



# CLIMATE INSURANCE-LINKED RESILIENT INFRASTRUCTURE FINANCING

INSTRUMENT ANALYSIS  
SEPTEMBER 2022

# Climate Insurance-Linked Resilient Infrastructure Financing

*LAB INSTRUMENT ANALYSIS*

*September 2022*

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## DESCRIPTION & GOAL —

Climate Insurance-Linked Resilient Infrastructure Financing (CILRIF) is a long-term insurance solution for cities, deployed in tandem with an infrastructure financing facility, that creates financial incentives and capacity for municipalities to invest in resilient infrastructure.

## SECTORS —

- Climate Adaptation
- Urban Infrastructure

## FINANCE TARGET —

- International and domestic insurers
- Fund managers
- Impact investors
- Commercial banks
- Development finance institutions
- Philanthropic donors

## GEOGRAPHY —

For the pilot phase:

- Makati, Philippines
- Durban, South Africa
- Freetown, Sierra Leone

The Lab identifies, develops, and launches sustainable finance instruments that can drive billions to a low-carbon economy. The 2022 Lab cycle targets four thematic areas: sustainable food systems, nature-based solutions, zero-carbon buildings, and adaptation, in addition to three geographic regions: Brazil, India and Southern Africa.

## AUTHORS AND ACKNOWLEDGEMENTS

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## SUMMARY

Cities face increasing risks from extreme climate events, and those in developing markets have limited resources for pre- and post- disaster resiliency development. Climate insurance could substantially reduce the financial burden on these municipalities, but current insurance products are unaffordable, and cities lack the resources to implement resilient infrastructure that would reduce risks and make premiums more affordable.

Climate Insurance Linked Resilient Infrastructure Financing (CILRIF) is an initiative promoted by the United Nations Capital Development Fund (UNCDF) and institutions across the public and private sectors. CILRIF is a long-term insurance solution that incentivizes municipalities to invest in resilient infrastructure. CILRIF aims to enable cities to access affordable, long-term climate insurance with pre-arranged premiums – contingent upon the cities' commitment to invest in climate resiliency.

Assessed against the Lab criteria, CILRIF is:

- **Innovative:** CILRIF is a novel offering of 10-15-year municipal climate insurance backed by commercial and donor capital focused on longer time horizons than other products in the market and with a unique link to climate resilient infrastructure investment.
- **Catalytic:** A pilot at the scale envisioned could leverage approximately USD 80 million of private capital for climate resilient infrastructure for each city and would have structured insurance coverage with approximately USD 20-30 million premiums for each city for climate risk coverage.

There are financial sustainability and actionability pathways for CILRIF:

- **Financial Sustainability:** The instrument has an articulated strategy to allow insurers to create and diversify risk pools while engaging commercial capital, however affordability of the early-stage CILRIF insurance product is likely to be contingent on access to substantial concessional capital. At scale, CILRIF aims to balance the insurance risk pool by involving cities with varied risk profiles, and offering products across a set of specific climate risks that would leverage geographic and market diversity. The CILRIF implementation team aims to develop a set of proprietary pricing models that can also be used to tranche out different risks to insurers and reinsurers and house the residual risk at CILRIF.
- **Actionability:** The instrument is backed by a voluntary working group of decision makers and key stakeholders in municipal climate resilient infrastructure and insurance. To move towards implementation, UNCDF and partners must: 1) Confirm the viability of pilot cities selected, 2) further develop a governance structure for partnership among entities involved in the structuring of CILRIF, 3) identify a fund manager of the private facility to lead the implementation of the insurance and finance facilities and confirm that a single institution can execute both functions, 4) identify a workable and scalable financing approach for climate resilience infrastructure investment in each city, 5) identify the climate resilience interventions to be financed in each city and develop an approach to pricing insurance premiums and financing based on the interventions identified, 6) further develop an insurance product informed by the identified climate risk in each pilot city with a viable insurance licensing approach or approaches, and 6) identify equity stakeholders and investors into the financing and insurance facilities. This process is likely to take 2-3 years.

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## CONTEXT

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*Cities have limited financial resources and technical capacity to support pre-disaster resiliency development that would minimize the risks and costs of post-disaster recovery.*

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Cities in emerging markets face serious economic development challenges concurrent to increasing environmental risks, lacking critical financial and technical resources to address adaptation and resilience. For these cities, pre-disaster investment in climate resilience is usually limited given the existing fiscal and capacity constraints, lack of incentives, and investor bias towards mitigation projects. The lack of pre-disaster investment in resilience in turn increases cities vulnerability to climate-related disasters, exacerbating the need for post-disaster financing. Moreover, the national governments in many emerging markets cannot adequately assist municipal governments because of a range of limitations, including high indebtedness, non-investment grade sovereign credit ratings, and a lack of a robust financial infrastructure.

Insurance can play a crucial role in transferring and mitigating risk, and the benefits of climate-risk insurance for cities go beyond increasing post-disaster financial and fiscal resilience. Insurance can raise risk awareness, provide incentives for risk mitigation, and support economic growth and capital mobilization. Still, cities continue underutilizing insurance, with few including insurance components in their resilience strategies.

Increasing insurance penetration in cities has been a challenge. Climate insurance in its current form is a costly financing option that emerging market municipalities can rarely afford. It is short-term in nature and does not embed climate resilience mechanisms. The issues are compounded by cities' lack of insurance knowledge and training for government officials, limited data on existing risks and vulnerabilities, and other financial, regulatory, and political barriers.

## CONCEPT

### 1. INSTRUMENT MECHANICS

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*CILRIF will operate a climate risk insurance facility and infrastructure finance facility. Cities participating in CILRIF will have access to long-term climate insurance and will receive support to build resilient infrastructure through below-market rate financing. Insurance premiums will reduce commensurately to the increase in city resilience.*

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The primary objective of CILRIF is to strengthen the socioeconomic resilience to climate change and extreme weather events of cities, their communities, and individuals in developing countries and small-island states. The CILRIF initiative targets local governments, as ultimate key policymakers and stakeholders, and intends to:

1. Provide post-disaster liquidity in a timely manner through parametric insurance, and
2. Design and build resilient infrastructure to reduce the severity of climate-related weather events through a global infrastructure fund.

