in countries aiming to implement any insurance solution. With regards to increasing the momentum and uptake around schemes providing holistic risk coverage, regulations concerning premium support and the exemption of value added taxes could make these schemes more affordable. Timely regulations for mobile insurance solutions could also enable insurance access for financially underserved populations.

  A further issue which gains increasing importance is transparency, especially for those schemes operating internationally under the eyes of many stakeholders. This includes the voluntary provision and communication of information regarding capital structure, financial capacity, and product performance as well as the compliance with international reporting standards.
- **Technology:** Technology is the key enabler for weather index based insurance solutions. More accurate weather data from satellites is crucial for further reducing basis risk. Apart from that, new technologies like data science and artificial intelligence could also significantly help build better models and considerably reduce basis risk. Adapting block chain technology could furthermore increase the speed of disbursement, cost-efficiency and transparency, thereby building the trust of costumers. For the provision of cost-effective solutions, it is therefore essential for insurers to keep up with technology advancements.

4.3. Product innovation

Supplementing parametric risk insurance with appropriate alternatives of cheaper risk financing mechanisms for covering residual risks could provide additional cost effectiveness. In terms of increasing product affordability, cost-effectiveness and sustainability, more research is needed on innovative risk models for insurance schemes designed for vulnerable populations. Some exemplary innovative risk models in the insurance space entail:

- **Residual risk layering and risk pooling**: The residual risk layer covered by insurance could be further divided as per increasing risk severity and decreasing risk frequency into lower, middle and top layer. Risk layers pooled amongst countries could cover the frequent, lower intensity events; reinsurance solutions could be applied for the middle layer of residual risk; followed by other financing mechanisms e.g. CAT bonds for covering the top layer. CCRIF SPC successfully applies such a model to provide fairly priced coverage to its member countries. A similar approach could also be applied to microinsurance schemes by pooling the retained risks arising from frequent, lower severity risks across communities/members; followed by insurance/reinsurance coverage for middle layer; and government support/alternative financing for the top layer.
- **Inter-regional climate risk pooling**: This could be another alternative for countries to share climate risk, as this would ensure losses are well diversified across geographies/regions as well as perils. Placing such diversified risks on the international market could help the pool to achieve more holistic and cost efficient solutions.
- **Peer-to-peer insurance**: The upcoming peer-to-peer insurance schemes (where policyholders can form their own pool of members to share risks) also have the potential to offer cheaper risk transfer mechanisms. When there are no, or low claims made to the pool, policyholders receive their entire or certain percentages of their previously paid premiums back, thereby reducing the overall costs of insurance. In the case of indemnity and area yield insurance, such a mechanism could provide added benefit to its members by incentivizing risk prevention and risk reduction measures to maintain the no/low claims record.

4.4. Expanding the cost effectiveness debate further through research

While this paper aimed to develop a comprehensive MCCEA framework to illuminate the cost-effectiveness of CRI products, knowledge gaps requiring further research and development of methodologies remain. Such additional work will also help to increase the cost-effectiveness of insurance by demonstrating room for product improvement. In addition to further refining this framework, research into expanding it should also be conducted so as to allow for better comparability across similar insurance schemes. Likewise, additional work on integrating the framework into other assessment approaches is needed to enable the consideration and comparison of different combinations of CDRF instruments, including insurance and DRR measures.

