Conservation Investment Blueprint:

Resilience Bonds

By re:focus partners, October 2019

1. Overview of the conservation need/opportunity

Cities around the world are facing increasingly frequent and severe weather events. Many governments and public utilities are overexposed and underinsured for these risks, including earthquakes, floods, and wildfire. In heavily developed urban areas, local leaders are also coping with aging and failing infrastructure systems that increase the potential for cascading failures and devastating losses. In developing countries and regions, officials are struggling to manage rapid growth, meet demand for new services and infrastructure, and manage the consequences of disaster in informal communities.

Natural disasters, even when they are classified as small or moderate, can have severe and long-lasting impacts on ecosystems[1] and trigger a vicious circle of increased ecological vulnerability to future disasters. Because of their great spatial extent and longevity, major floods and droughts can be especially damaging to the environment. Floods and droughts can undermine soil stability, destroy natural habitats and disrupt water provision in a landscape, with knock-on effects on species and long-term ecosystem resilience. Earthquakes, hurricanes, thunderstorms and winter storms cover less territory and tend to have less pervasive and long-lasting environmental impacts[2] but can nonetheless cause significant damage. In addition to damages from ground shaking, major earthquakes can create risks or other types of ground movement, ranging from landslides to liquefaction of soils. These risks are often amplified in areas near critical infrastructure, such as major dams or seawalls. Infrastructure damage during these events can create cascading failures—fires resulting from downed power lines or flooding caused by water main breaks—leading to escalating losses in exposed ecosystems.

But nature can also be a means to enhanced catastrophe resilience. For example, mangrove forests can reduce storm surges by 26-76%[3]. Healthy coral reef can reduce up to 97% of a wave's energy before it hits the shore, reducing both the effects of storm surge and daily erosion to coastlines[4]. And it is estimated that during Hurricane Sandy, temperate coastal wetlands saved more than $625 million in flood damages and hundreds of millions of dollars in New Jersey alone[5]. By using green infrastructure, governments can both restore nature and harness it for protection against natural disasters. Amongst others, the World Bank has been exploring the potential of nature-based solutions for addressing flooding, erosion and drought risk, and its Nature-Based Solutions Program aims to facilitate uptake of green infrastructure in disaster risk management[6]. Green infrastructure is also a response to the conundrum whereby some grey infrastructure investments can amplify future environmental vulnerability to natural disasters (e.g. road networks worsening the impacts of flash floods and landslides).

Natural disaster preparedness and recovery is typically funded by governments who act as "insurers of last resort". More recently, as the frequency and severity of different types of disasters have grown, the gap between insured losses and total economic losses has also grown. As a result, many local, state, and national government agencies have found themselves in the position of the expected insurers of *first* resort. This is an unsustainable situation for budget-constrained public entities that are already struggling to meet existing needs with current taxpayer dollars, let alone fund unpredictable crises.

One new financing mechanism that can help bridge the gap is the resilience bond, a variation on conventional insurance industry catastrophe bonds. Resilience bonds explicitly value the reduction in disaster-related expected loss that results from the implementation of resilience projects through a rebate structure. The resulting "resilience rebate" can serve as a source of predictable funding which governments can proactively invest in projects that strategically reduce catastrophe risk. By investing in such projects and leveraging green infrastructure innovation, governments can both restore ecosystems and finance ecological resilience. By connecting catastrophe bonds to investments in physical risk reduction projects, the insurance industry has the opportunity to catalyse investments in resilience projects, similar to how health insurers are now focusing on options for expanding preventative care.

2. Describing how the Blueprint contributes to conservation goals

Overall statement

This blueprint addresses the lack of funding for the protection of ecosystems against natural disasters. It does so by presenting a new financing mechanism (based on conventional catastrophe bonds) which provides governments with new, upfront project finance capital for resilience projects that measurably reduce catastrophe risk. The blueprint further contributes to the restoration of ecosystems by using green infrastructure to increase resilience to natural disasters.

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[1] Mata-Lima H. et al. 2013."Impacts of natural disasters on environmental and socio-economic systems: what makes the difference?" *Ambiente & Sociedade*. 16 (3). http://www.scielo.br/scielo.php?pid=S1414-753X2013000300004&script=sci_arttext&tlng=en

[2] National Research Council. 1999. *The Impacts of Natural Disasters: A Framework for Loss Estimation.* Washington D.C.: National Academy Press. https://www.nap.edu/read/6425/chapter/8#57

[3] Blankespoor et al., 2017; Sheng and Zou, 2017; Zhang et al., 2012. Taken from: https://blogs.umass.edu/natsci397a-eross/using-mangroves-to-mitigate-hurricane-damage-to-the-southern-us-coast/

[4] The Nature Conservancy. 2019. "Insuring nature to ensure a resilient future" (blog). Sept. 3. https://www.nature.org/en-us/what-we-do/our-insights/perspectives/insuring-nature-to-ensure-a-resilient-future/

[5] Narayan, S. et al. 2016. *Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA.* London: Lloyd's Tercentenary Research Foundation.