**Project Development Governance:** The development of CILRIF to date has been driven by the CILRIF Working Group<sup>1</sup> which is convened at the initiative of the UN Capital Development Fund (UNCDF), a special purpose fund of the United Nations mandated to provide capital and technical advisory services to the Least Developing Countries (LDCs). As part of its mission to support inclusive finance and local development, the UNCDF is committed to promoting climate resilience in urban areas.

The overall project management responsibility for development of CILRIF rests with UNCDF. CILRIF is expected to keep in regular contact with an implementation team (to be established with each city as they join CILRIF) and to monitor project progress, adherence to the workplan, and any significant planning or conceptual issues that may arise. UNCDF convenes regular working group sessions and one-on-ones with CILRIF partners as well as pilot city authorities, where project concerns are raised by the local implementation teams and recommendations are assembled on the future direction of the project.

UNCDF is also responsible for bringing in further thematic experts, recruited through its partner networks, to facilitate discussions and knowledge dissemination. CILRIF partners are expected to provide relevant subject matter expertise, whereas senior city officials, including budget committee, legal counsel, and environmental management, will be consulted with regard to the specificities of implementing the project in each location.

**Project Implementation Governance:** Following development of the CILRIF model conceptually, the implementation team will seek to pilot in several cities before scaling up to a larger suite of cities. To this end, UNCDF or a similar international entity would run the CILRIF Public Facility, while the Private Facility is envisioned to be housed in a private sector entity (please refer to Figure 1). UNCDF has not started the process of shortlisting public or private sector entities.

**Instrument Mechanics Overview:** The design of the CILRIF model is still under development. The preliminary expectation is to create a centralized financial structure ('CILRIF Private Facility') with an operator managing two separate components: an insurance facility and a financing facility, to be designed to prevent any conflicts of interest. The CILRIF Private Facility will house the residual risk from the insurance facility and the debt financing facility on its balance sheet. CILRIF is being housed in the same entity to ensure the benefits of pricing climate risk as well as building resiliency and purchase of insurance get translated into actual pricing and this entity is responsible for pricing both sides of the transaction- buying and selling of climate risk.

**Insurance Facility:** The CILRIF insurance facility will offer municipal governments a long-term climate insurance product (e.g., equal to or more than 10 years), featuring fixed premiums and coverage terms. This will provide municipal governments with critical post-disaster liquidity in the case of an event, as well as help streamline fiscal planning to free up additional resources required due to an extreme weather event.

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<sup>1</sup> Members of the CILRIF voluntary Working Group are: 1) Convener: UNCDF, 2) Insurance/reinsurance companies: AXA Climate & AXA XL, Munich Re, 3) Investment managers: Nuveen, Ontario Teachers' Pension Plan Board, 4) Development finance institutions: Swedish International Development Cooperation Agency (SIDA), UAE Ministry of Foreign Affairs and International Cooperation, US Agency for International Development (USAID), 5) Climate networks, experts, and consultancies: Climate Advisory LLC, ClimateWorks Foundation, Columbia University, C40 Cities, GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit, ICLEI, Milliman, Re:Focus Partners, 6) Structural engineering firms: Miyamoto International, 7) Pilot city administrations: Durban, South Africa, Freetown, Sierra Leone, Makati, Philippines.

CILRIF will own the municipal bonds for cities and carry out repricing of premiums after a resilience intervention is completed by the cities. CILRIF will pursue options for licensing operation which include engagement with implementers in-country who are able to deliver the CILRIF approach or use of alternative financial mechanisms to provide the insurance product.

- **Coverage:** Coverage will be on municipally owned assets and activities, related to one climate-risk (either heat or flood) depending on the climate risk context of the city.
- **Investment in adaptation yields impacts premium pricing:** CILRIF climate insurance policies will be contingent upon the city's commitment to invest in climate adaptation projects to enhance the resiliency features of critical urban infrastructure covered by the insurance policy. The technical committee of the central operator will work with cities on recommendations for effective resilient infrastructure interventions. In turn, the insurance product will be structured to reflect how these investments contribute to reducing risks. If the city successfully meets the adaptation infrastructure milestones provided in the insurance policy, the insurance premium will be reduced, which will result in cost savings that the city can leverage to promote additional adaptation measures.
- **Hybrid structure:** The facility will provide a hybrid parametric and indemnity product. The parametric coverage will provide immediate payout in the event of a climate shock to support liquidity of the city in response to the event. The parametric trigger(s) will be structured to reflect the physical impact of the climate shock (e.g., temperature threshold for heat or flood levels for flood).<sup>2</sup> The indemnity product will operate as a complementary component and is necessary to reflect the climate risk reduced by the municipalities' resilience intervention(s) in order to affect premium pricing decisions.<sup>3</sup>
- **Risk diversification.** As a pool of CILRIF cities is established, a risk analysis process will be carried out to tranche risks (A-C) based on climate, credit and tenure factors.

**Financing Facility:** The CILRIF infrastructure finance facility will be a commercial investment vehicle focused on financing resilient municipal infrastructure where a cities' access to finance through a facility is contingent on taking out a CILRIF insurance policy. The CILRIF implementing team will establish a global fund that will be able to directly invest in the resilience interventions identified as part of the insurance contract through project finance or municipal bond purchase.

The CILRIF Fund is targeting USD 800 million of commercial investment and USD 200 million in concessional investments. Concessional equity investors will receive repayment and returns after commercial investors. The Fund will target private investors (e.g. institutional investors such as pension funds, insurance companies, endowments, and foundations) for

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<sup>2</sup> As outlined in further detail in Section 4, flood risk coverage could cover, for example, flood damage to municipally owned roads, public transport, buildings, and water treatment facilities, while heat risk coverage could cover surplus costs associated with municipal energy, municipal health care, road damage, and municipal labor productivity.

<sup>3</sup> For example, if the climate risk covered is extreme heat, the parametric trigger could be a set number of days above a pre-determined temperature threshold, resulting in an immediate payout, while the indemnity payout could be linked to on the ground impacts of the heat event (e.g., hospitalizations from heat stroke or road buckling from high temperature) and therefore the probability of indemnity payouts could be linked to resilience interventions.