- **Evaluation and integration of intangible, non-monetary benefits**: So far, evidence on the resilience impact enabled and provided through climate risk insurance schemes remains low and mostly qualitative. As many advocates from civil society organizations keep pointing out, further research on the benefits, especially the intangible, non-monetary development benefits, such as improved protection from disasters through risk mitigation measures, livelihood diversification, education undisrupted by climate impacts, decreased discrimination among gender, improvements achieved for marginalized groups via inclusive approaches, as well as spill-over effects arising from e.g. strengthened and expanded financial infrastructure, and higher income and livelihood security due to better credit access, is needed. Such research should furthermore aim for results formalized through rigorous metrics to allow for integration into the MCCEA framework to increase the informative value of the assessment and – where applicable – comparability.
- **Measuring basis risk**: Measuring basis risk is essential to designing accurate and reliable parametric insurance products. So far, however, substantial gaps regarding the research on quantifying basis risk for different parametric insurance products remain. Here, work should center on quantifying basis risk for different parametric products and trigger calculation methodologies to help identify the most accurate methodologies. Additionally, determining how much basis risk can be mitigated by corresponding reduction measures can advance the promotion and adoption of best practices among decision makers.
- **Enable measurement of payout turnaround time via development of tracking tools for payout utilization:** Further research and development of methodologies allowing tracking the use of payouts once disbursed to governments with the purpose of satisfying their immediate liquidity needs would be crucial to acquire further insight into payout turnaround times. This would also serve to illuminate potential shortcomings or benefits regarding cost-effective regime and/or product design. More specifically, such tracking tools would allow identifying potential barriers to speedy and cost-effective payout usage, and thus highlight areas where either one or the other – less flexible rules of payout usage prior to disasters or more flexibility for using payouts during disaster – would be needed. Product and contract design could be adapted accordingly, for example by integrating the preparation of payout disbursement plans as an eligibility requirement for insurance access. To allow for sufficient flexibility, such plans could furthermore give room for deviation where the need

for it can be expected by indicating, for instance, a ranking of channels that might be used to direct payouts to more urgent causes, instead of the previously indicated ones. Similar tracking tools and improvement potentials could also be considered in the context of other indirect schemes, such as ARC, where payouts are distributed via targeted distribution channels, such as social safety nets.

- **Identify and add financial performance indicators to allow for better comparison across similar insurance schemes:** As highlighted when pointing out the limitations of our assessment framework, further expansion to include additional financial performance indicators would be needed to improve its applicability for comparing performance across insurance schemes.
- **Integrate the developed MCCEA framework into, and expand, other approaches to allow for comparison across different mixes of CDRF instruments and insurance:** As stated at the outset of this paper, this framework focused particularly on the cost-effective performance of CRI approaches and is not feasible for comparing across different CDRF tools. Furthermore, it was also mentioned that the most sensible comparison is not between different CDRF instruments, but between different combinations of differently modified CDRF instruments (according to the frequency and severity of the impact, e.g. contingent credit lines, insurance) and disaster risk reduction measures to evaluate the mix that constitutes the most cost-effective response arrangement. This is because CDRF instruments can leverage each other's costs and effectiveness; using and consequently comparing instruments in isolation is less feasible since higher costs are usually implied for standalone instruments. To facilitate such comparison, further research would be needed to integrate the here developed framework into already existing approaches, such as the Economics of Climate Adaptation (ECA) Framework[60], as well as expand the scope of such approaches to also include the assessment of other CDRF instruments. More specifically, further work around assessing the cost-effectiveness of CRI approaches could focus on three areas: (1) developing similar cost-effectiveness assessment frameworks for other CDRF instruments; (2) harmonizing these frameworks to enhance comparability between CDRF instruments and insurance; and (3) integrating said harmonized frameworks into other approaches to allow for a comprehensive assessment and comparison across different CDRF mixes, including insurance.

5. Annex

ARC - Summary of annual portfolio (As of 2017)

Drivers	Insurance Pool	Total/ Cumulative to date	2016/17	2015/16	2014/15
	Type of insurance	Modeled loss parametric, Pan Africa risk pooling disaster response system			
	Perils covered	Drought, Flood and Cyclone			
	Participating countries	32 eligible countries[g], 8 participate/d till date	Burkina Faso, The Gambia, Mali, Mauritania, Niger, Senegal	The Gambia, Kenya, Malawi, Mali, Mauritania, Niger, Senegal	Kenya, Mauritania, Niger, Senegal
	Aggregate coverage limit (US$ million)	134 (Average)	95	178	129
Benefit of insurance	Aggregate insurance payout (US$ million)	34.4	0	8.1[h]	26.3
Benefit to cost ratio	Loss ratio (%)	64.54%	-	32.8%	154.7%
Insurance penetration	Percentage of countries participated to eligible countries	25%	19%	22%	13%
Persistency	Renewal rate (%)	-	71.42%	100%	-

[g] "Eligible countries" refers to the 32 countries that have signed the ARC treaty.
[h] Payout was made with delay in 2017, but fell under coverage from 2015/16.