[6] GFDRR, World Bank Group, PROFOR and World Resources Institute. 2018. *Nature-based solutions for disaster risk management.* Washington, D.C.: World Bank Group. .http://documents.worldbank.org/curated/en/253401551126252092/pdf/134847-NBS-for-DRM-booklet.pdf

Identifying key metrics

Examples of metrics that may be used in assessing the conservation impact of a resilience bond include:

1. Ecological resilience metrics

    a. % of land within the area covered by the insurance policy that is considered resilient against a 100-year, 250-year and/or 500-year event.
    b. % of infrastructure within the area covered by the insurance policy that is located close to high-value ecosystems and that is considered resilient against a 100-year, 250-year and/or 500-year event

Measurement frameworks related to resilience are still in their infancy, and ecological resilience is particularly difficult to quantify given complex relationships within ecosystems and high levels of unpredictability in ecological response to disasters[7]. A simple interpretation of ecological resilience refers to ecosystems that appear to be sufficiently healthy to withstand and rebound from significant disruption. Ecosystem service indicators (e.g. water quality and quantity, soil quality) and fauna and flora diversity and stability can be used as a proxies of ecosystem health.

For each bond, a prioritisation exercise should be conducted to identify ecosystems that are most exposed and vulnerable to natural disasters. An assessment would then take place to identify context-specific resilience indicators and appropriate interventions to restore or maintain ecosystem resilience.

2. Additional conservation metrics

    a. % of resilience budget allocated to green infrastructure projects
    b. Number and area of nature-based solutions established or enhanced
    c. Area (ha) of habitat or kilometres of coastline rehabilitated, restored or protected per dollar spent

Priority should be given to green infrastructure projects, and when a grey infrastructure project is considered, a rationale should be given to explain why green infrastructure is not appropriate for the project[8]. Both green and grey infrastructure projects should follow strict design procedures to ensure their contribution to ecosystem restoration, biodiversity and habitat connectivity. Each resilience project will be monitored using context-specific conservation indicators.

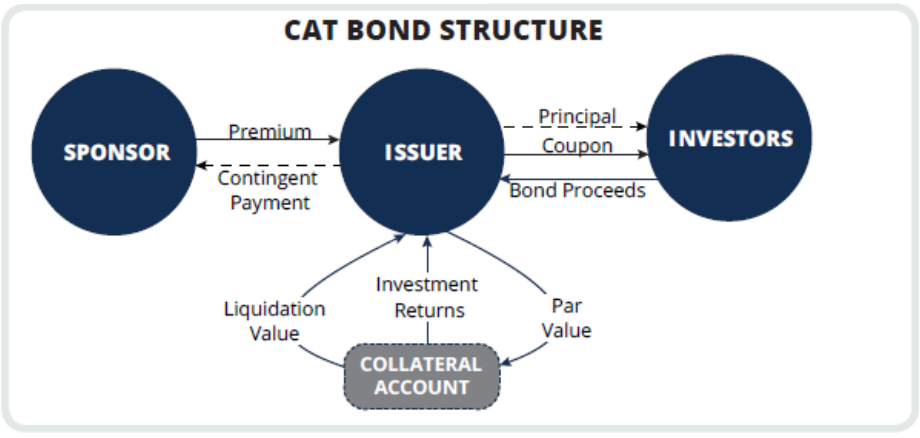
3. *The business model*

Catastrophe bonds: the basis for resilience bonds

The main point of departure for a resilience bond is a catastrophe bond. Catastrophe bonds, also known as cat bonds, have traditionally been used by large insurance and reinsurance firms to protect themselves against extreme losses associated with potentially devastating natural disasters. These bonds are more like insurance policies than traditional municipal bonds and are designed to reduce the financial risks associated with very low-probability, high-consequence natural disasters. For example, if a hurricane strikes, the aim of a catastrophe bond is not to limit the damages on the ground, but instead to reduce the resulting economic disruption.