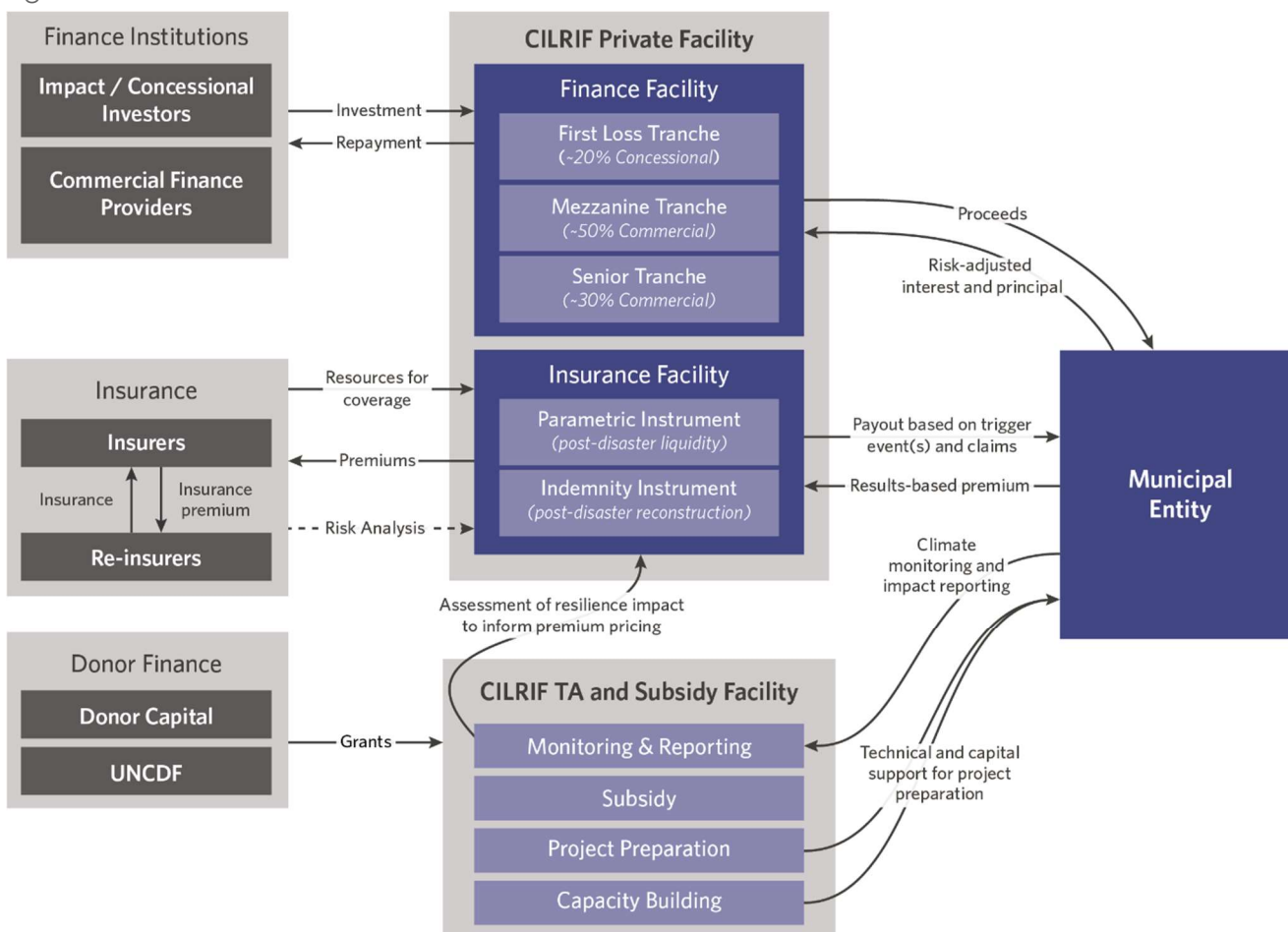


commercial investments, and public investors (e.g., multilateral, and bilateral development banks and government official development assistance agencies) for both non concessional and concessional investment and grants. Concessional and non-concessional public investment in the Fund will act as anchor capital that can “crowd-in” commercial private capital and allow the Fund to invest in municipalities in regions that would otherwise not have access to infrastructure finance.

Overall, the blended finance structure and distributed risk will help keep interest rates low for municipalities, while still providing market returns for senior tranche investors.

**The CILRIF TA and Subsidy Facility’:** A complementary facility will enable the provision of technical support to cities in developing countries through grants. This technical assistance will also support cities to secure funding for the proposed interventions, alongside the finance offered by the financing facility. The public facility will be used to provide TA but also play a role in supporting the CILRIF structure through subsidies or the flow of grant funding in the initial phase of CILRIF before the pool becomes sufficiently diversified.

Figure 1. Instrument Mechanics of CILRIF



A diverse set of stakeholders will be involved in the mechanics of CILRIF, as shown in Table 1.

Table 1. Key CILRIF Stakeholders and Relevant Implementation Strategy

Stakeholder	Involvement in implementation and strategy for engagement
Fund manager	A fund manager, to be identified, will manage an SPV that oversees all elements of the structure of the private CILRIF facility. The fund manager will direct operations of both the insurance facility and financing facility.

Municipal government	Target municipal governments will work with the CILRIF Private Facility to access financing for infrastructure (including building climate resilience) and to purchase the climate insurance product. The municipal entity will also work with the CILRIF Public Facility to develop a monitoring and reporting strategy related to the adaptation interventions that will inform premium pricing and interest rates on the debt finance.
Global and local insurers	Insurers will provide resources for coverage through the insurance facility brokered by the fund manager. They will support structuring the results-based premium linked to adaptation interventions financed via the debt facility.
Reinsurers	The CILRIF Private Facility will cede a portion of the risk held in the insurance facility to re-insurers.
Donors	Donor capital, including from UNCDF, will support the CILRIF Public Facility operations and may also flow into the first loss tranche of the finance facility.
DFIs	DFIs and other impact investors will invest in the first-loss tranche of the finance facility operated as part of the CILRIF Private Facility.

## 2. INNOVATION

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*CILRIF is a novel offering of discounted municipal climate insurance, made possible by using longer time horizons than other climate risk products in the market and with a unique link to climate resilient infrastructure investment.*

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### 2.1 BARRIERS ADDRESSED

**CILRIF is structured to close the resilient infrastructure investment gap and increase urban centers' financial and physical climate resilience.**

Barrier 1: Globally, there is very limited existence of long-term fixed-price climate insurance coverage due to underdeveloped insurance markets and cities are generally unable to afford existing climate insurance. CILRIF Strategy 1: CILRIF offers a long-term climate insurance product geared to meet the climate adaptation needs of various stakeholders. The climate insurance offered through CILRIF is structured in a tiered premium reduction model which reduces total strain on cities' budgetary resources.