Cost of insurance	Aggregate premium paid (US$ million)	53.3	11.3	24.7	17
Premium rate	Premium rate (%)	13%	11.9%	13.87%	13.18%
Cost to benefit ratio	Premium multiple (ratio)	1.55	-	3.05	0.65
Speed of disbursement	Claim processing time	The payout turnaround time of 120 days has been missed for 3 out of 4 payouts			
	Payout process	Self-certification of loss required and certified contingency plan required before payout is made. Payout calculated within 10 days of end of risk period (for drought), 7 days for TC/FL.			
	Reinsurance summary	Traditional multi-peril reinsurance agreement with 24 participants. 41% of aggregate limit reinsured in 2016/17.			

CCRIF SPC - Summary of annual portfolio (As of mid-2018)

Driver	Insurance Pool	Cumulative to date	2017/18	2016/17	2015/16	2014/15	2013/14	2012/13	2011/12	2010/11	2009/10	2008/09	2007/08	Cumulative to date	2017/18	2016/17	2015/16
			Caribbean												Central America		
	Type of Insurance	Modeled loss parametric, Multi-country risk pool regional catastrophe fund															
	Perils Covered	Earthquake, Tropical cyclone, Excess rainfall															
	Participating Countries	20 eligible[j], 16 partici-pate/d[k]	The Bahamas returned	The Bahamas, Bermuda left	Anguilla, Antigua and Barbuda, The Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Dominica, Grenada, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, Turks and Caicos Islands									7 eligible, 1 partici-pated[l]	Nicaragua		
	Aggregate coverage limit (US$ million)	630 (Average)	754	697	723	653	620	625	625	620	600	560	450	27.2 (Average)	35.3	28.2	18
Benefit of Insurance	Aggregate Insurance Payout (US$ million)	128.4	61.4[m]	29.4	2.4	3.4	0	0	0	24.9	0	6.3	0.9	1.6	0	1.6	0
Benefit to cost ratio	Loss ratio (%)	55%	216.96%	138.03%	14.28%	14.72%	-	-	-	119.7%	-	28.63%	4.5%	30.18%	-	106%	-
Persistency	Renewal rate (%)[n]	-	94%	88%	100%	100%	100%	100%	100%	100%	100%	100%	-	-	100%	100%	-
Cost of Insurance	Aggregate Premium paid (US$ million)	233.3	28.3	21.3	16.8	23.1	19.5	20	20	20.8	21.5	22	20	5.3	2.3	1.5	1.5
Premium rate	Premium rate (%)	3.41%	3.75%	3.06%	2.32%	3.54%	3.15%	3.2%	3.2%	3.35%	3.58%	3.93%	4.44%	6.72%	6.51%	5.32%	8.33%

Cost to benefit ratio	Premium multiple (ratio)	1.8	0.46	0.72	7	6.8	-	-	-	0.84	-	3.49	22.22	3.31	-	0.94	-
Insurance penetration	% of participa-ting to eligible countries	80%	75%	70%	80%	80%	80%	80%	80%	80%	80%	80%	80%	14%	14%	14%	14%
Claim processing time	Claim processing time	All payouts made within 14 days															
	Payout process	Self-certification of loss required. Initial estimate in 3-5 days, payout made after 14 days.															
	Reinsurance Summary	Panel of traditional reinsurers and capital market via World Bank CAT Bond. 25% of aggregate limit reinsured in 2016/17.												Traditional reinsurers and capital market via World Bank CAT Bond. 66% of aggregate limit reinsured in 2016/17.			

[j] "Eligible countries" refers to CARICOM member states and associate members for the Caribbean.

[k] Three additional countries have joined the pool in 2018, but for the purpose of this report we have only considered the data until 2017. Central America is considered as a separate risk pool.

[l] "Eligible countries" refers to COSEFIN member states for Latin America.