A defining aspect of cat bonds, compared to Treasury Bonds or municipal bonds, is that they are designed to be 'triggered' in the event of a disaster. This means that when a disaster reaches a predetermined threshold (such as $500 million USD in losses or a storm surge height of 10+ feet above a datum) during a bond term, the bond sponsor (the insurance purchaser) keeps a portion of the bond value to pay off losses and investors lose some—or potentially all—of their principal invested. If there is no trigger event during the bond term, then the investors get their money back at the bond's maturity date. This return of principal, combined with the coupon payments, provides investors with a return on investment.

Figure 1. Traditional catastrophe bond structure



[7] Baho, D. L. et al. 2017. "A quantitative framework for assessing ecological resilience". *Ecology and Society* 22 (3) :17. https://doi.org/10.5751/ES-09427-220317

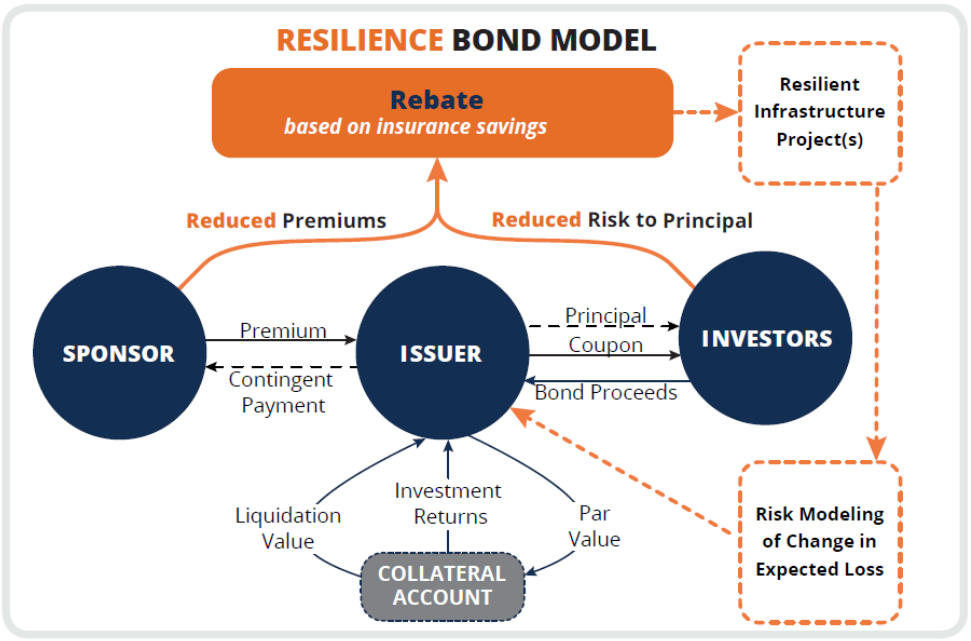
[8] The 2019 World Bank and WRI report on integrating green and grey infrastructure can serve as a guidance document for doing this. Browder et al. 2019. *Integrating green and gray: creating next generation infrastructure*. Washington D.C.: World Bank Group and World Resources Institute.

Cat bonds were originally developed to provide insurance companies with an alternative to traditional reinsurance; however, their cost effectiveness and flexibility has made these types of bonds an attractive insurance option for large asset holding entities who could be devastated by natural disasters. As a result, cat bonds are increasingly being used by public or quasi-public entities to complement traditional insurance or reinsurance coverage.

From catastrophe bonds to resilience bonds

A resilience bond is a new insurance instrument designed to help cash-strapped governments increase *both* financial insurance and physical protection against disasters. These bonds link insurance coverage that public sector entities can already purchase with capital investments in resilience projects that reduce expected losses from disasters. The insurance benefits and governance relationships of resilience bonds are generally similar to those available through conventional cat bonds. The distinguishing features of resilience bonds reflect their goal of capturing a portion of the insurance value created by resilience projects in the form of a rebate.

Figure 2. Resilience bond structure



The figure above shows how the addition of a resilient infrastructure project to a conventional cat bond structure can reduce investors' risk of losing their principal invested and result in lower premium payments for sponsors. The basic relationships among sponsors, issuers, and investors are similar to conventional cat bonds. The difference is that resilience bonds explicitly incorporate the risk reduction value of a specific resilience project on the expected loss to investors. This is a two-step process. The first step is for the issuer to use financial catastrophe models to validate if and how much a resilience project reduces expected losses. This is used to set the value of the reduction in coupon payments to investors. The second step is to capture the cost savings from the reduction in coupons paid to investors and distribute these savings to bond sponsor(s) in the form of a resilience rebate which can be used to finance risk reduction investments.