Barrier 2: Municipalities with sub-investment grade ratings have constrained access to capital markets. CILRIF Strategy 2: CILRIF offers a tailored solution designed specifically for cities which aims to allow them to access capital to fund infrastructure resilience projects, contingent upon a commitment to buying climate insurance and building climate resilience.

Barrier 3: Cities generally lack incentives to build resiliency into existing and new infrastructure. CILRIF Strategy 3: CILRIF creates an incentive for investment in resiliency because that investment is structured to yield results-based premium reductions on the insurance product.

### 2.2 INNOVATION

**CILRIF offers long-term insurance coverage and incentivizes cities across the globe to invest in resilience.**

CILRIF is unique in its focus on long-term 10-15-year coverage, the intended link between investment in resilience and premium price reductions, and the urban and global focus of the instrument. Existing climate insurance products typically offer short-term coverage (1-3 years) for central governments and do not include incentives for investment in resilience. The Lab

Secretariat has assessed several approaches with similar aims and risk transfer strategies. Table 2 summarizes these instruments and outlines how they are differentiated from CILRIF.

Table 2. Comparable Instruments to CILRIF

Similar Instruments	Description	Differentiation
African Risk Capacity (ARC)	Risk pooling mechanism that offers African countries insurance covering natural disasters. The product is annually renewed, payouts occur within 2-4 weeks, and coverage is of drought and tropical cyclone risk depending on the country.	<p>All three instruments are differentiated from CILRIF in similar ways:</p> <ol style="list-style-type: none"> <li>1. Policies are renewed annually via these instruments.</li> <li>2. The premiums structured are not linked to financing resilient interventions.</li> <li>3. All three have a country-level or regional-level focus.</li> </ol>
Philippine City Disaster Insurance Pool	A pool designed to provide post-disaster financing based on a parametric insurance model. Ten cities participated in the design of the pool and were selected based on factors including disaster risk and risk management governance, geographic location, and data availability. Coverage is of varied physical climate and natural hazard risks.	
Caribbean Catastrophe Risk Insurance Facility (CCRIF)	Multi-country risk pool that aims to limit the financial impact of natural disasters in the Caribbean. The product is annually renewed, payouts occur in approximately 2 weeks, and coverage is of tropical cyclones, earthquakes, and excess rainfall depending on the policy.	

### 2.3 CHALLENGES TO INSTRUMENT SUCCESS

There is an array of significant challenges to be mitigated to ensure CILRIF's success, summarized in Table 3 below.

Table 3. Challenges and Management Strategies for CILRIF

<p><b>Challenge #1 Affordability of premium:</b> Insurance providers face many barriers to offer an affordable product, and the cost of long-term climate insurance could be prohibitively expensive for target cities.</p>	
<p><b>Mgmt. Strategies:</b></p>	<p><b>Significant results-based premium reduction:</b> The connection between the insurance offering and financing facility to build resilience to covered climate risks is critical to managing premiums. A strong link must be created between the two elements to ensure premiums can reduce quickly.</p> <p><b>Separating the provision of parametric and indemnity coverage.</b> The parametric component could be provided in the form of a post-disaster liquidity fund to which DFIs and even national governments could contribute, thus reducing the commercial premium.</p> <p><b>Risk pooling:</b> Over time, scaling CILRIF implementation to many cities with varied climate risks can support the reduction in premiums as insurers will have wider coverage. That is, the CILRIF risk pool will diversify across geographies, climate disaster types, and economic contexts. The coverage will rely on each city's ability to pay. At the initial stage, development institutions or other donors may provide partial subsidies/grants.</p>

<p><b>Challenge #2 Difficulty pricing resilience impact:</b> Initial and ongoing valuation of the risk reduction benefits provided by adaptation interventions is multifaceted, not yet well documented, and impact is highly site-specific. The pricing approach envisioned by CILRIF is unproven in terms of scale, thus highly technical and potentially costly.</p>	
<p><b>Mgmt. Strategies:</b></p>	<p><b>Pricing resilience impact by third parties:</b> At the pilot stage, insurance companies will enter into bilateral agreements with cities, and resilience impact valuation will be validated by a third-party, though the ability of these entities to validate and price impact is unproven.</p> <p><b>Standardization of features for resiliency interventions:</b> CILRIF will be responsible for collaborating with municipalities to define and select key interventions. One important insight from UNCDF's discussions with a global structural engineering firm is that many measures will be standardized at some level, making it easier to price resiliency interventions and replicate them worldwide.</p>
<p><b>Challenge #3 Need to prove value proposition to cities:</b> CILRIF must be able to demonstrate the value proposition of the instrument given competing avenues for spending by cities to build climate resilience (e.g., spending on insurance premiums in competition with direct infrastructure investment, investment in climate risk mapping, etc.).</p>	
<p><b>Mgmt. Strategies:</b></p>	<p><b>Post-disaster liquidity:</b> Efficient liquidity provision in the aftermath of a natural disaster is the core value proposition of CILRIF for municipal governments and local communities. Under the approach proposed by CILRIF, cities would not have to reallocate funds toward post-disaster liquidity as infrastructure and business interruption losses will be covered under the insurance contract.</p> <p><b>Blend of insurance and financing:</b> CILRIF's blend of insurance and financing is critical to proving value for cities. Ensuring that the financing model is robust (and scalable) for bringing funding to the table can be a major differentiator and point of interest for CILRIF.</p> <p><b>Technical assistance:</b> Support through TA from actors involved in CILRIF, especially insurers and DFIs, can bring a significant value-add to cities that could differentiate the product from other options.</p>
<p><b>Challenge #4 Limited concessional investment in cities:</b> Many international DFIs are constrained by their mandates and balance sheets to invest directly in cities. International DFI financing processes are generally designed for national-level government recipients.</p>	
<p><b>Mgmt. Strategies:</b></p>	<p><b>Engagement with DFIs:</b> The proponent team will engage with DFIs to assess their operational constraints and which DFIs have broad mandates to work directly with cities.</p> <p><b>Engagement with national agencies:</b> CILRIF is set up as a private sector entity. Resiliency measures will be deployed at the city level subject to local regulatory requirements but for efficiency could be aggregated under national agencies (like FEMA in the United States), which manage national programs to mitigate climate hazards.</p>
<p><b>Challenge #5 Basis risk:</b> Parametric coverage yields basis risk – the difference between the actual loss experienced by a policyholder and the payouts received. This reduces buyers' trust in the insurance product, as it cannot be relied upon to cover actual losses incurred.</p>	
<p><b>Mgmt. Strategies:</b></p>	<p><b>Well-designed parametric coverage:</b> Management of this risk requires well-designed parametric coverage with robust design standards and testing of contract parameters to ensure that the parametric coverage closely aligns with losses.</p> <p><b>Connection to climate-resilient investment:</b> Required investment in climate resilient interventions through the CILRIF financing facility can also reduce basis risk by reducing loss probabilities during the coverage period.</p>

**Challenge #6 Project pipeline:** There is a risk that there will not be a sufficient pipeline in target municipalities that are moderately bankable and address the same climate risks as targeted by the insurance product.