[m] Not including payouts made under the newly introduced Aggregated Deductible Cover (ADC), US$ 608.550.

[n] As measured by the number of member countries with policies.

PCRAFI - Summary of annual portfolio (As of 2017)

Driver	Insurance Pool	Cumulative to date	2016/17	2015/16	2014/15	2013/14	2012/13
	Type of Insurance	Modeled loss parametric, Market based sovereign risk insurance scheme					
	Perils covered	Tropical cyclones and earthquake/ tsunamis					
	Participating Countries	15 eligible[o], 6 countries participate/d	All are the same except Solomon Islands left and Cook Islands joined for 2014/15				Marshall Islands, Samoa, Solomon Islands, Tonga, Vanuatu
	Aggregate coverage limit (US$ million)	47.2 (Average)	38	43	43	67	45
Benefit of Insurance	Aggregate Insurance Payout (US$ million)	3.2	0	1.9	1.3	0	0
Benefit to cost ratio	Loss ratio (%)	33.33%	-	82.6%	100%	-	-
Persistency	Renewal rate (%)	-	100%	100%	80%	100%	-
Cost of Insurance	Aggregate Premium paid (US$ million)	9.6	2.3	2.3	1.3	2.2	1.5
Cost to benefit ratio	Premium multiple (ratio)	3	-	1.21	1	-	-
Insurance Penetration	Countries participated	33.34%	33.34%	33.34%	33.34%	33.34%	33.34%
Premium rate	Premium rate (%)	4.21%	6.05%	5.35%	3.02%	3.28%	3.33%
Claim processing time	Claim processing time	All payouts made within 10 days					

[o] "Eligible countries" refers to the 15 Pacific Islands Countries (PICs).

Payout process	Countries may give notice of applicable event to World Bank, following which calculation agent is notified to produce calculation report. The loss is then self-certified by countries.
Reinsurance Summary	Panel of 5 reinsurers. 90% of aggregate limit reinsured in 2016/17.

R4 Initiative - Summary of annual portfolio (As of 2017)

Driver	Insurance Pool	Cumulative to date	2017	2016	2015	2014	2013	2012	2011	2010	2009
	Type of Insurance	Modeled loss hybrid index									
	Perils Covered	Drought, dry spells									
	Participating Countries	5 countries participate/d	As per 2016 plus Kenya	Ethiopia, Malawi, Senegal, Zambia		Ethiopia, Senegal			Ethiopia		
	Aggregate coverage limit (US$ m)	2.1 (Average)	6.6	5.1	2.2	1.5	1.2	1.3	0.94	0.07	0.01
Benefit of Insurance	Aggregate Insurance Payout (US$ m)	2.4	1.5	0.073	0.45	0.038	0.027	0.32	0.017	-	-
Benefit to cost ratio	Loss ratio (%)	72% (average)	136%	9.35%	125%	12.67	9.64%	118.51%	7.72%	-	-
Premium rate	Premium rate (%)	22% (average)	16.67%	15.29%	16.36%	20%	23.34 %	20.76%	23.4%	38.57%	25%
Cost of Insurance	Aggregate Premium paid (US$ m)	3.35	1.1	0.78	0.37	0.3	0.28	0.27	0.22	0.027	0.002 5
Cost to benefit ratio	Premium multiple	1.4	0.73	10.68	0.8	7.89	10.37	0.84	12.94	-	-
Insurance Penetration	Farmers participated		57625	41,971	32,193	26,132	20,465	19,407	13,000	1,300	200

Claim processing time	Claim processing time	No data found
	Payout process	No data found
	Reinsurance Summary	No data found

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About MCII

The Munich Climate Insurance Initiative was initiated as a charitable organisation by representatives of insurers, research institutes and NGOs in April 2005 in response to the growing realization that insurance solutions can play a role in adaptation to climate change, as suggested in the UN Framework Convention on Climate Change and the Kyoto Protocol. This initiative is hosted at the United Nations University Institute for Environment and Human Security (UNU-EHS). As a leading think tank on climate change and insurance, MCII is focused on developing solutions for the risks posed by climate change for the poorest and most vulnerable people in developing countries.

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