It is also worth emphasizing that there is no one-size-fits-all design for either cat bonds or resilience bonds. Bond design decisions will ultimately be driven by a number of factors and the specific interests of sponsors.

Relevant stakeholders

The key stakeholders that need be involved to make the resilience bond model a reality are:

Resilience bond sponsors are the entities that require insurance and that have an interest in reducing physical damages from disasters. Like purchasers of conventional insurance, resilience bond sponsors pay insurance premiums in exchange for a payout if disaster strikes. Unlike purchasers of conventional insurance, or sponsors of conventional cat bonds, resilience bond sponsors can recognize a portion of the insurance value created by resilience projects in the form of rebates on their insurance policy premium payments.

Resilience bonds naturally lend themselves to situations with multiple co-sponsors, as risks from catastrophic events are typically shared among many affected parties. In particular, financial risks from catastrophes are typically born by local residents, businesses, local governments and utilities, owners of public and private assets, private insurance companies, and state and federal agencies as the 'insurers of last resort.' Most, if not all, of these parties could benefit from the transfer of financial risks to capital markets that resilience bonds can provide. Resilience bond co-sponsors would share premiums based on their anticipated risk reductions and dedicate proportionate allocations of their rebate to project implementation or cost-recovery.

It should be noted that resilience bonds are different products than municipal bonds or corporate bonds issued by the sponsors. Sponsors are entering into an insurance contract with the issuer of the resilience bond. They are not responsible for repaying bond principal, and resilience bonds are unlikely to compromise their balance sheets or available debt capacities. Sponsors are only responsible for premium payments—just like any other insurance purchase.

Issuers. A cat bond is typically issued by a special purpose vehicle (SPV) established by an insurance firm or major investment bank (or both) that structures the terms of the financial transaction, creates the legal framework for implementation, takes responsibility for getting the bond to market, and manages the proceeds from the bond sales in a collateral account. During the term of the bond, the

issuer collects both premiums from the sponsor and interest earned on the investments made in the collateral account and distributes regular coupon payments to investors.

Risk modellers and other technical experts. Sponsors who wish to start the process of procuring a resilience bond should begin by engaging a trusted team of dedicated experts. This includes third party financial, technical and legal support for effective pre-transaction analysis. In particular, both the sponsor and issuer should work with an independent risk modelling firm that uses catastrophe models to evaluate the chances of a trigger event occurring, and the associated downside risk to investors. In the case of a resilience bond, the risk modelling firm will also be tasked with modelling at least two scenarios: a base case, representing expected losses before a resilience project is in place; and a resilience case, after a project is complete and has generated risk reductions.

Investors. The investor base for resilience bond should be similar to that of cat bonds. Cat bond investors can come in a variety of shapes and sizes but tend to be mostly specialised catastrophe funds and institutional investors. These investors are typically seeking diversification in their portfolios and are willing to take more risk (including the risk of losing their principal invested) for higher returns on investment. See the investment model section for more information on investors.

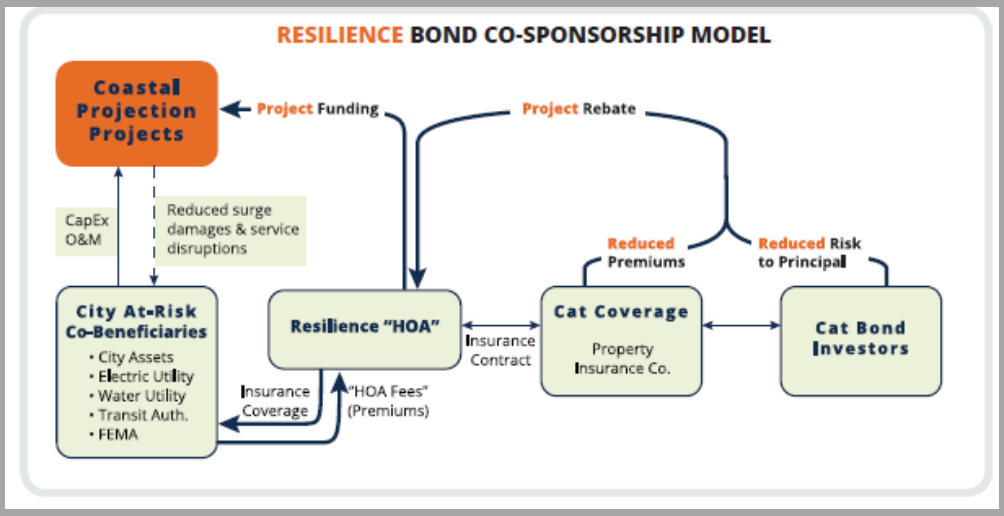
Project developers. A pipeline of well-formulated resilience projects is fundamental to the realisation of a resilience bond. By investing in project predevelopment, project developers can demonstrate where new investments can have clear risk reduction benefits that can be implemented in a predictable timeframe. These developers may need to get comfortable with an insurance-linked repayment mechanism for project implementation.