**Mgmt. Strategies:**

**Careful selection of pilot cities:** The proponent team will carefully select pilot cities with existing project pipelines that currently have a financing gap. The team has and will continue to pre-vet cities with climate coalition partners and experts to ensure that the pilot location will be ready to implement resilience interventions that respond to the covered climate risk.

**Engagement with DFIs:** Engagement with a diversity of financial actors – especially DFIs – can also be beneficial given those actors' existing efforts to support cities and countries' NAP implementation.

## MARKET TEST AND BEYOND

### 3. IMPLEMENTATION PATHWAY AND REPLICATION

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*Initially, CILRIF targets the cities of Durban in South Africa and Makati in the Philippines, where the team is working with key stakeholders. The approach would then expand to other viable cities to cover riverine flood and heat risks.*

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Initial target cities for CILRIF are Durban (South Africa) and Makati (the Philippines), focusing on riverine floods as the climate-related hazard. For these cities, proponents have established contacts with key stakeholders in local governments. The next near-term target city is Freetown (Sierra Leone), where the focus is on extreme heat as the climate-related hazard.

For future target cities, CILRIF implementers will identify cities across a range of criteria:

- Evidence of administrative and technical capacity within the city government.
- Bankable with at least some access to finance.
- Moderate political stability.
- Presence and assessment of flood or heat risk in the city.
- Legal and regulatory capacity to purchase parametric and indemnity insurance.

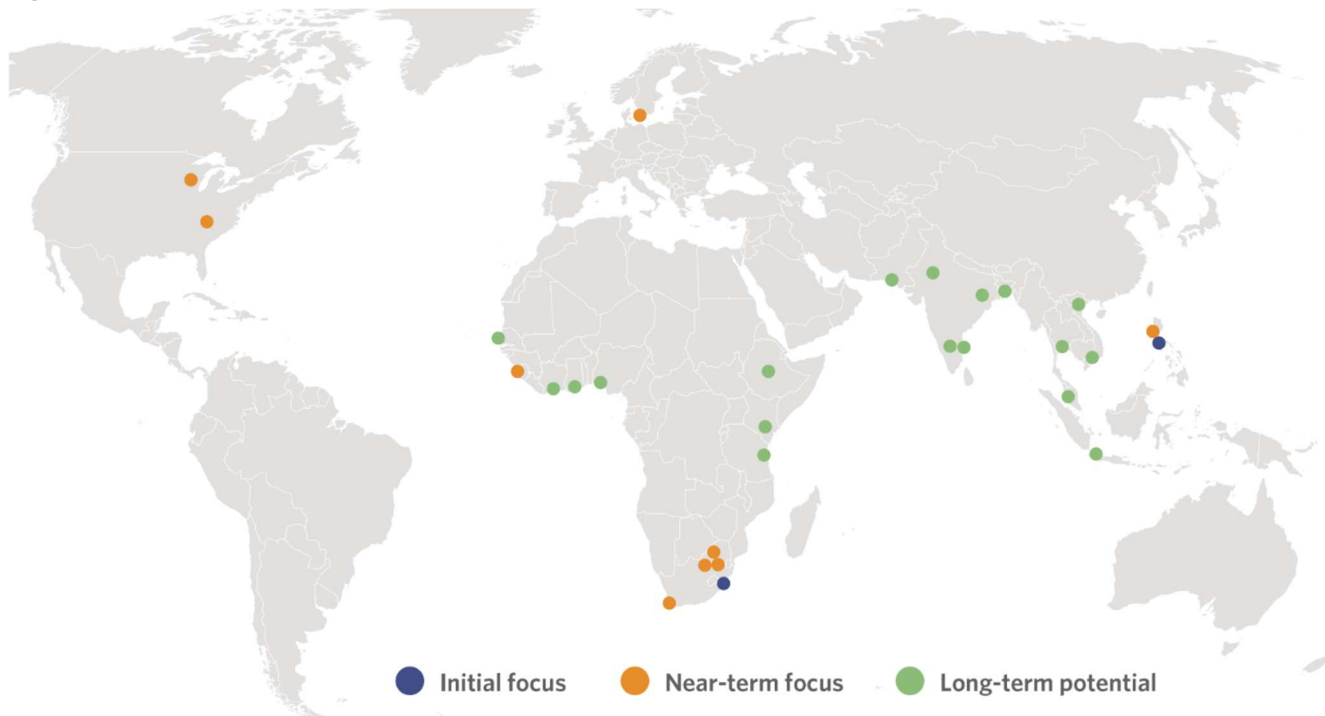
Based on these criteria, an initial mapping of potential cities for CILRIF implementation is shown below.<sup>4</sup>

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<sup>4</sup> Near term focus cities are Cape Town, Ekurhuleni, Johannesburg, Madison, Malmo, Nashville, Quezon City, and Tshwane. Long-term potential cities are Abidjan, Accra, Addis Ababa, Bangkok, Bengaluru, Chennai, Dakar, Dar es Salaam, Delhi, Dhaka, Hanoi, Ho Chi Minh City, Jakarta, Karachi, Kolkata, Kuala Lumpur, Lagos, and Nairobi.



Figure 2. Map of CILRIF Potential Implementation



To move towards implementation, UNCDF and partners will take the following next steps:

1. Develop a governance structure for partnership among entities currently involved in the structuring of CILRIF.
2. Confirm the viability of pilot cities selected.
3. Select a fund manager to lead the implementation.
4. Fully identify a workable financing approach for climate resilience infrastructure in each city.
5. Identify the climate resilience interventions to be financed in each city and develop an insurance product informed by the identified climate risk in each pilot city.
6. Develop an approach to pricing insurance premiums based on the interventions identified.
7. Engage donor capital to cover structuring costs and keep premium prices affordable for cities.

## 4. FINANCIAL IMPACT AND SUSTAINABILITY

### 4.1 QUANTITATIVE MODELING

The Lab Secretariat developed a financial model for CILRIF. The model assumes that the CILRIF insurance facility offers a long-term insurance product to 40 municipal governments covering flood risk in 20 cities and heat risk in 20 more cities. The model considers a global spread of cities covered, where all cities are bankable with the ability to borrow.

The model adopts four city typologies, each one being represented ten times in the 40-city risk pool.

- **City type A** reflects a **large city**, purchasing coverage for **moderate flood risk**.
- **City type B** reflects a **medium-sized city**, purchasing coverage for **high flood risk**.
- **City type C** reflects a **medium-sized city**, purchasing coverage for **moderate heat risk**.
- **City type D** reflects a **large city**, purchasing coverage for **high heat risk**.

The model assumes the following about purchased coverage:

Table 4. Coverage Details of CILRIF Model

City Type	Purchase coverage for:	Maximum Coverage Limit
City Types A and B	Climate-related flood risk to municipally owned roads, public transport, buildings, and a water treatment facility (treatment facility only assumed for city type A)	City Type A: USD 930 mn City Type B: USD 280 mn
City Types C and D	Surplus costs associated with municipal energy, municipal health care, road damage, and municipal labor productivity	City Type C: USD 180 mn City Type D: USD 210 mn

A parametric trigger structure with three layers of triggers is assumed for each coverage type to reflect the climate risk covered. For city types A and B, the parametric trigger is structured in three layers, measured by flood gauges across the city, and where payouts are considered to increase from trigger 1 up to trigger 3. City type A is considered to be slightly less at risk than city type B, reflected in the annual predicted probability of each trigger below.

Table 5. Illustrative Flood Parametric Triggers for CILRIF Model

Parametric Trigger #	Trigger Description	Annual Probability Type
Parametric Trigger 1	Greater than 1.5-meter flood depth across at least 10% of the city.	City type A = 3% City type B = 5%
Parametric Trigger 2	Greater than 1.5-meter flood depth across at least 20% of the city.	City type A = 2% City type B = 3%
Parametric Trigger 3	Greater than 1.5-meter flood depth across at least 50% of the city.	City type A = 1% City type B = 2%

For city types C and D, the parametric trigger is, likewise, structured in three layers, to be measured by disbursed temperature gauges throughout the city, and again structured to increase from trigger 1 up to trigger 3. City type C is assumed to be slightly less at risk than city type D, reflected in the annual predicted probability of each trigger below.

Table 6. Illustrative Heat Parametric Triggers for CILRIF Model

Parametric Trigger #	Trigger Description	Annual Probability Type
Parametric Trigger 1	Temperature 10 or more degrees above average highs in its hottest month of the year for three days or more. <sup>5</sup>	City type A = 3% City type B = 5%
Parametric Trigger 2	Temperature 12 or more degrees above average highs in its hottest month of the year for five days or more.	City type A = 2% City type B = 3%
Parametric Trigger 3	Temperature 15 or more degrees above average highs in its hottest month of the year for five days or more.	City type A = 1% City type B = 2%

The model assumes that every city receives maximum parametric coverage over the 10-year term of the policy up to 80% of total insurable losses, with the remaining 20% covered via a hybrid indemnity portion of the coverage. In practice, if a city experiences multiple hazard events in back-to-back years (e.g., triggering parametric trigger 3 in 2 back-to-back years), the coverage would yield parametric payouts up to 80% of the covered maximum in total, and an additional 20% potential payout from the indemnity portion, but then the coverage would be exhausted for the duration of the policy period.

Return expectations for insurance offering are assumed to be 10%, interannual volatility in payouts is assumed to be 9%, and the model assumes that 50% of the risk is ceded to reinsurers. At the same time, the remainder is held by the CILRIF operator.

Informed by the inputs above, Table 7 reflects key inputs for premium pricing for each city covered by the CILRIF insurance facility:

Table 7. Key Inputs for Premium Pricing for CILRIF Model (USD)

Inputs	City type A	City type B	City type C	City type D
Which events are covered?	Flood	Flood	Heat	Heat
Maximum payout	930 mn	280 mn	180 mn	210 mn
Average annualized payout from insurer	11.7 mn	5.9 mn	6.7 mn	13.4 mn
Expenses assumed from other comparable instrument models <sup>6</sup>	4.0 mn	1.2 mn	0.8 mn	0.9 mn
Amount of reinsurance cover offered	460 mn	140 mn	90 mn	105 mn
Reinsurance premium	4.6 mn	2.8 mn	0.9 mn	1.1 mn

<sup>5</sup> For example, the average high in Freetown is 88 degrees F, so parametric trigger 1 would be triggered if the temperature in Freetown was above 98 degrees F for three days in a row.

<sup>6</sup> Expense costs are structured using inputs from CCRIF 2020-2021 Annual Report, which indicates the cost of expenses and maximum coverage provided for a range of programs. The average expense cost as a percentage of maximum coverage is 0.4% for CCRIF programs, so this proportion is assumed for CILRIF.

To implement CILRIF, the proponent team will leverage expertise from insurers and climate risk experts to price the insurance premiums. The Lab Secretariat has aimed to develop an initial benchmark for a premium price range for the CILRIF insurance offering, to be further refined by experts as proponents move CILRIF towards implementation. Using the inputs above, the Lab Secretariat team finds the following projected range for an annual premium price for each city type:

Table 8. Lab Secretariat Assessed Premium Price Range for CILRIF Model (USD)

City Type	Maximum Coverage	Trigger Payouts	Probabilities of Payouts	Annual Illustrative Premium
City Type A	930 mn	1. ~90 mn 2. ~220 mn 3. ~480 mn	1. 3% 2. 2% 3. 1%	~ 22.4 mn
City Type B	280 mn	1. ~30 mn 2. ~60 mn 3. ~140 mn	1. 5% 2. 3% 3. 2%	~ 11.0 mn
City Type C	180 mn	1. ~90 mn 2. ~130 mn 3. ~140 mn	1. 3% 2. 2% 3. 1%	~ 9.3 mn
City Type D	210 mn	1. ~110 mn 2. ~150 mn 3. ~170 mn	1. 5% 2. 3% 3. 2%	~ 16.9 mn

The model then captures the potential impact of resilience interventions on premium prices. As described in Section 1, CILRIF climate insurance policies will be contingent upon the city's commitment to invest in climate adaptation projects to enhance the resiliency features of critical urban infrastructure covered by the insurance policy. If the city successfully meets the adaptation infrastructure milestones provided in the insurance policy, the insurance premium will be reduced. The Lab Secretariat team has modeled this approach for each City Types using the following assumptions.