HYPOTHETICAL RESILIENCE BOND PROGRAM

A hypothetical example of a resilience bond for the "City of At-Risk" will be used throughout this blueprint to provide an illustration of how the resilience bond concept may be applied in practice. Keep an eye out for grey boxes throughout the blueprint where you can follow the story. All pricing is purely illustrative, as actual resilience bond pricing will vary widely depending on a number of factors.

The City of At-Risk has recently become aware of the potential impacts to its community of storm surge events. The city reviewed the schedule of values used for its insurance program, along with those for other quasi-public entities operating in and around the city. All exposed entities agreed to come together under a new administrative structure, similar to a homeowners association or HOA, to jointly manage their risk. The city further commissioned a catastrophe modelling study, which indicated that losses to these assets are, on average, expected to exceed $300 million every 50 years, including the costs of service disruptions. In response to these insights the city is undertaking a coastal protection project, with support from federal public assistance grants.

These grants are associated with various insurance coverage compliance requirements. The proposed project totals $110 million and includes a combination of hardening measures and natural protections designed to protect the city from storm surge up to the 200-year surge level. Construction of these coastal protections is expected to take two years, and the city is pursuing a resilience bond program to support the implementation of additional phases of the project in future.



Products and services being sold

Resilience bonds are insurance products, in which the bond sponsor is the buyer of insurance and the bond issuer is the seller. The bond sponsor pays premiums to the insurance provider but agrees a discount on its premium payments conditional to the implementation of risk-reducing resilience projects. These resilience projects contribute to ecological resilience and can further strengthen ecosystems in instances where green infrastructure is used.

When either a resilience or catastrophe bond is issued, the capital raised from investors is held in a secure low-yield collateral account for the term of the bond. If there is no triggering disaster during this term, then investors get their money back at the bond's maturity date, just like any conventional bond. This return of principal combined with regular coupon payments (from the sponsor's insurance

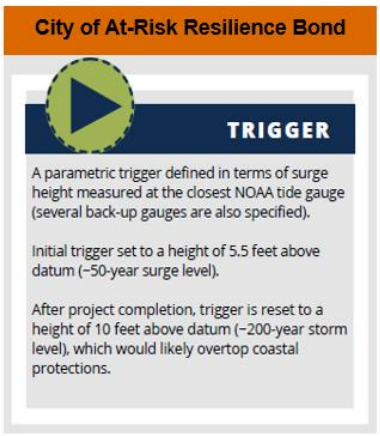
premiums and interest on the collateral account) provides investors with their return on investment. On the other hand, if a trigger event does happen during the bond term, then the investors lose all or a portion of their principal invested. This money is used to make a payout to the bond sponsors. Investors accept this risk on the basis that a trigger event is unlikely to happen during the bond tenor and that this investment gives them exposure to a risk that is uncorrelated to systematic risk in the economy.

Key product features

A number of features define resilience bonds. They are presented below and briefly illustrated using the "City of At-Risk" hypothetical resilience bond program example.

Coverage. Coverage describes the level of insurance purchased by resilience bond sponsors. Insurance coverage provided by a resilience bond can be tailored to complement existing insurance and risk management programs. First, similar to traditional insurance, sponsors must specify the particular perils or hazards that are to be covered. Perils covered by recent cat bonds provide clear precedents for what risks resilience bonds can address. For example, storm surge, wind, tornado, winter storm, earthquake, and excess mortality are all associated with recent cat bond issuances. Second, sponsors will generally need to specify the sources of damages, or exposures, to be covered. Exposures may include, for example, the sponsors' physical assets, business operations, supply chains, or personnel that may be affected when disaster strikes. Again, this is no different than traditional insurance. Initiatives such as the Global Ecosystem Resilience Facility have been exploring ways to insure natural capital assets against disasters using insurance-linked securities such as cat bonds[9].

One aspect of coverage that is unique to resilience bonds is its implication for coupon pricing and reductions from resilience projects. This is because resilience projects often reduce risks in very particular ways. As a result, resilience bonds' coverage must be defined to encompass risks that resilience projects will actually reduce. This can create unique trade-offs with respect to insurance benefits and potential rebate benefits of resilience bonds. Striking an appropriate balance between these two types of benefits will require a number of decisions that will be driven by local factors and the particular interests of the sponsors.