Table 9. Lab Secretariat Assessed Resilience Intervention Details

City Type	Resilience Interventions Financed	Year of Resilience Impact Start (Respectively)	Assumed Impact on Premium Price (Respectively)
City Type A	1) Installation of road drainage systems, 2) Pump stations for public transport flood protection, 3) Stormwater retention and drainage system	1) Year 2, 2) Year 4, 3) Year 5	1) 5%, 2) 10%, 3) 10%
City Type B	1) Installation of road drainage systems, 2) Pump stations for public transport flood protection	1) Year 2, 2) Year 4	1) 5%, 2) 10%
City Type C	1) Extreme heat early detection system, 2) Cooling center, 3) District cooling network	1) Year 2, 2) Year 3, 3) Year 5	1) 8%, 2) 8%, 3) 9%
City Type D	1) Extreme heat early detection system, 2) Green corridors, 3) Cooling center, 4) District cooling network	1) Year 2, 2) Year 3, 3) Year 4, 4) Year 5	1) 8%, 2) 5%, 3) 8%, 4) 9%

Given these assumptions, the following table illustrates the hypothetical impact of these resilience interventions, if successfully executed on premium prices over the ten-year coverage period.

Table 10. Lab Secretariat Assessed Resilience Intervention Hypothetical Impact on Premium Price

Year	City Type A	City Type B	City Type C	City Type D
1	22.4 mn	11.0 mn	9.3 mn	16.9 mn
2	21.3 mn	10.4 mn	8.5 mn	15.6 mn
3	21.3 mn	10.4 mn	7.8 mn	14.8 mn
4	19.2 mn	9.4 mn	7.8 mn	13.6 mn
5	17.2 mn	9.4 mn	7.1 mn	12.4 mn
6	17.2 mn	9.4 mn	7.1 mn	12.4 mn
7	17.2 mn	9.4 mn	7.1 mn	12.4 mn
8	17.2 mn	9.4 mn	7.1 mn	12.4 mn
9	17.2 mn	9.4 mn	7.1 mn	12.4 mn
10	17.2 mn	9.4 mn	7.1 mn	12.4 mn

The Lab Secretariat also assessed quantitatively the CILRIF finance facility which is a commercial investment vehicle focused on financing municipal infrastructure (with climate resilience benefits). The CILRIF implementing team will aim to establish an initially sized USD 1 billion global fund that can directly finance municipalities. In the pilot stage, the CILRIF finance facility will finance up to USD 200 million per city. Concessional and non-concessional public investment in the finance facility will act as anchor capital that can “crowd-in” commercial private capital.

Overall, the blended finance structure and distributed risk will help keep interest rates low for municipalities where needed, while still providing market returns for senior tranche investors. The financing facility will invest this capital in cities participating in the CILRIF Insurance Facility. Details on the basic structure of the fund are below:

Table 11. Finance Facility Illustrative Inputs

Key Input Categories	Inputs
Originating lenders	20% first loss tranche 50% mezzanine tranche 30% senior tranche
Loan amount per municipality	USD 100-200 million average
Pricing	First-loss tranche: LIBOR + 0.06% transaction fee per annum Mezzanine tranche: LIBOR + 10-12% Senior tranche: LIBOR + 6-8%

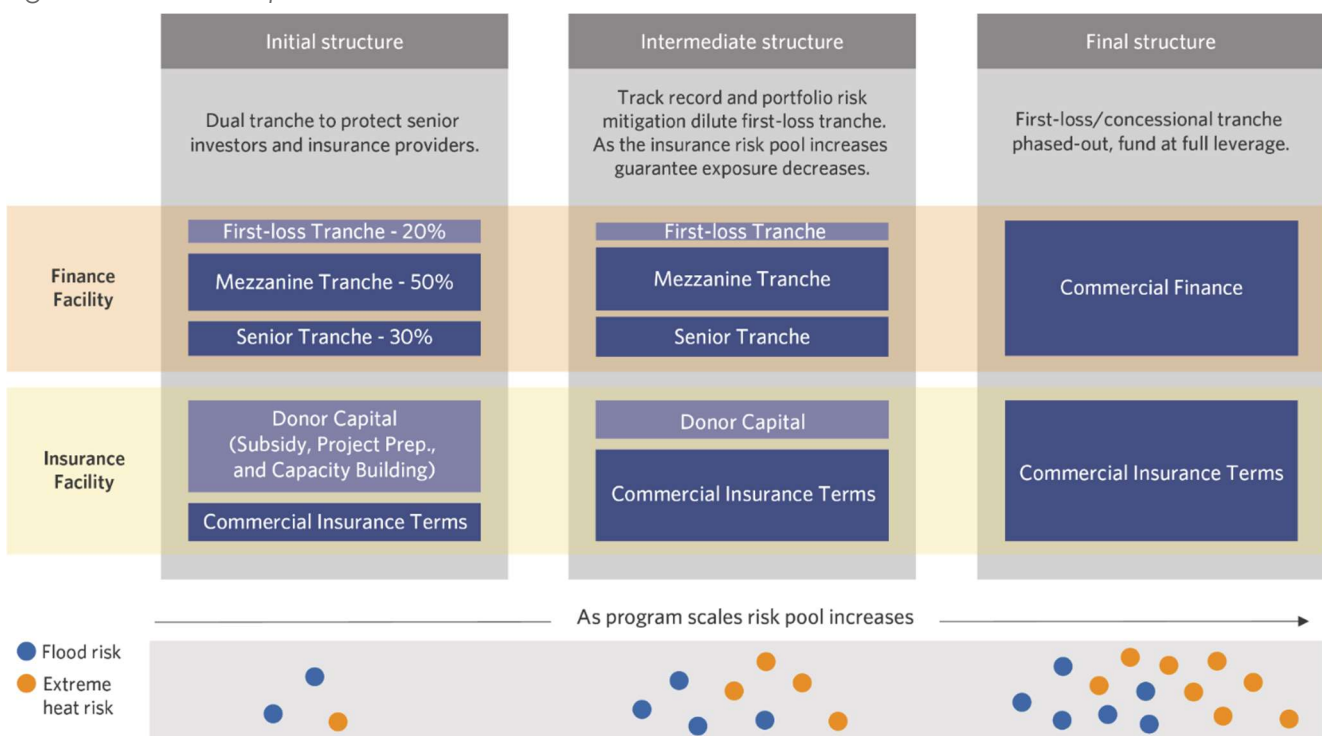


Adjustment in pricing due to insurance coverage access and resilience interventions	First-loss tranche: 50-100 bp decrease Mezzanine tranche: 50-100 bp decrease Senior tranche: 50-100 bp decrease <sup>7</sup>
Term length	10 years
Repayment Schedule	Priced as bullet

## 4.2 PRIVATE FINANCE MOBILIZATION AND REPLICATION POTENTIAL

After the pilot, CILRIF aims to scale the size of the pool substantially. Replication is highly contingent on the financing structure determined for cities. Attracting private investment at scale will require a phased approach, visualized through a capital stack over time. In this stack, as the program scales, the first loss investment in the financing facility is phased out, and donor capital towards the insurance facility is likewise reduced.

Figure 3. Risk Pool Impact on Structure



## 5. ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACT

*CILRIF aims to offer cities sufficient access to finance solutions and risk transfer mechanisms to reduce their climate-related risks substantially*

### 5.1 ENVIRONMENTAL IMPACT

CILRIF aims to support cities in building climate resilience to extreme heat events and flooding via 1) structuring the insurance policy to require a commitment to resilience interventions, 2) incentivizing follow-through on resilience building through results-based premium pricing structure, and 3) offering finance for resilience building through the debt financing facility.

<sup>7</sup> Cumulative change, likely to be distributed over several years.

For cities targeting extreme heat risk, interventions financed can include district cooling networks, green spaces and corridors, cooling centers, and extreme heat early detection systems. Cities can gain an array of benefits from these interventions. District cooling networks use cold groundwater as a part of their heat exchange, which is more cost-effective, quiet, power-efficient, easily maintained, and long-lasting than mounted chilling systems. Green spaces and corridors will allow the city to lower its overall temperature while increasing levels of biodiversity and low-emissions travel options (e.g., bicycling or walking). Cooling centers offer sites to keep cool during extreme heat events and avoid heat-related illnesses, benefiting marginalized and vulnerable groups the most. Extreme heat early detection systems can allow urban residents to prepare for a heatwave and avoid/minimize risks as needed.

For cities targeting climate-related flooding, interventions finance can include the installation of drainage systems, reinforcement of river basins, well flood resilience, stormwater retention and detention systems, pump stations, leakage management, detection, and repair of piped systems, flood protection for human settlements, and protection systems for dams. Flood resilient infrastructure equally benefits the natural environment as it does the city's population. With flood management systems, floodplain and river biodiversity and habitats will be better protected from disruption and pollution. A city's avoidance of a catastrophic flood event will preserve food sources (e.g., fish stocks), transport networks, electricity supply, clean water supply, homes and other built structures, agriculture and business operations, economic stability, and lives.

Table 11 indicates potential outcome indicators for these interventions:

Table 11. CILRIF Outcome Indicators


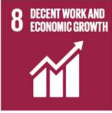



Extreme Heat Interventions	
District cooling networks	Number of buildings covered Decrease in heat-related hospitalizations Increase in labor productivity/reported hours worked
Green spaces and corridors	Decline in surface temperature with and without intervention
Cooling centers	Number of people covered Decrease in heat-related hospitalizations
Extreme heat early detection systems	Number of people informed Decrease in heat-related hospitalizations
Flooding Interventions	
Installation of drainage systems Reinforcement of river basins Well flood resilience Stormwater retention and detention systems Pump stations Leakage management, detection, and repair of piped systems Flood protection for human settlements Protection systems for dams	Reduced damage costs of systems or regions protected by drainage systems/catchment basin. Decrease in households flooded. Reduction in number of days facility is out of service due to flooding. Proportion of asset that is waterproofed and located outside of current and projected flood plains. Achieving no or limited reduction in the quality of water supplied during flood occurrence. Additional households with access to safely managed drinking water.

## 5.2 SOCIAL AND ECONOMIC IMPACT

Climate change does not impact all people equally – its effects exacerbate existing disparities in vulnerability across social factors such as race/ethnicity, class, sex, and gender identity, as well as age, physical ability, and many other factors. Women in particular face unequal risks from climate change: per the UN, women represent 80% of people globally displaced by climate change. Women also often bear disproportionate responsibilities during and after climate events related to caring for family members and immediate household needs. For example, in many parts of the world, women’s livelihoods are often closely linked to food, water, fuel, and subsistence living, which can be devastated by extreme weather. Increasing climate resilience of cities will therefore have a disproportionate impact on women and girls.

CILRIF-financed projects will also address several the key issues related to improving community well-being, which are clearly expressed through the Sustainable Development Goals (SDGs). Table 12 shows those SDGs where CILRIF can have a direct impact.

Table 12. CILRIF Impact by SDG

SDG	CILRIF Impact
 <p>6 CLEAN WATER AND SANITATION</p>	To ensure availability and sustainable management of water and sanitation for all, resilience interventions financed can protect against flood risk to water provision in cities.
 <p>8 DECENT WORK AND ECONOMIC GROWTH</p>	To promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, municipal access to insurance is an increased ability to respond to disasters without falling into a debt spiral, potentially yielding positive economic benefits.
 <p>9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	To build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation, a core aim is to build resilient infrastructure in cities against heat and flood risks.
 <p>11 SUSTAINABLE CITIES AND COMMUNITIES</p>	To make cities and human settlements inclusive, safe, resilient, and sustainable, a core focus of CILRIF is building financially and physically resilient cities.
 <p>13 CLIMATE ACTION</p>	To take urgent action to combat climate change and its impacts, the focus is on climate adaptation and broader potential implications for financing adaptation beyond cities through linkage to insurance.

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