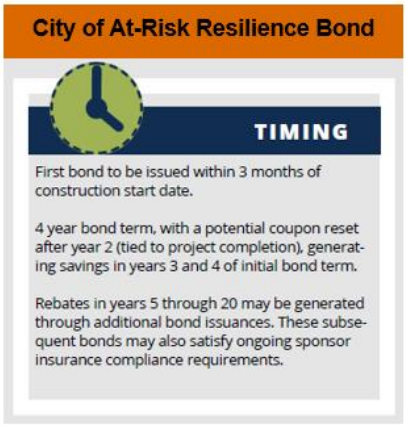


Trigger. Sponsors also need to decide how severe an event should be before the resilience bond provides an insurance payout. Severity can be defined in terms of threshold levels of monetary damages or total losses from an event to the insurance industry. Threshold severities can also be based on physical measurements of the event itself. Examples include the storm surge height, wind speed, or earthquake magnitude or ground motion acceleration. These threshold options are referred to collectively as bond 'triggers'.

There are at least 4 trigger types. Indemnity and industry loss triggers pay when financial losses are documented, which implies that payouts may be delayed by accounting processes. Parametric and modelled loss triggers can provide rapid response funds but may not provide payouts when losses are incurred if the threshold parameter value isn't reached. Generally speaking, the premium costs for resilience bonds will tend to decrease with the trigger's transparency to investors, as more transparent triggers will increase investors' understanding of the degree of uncertainty in the estimated probability of a trigger event occurring.

Timing. Resilience bond
and development milestones of
variety of ways. Examples
resets and longer-term

Resilience projects are often
stakeholders. As a result, these
and execute than already drawn
planning, permitting, and
resilience bonds, can serve as a
clear objectives for project
of reduced insurance costs and
in resilience bonds increase the
more total coverage for the same
aligns the timeline for insurance
implementation, can help local
line.



issuance should be coordinated with the timelines
specific resilience projects. This can be done in a
include short-term, single issue bonds with price
sequences of resilience bonds.

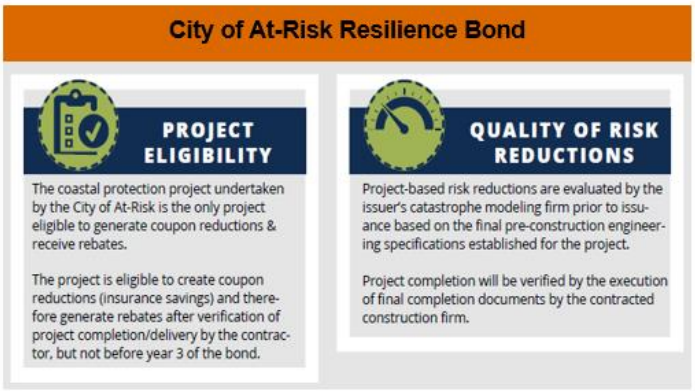
complex, involving multiple sectors and
infrastructure projects can take even longer to plan
out timelines for conventional infrastructure
construction. Insurance mechanisms, including
financial incentive to help local governments set
completion in order to recognize the potential value
associated rebates. Not only can strategic investment
value of public sector coverage—lower premiums or
premium— a thoughtfully structured bond that
procurements with target dates for project
officials push resilience projects across the finish

Resilience projects. Resilience bonds must specify which resilience projects are eligible to generate potential rebates. This specification should both identify eligible projects and indicate which project parameters will be used to measure risk reductions. For

9 Willis Towers Watson. 2019. Global Ecosystem Resilience Facility webpage. https://www.willistowerswatson.com/en-GB/Insights/2019/09/~/~/link.aspx?_id=766F7367ADA2461F98BB9DDBA443D0B5&_z=z

example, in the case of surge risk reductions, the primary specifications required for modelling potential risk reductions are detailed location data and a defined height above datum or a corresponding event level of protection, such as a 500-year surge level. Taken together, these definitions provide a clear basis for quantifying risk reductions.

Resilience bonds must also specify how project generated risk reductions will be qualified under the bond program. Measuring the risk reductions involves a number of staged activities, starting with defining an appropriate risk modelling plan. The plan should reflect the insurance needs of the sponsors, the data available regarding sponsor exposures, expected risk reductions from the resilience projects, the basic structure of resilience bonds, and information needs of capital market investors. It also includes protocols to define when a project is completed.



Rebates. Resilience bonds must pre-specify the mechanics of rebate transactions, including how coupon reductions will be translated into rebates and who will receive them. The use of rebate funds must be specified in advance. This includes allocating funds among capitalizing resilience projects, reducing premiums, and increasing coverage as well as defining the detailed use of funds within each of these categories.

Cash flows and commercial sustainability

There are seven main types of cash flows associated with a resilience bond model, as presented in Figure 3.

A. Bond Purchase: Investors buy the bond from the issuer.

B. Proceeds Deposit: The issuer deposits the proceeds from the bond sale into a collateral account, where the funds are invested in liquid securities with low risks.

C. Premium Payment: The bond sponsor pays premiums on its insurance contract to the issuer.

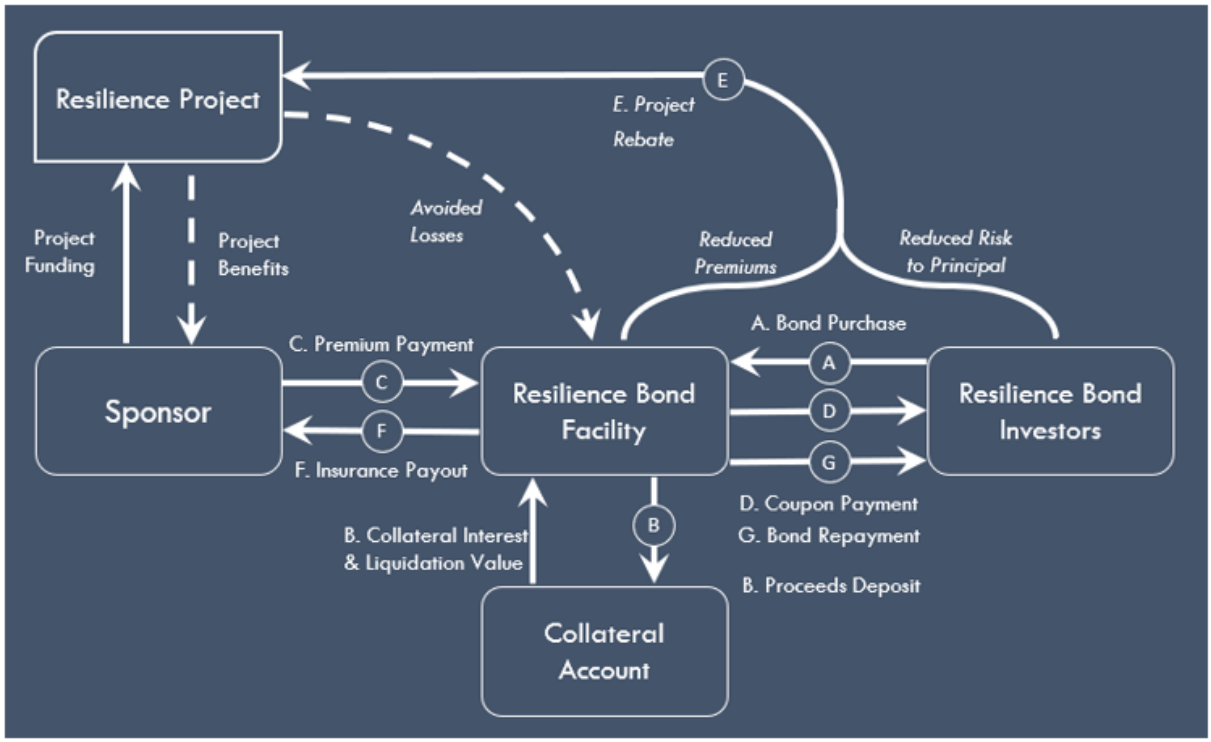
D. Coupon Payment: The issuer makes coupon payments to investors in accordance with the bond's pre-agreed schedule. *Once resilience projects are implemented in accordance with pre-agreed milestones, the issuer makes lower coupon payments to investors, to reflect the reduced risk profile of the bond.*

E. Project Rebate: *Resilience "rebates" calculated prior to bond issuance are transferred as upfront capital for the implementation of pre-agreed resilience projects.*

F. Insurance Payout: If a qualifying event occurs over the life of the bond, the issuer uses some or all of the total liquidation value of the collateral account to make a lump sum payment to the sponsor.

G. Bond Repayment: If no qualifying event occurs, the issuer returns their principal to investors when the bond reaches maturity.

Figure 3. Resilience bond cash flows



These cash flows are mostly identical to traditional catastrophe bonds, **with the exception of flows marked in the italicized text above which differentiate resilience bonds from catastrophe bonds.** These innovative features benefit bond sponsors who not only get insurance coverage at lower cost, but also invest in their resilience to lower losses from catastrophes in the future. Through this distribution of cash flows, sponsors can finance resilience projects, leverage capital markets for their insurance needs and ultimately protect themselves from devastating losses from increasingly severe and frequent catastrophes. Using this model can create a virtuous circle of investment in resilience, as sponsors who have overcome the hurdle of getting a first resilience bond to market can benefit from lower transaction costs as they sponsor repeat resilience bond issuances and derive a steady stream of rebate financing from this.

The issuer, as provider of insurance policy, also benefits from the resilience bond. First, it leverages capital markets to free capital on its balance sheet using a tried and tested catastrophe bond model structure. Second, it shields itself from sizeable payouts by supporting insurance policyholders in decreasing their vulnerability to extreme losses.

External dependencies

The success of the resilience bond model depends on both advancements in data capture and modelling methodologies as well as a supportive legal environment.

Data availability. Governments and public sector agencies rarely have high-quality data on public buildings and infrastructure. To start the process of determining whether a resilience bond is an appropriate investment in the public interest, the first step is for any interested party to start by compiling several key pieces of data, including, but not limited to, the data points in figure 4. Determining who should be the lead sponsor and which entities may have significant co-sponsorship interests requires reliable data on *each* stakeholder's exposure to specific perils and the distribution of expected losses and benefits across various public and private asset holders.

Figure 4. Key data points for resilience bond planning

- Asset locations and values—Schedule of Values (SOV) and/or appraisals
  - Buildings and contents
  - Other property and land holdings
  - Public infrastructure
    - Water systems
    - Electric generation and distribution assets
    - Transit systems
- Insurance holdings—Existing coverage and premium payments
  - Cash reserves
  - Risk pool contributions
  - Private insurance purchases
  - Current and anticipated compliance requirements
- Resilience project(s)—Basic design specifications
  - Location(s)
  - Level of protection
  - Area(s) protected

Data is also needed on how resilience projects are likely to reduce expected loss for investors. In the case of resilience projects, the data on interventions that create measurable risk reductions are not as readily available or as easily extrapolated across projects, and likely to be particularly lacking for green infrastructure projects. Everything is site and context specific; for example, a seawall reinforcement can have wildly different risk reduction profiles in different locations.

Advancements in catastrophe modelling. Catastrophe models are currently limited in the types of perils they can effectively model. Hurricane-linked wind and coastal surge risks are relatively well understood by modellers and accepted by investors. In contrast,

model coverage of inland (riverine) flooding and rainfall related risks is less complete, and there are greater challenges associated in modelling projects designed to mitigate against high-frequency flood events. However, this is an active area of research with new models in development and soon coming to market. In addition, all catastrophe models are regularly refined and updated to incorporate the latest scientific and technological capabilities and to address the needs of users.

Catastrophe models also generally lack the resolution required for re-pricing risk based on project-specific loss mitigation measures. Capturing these reductions requires significant up-front work with risk modellers. This involves associating key features and design parameters of the resilience project with catastrophe model components that can be efficiently modified. Catastrophe models are well suited to modelling some types of risk reductions, but not others. Depending on the type of resilience project under consideration, it may not be possible to model the anticipated risk reduction in a rigorous enough way to build investor confidence. For example, the value of coastal storm surge protections can be modelled with greater precision than retention basins that reduce inland flood risk.

Figure 5. Resilience projects that are not a good fit for resilience bonds

Too difficult to model (peril or project)	Water retention or detention basin projects	Inland flooding perils
Too small (size of project or level of risk reduction)	Rebuilding a damaged fire station	Wildland brush clearing for residential wildfire risk
Too diffuse	Best practices or capacity building programs	Emergency preparedness plans/planning processes
Chronic (not catastrophic) risk	Green stormwater infrastructure	Tidal flood gates
High operational uncertainty	Transit system backups (e.g. buses on standby)	Removable or flexible flood barriers

This challenge is likely to be especially significant for green infrastructure projects that tend to be diffuse and aimed at mitigating high frequency events. The coverage of catastrophe models is, however, constantly expanding; resulting in capabilities to model an even larger range of risk reduction measures in the future.

Legal restrictions. Alternative repayment mechanisms, like resilience bond rebates, involve a number of trade-offs, and the right mechanism for any particular resilience bond program will be driven by local procurement requirements, public agency rules on the receipt and distribution of funds, and other relevant legal factors. It is important to consider this context at the very start of resilience bond issuance planning to avoid bad surprises.

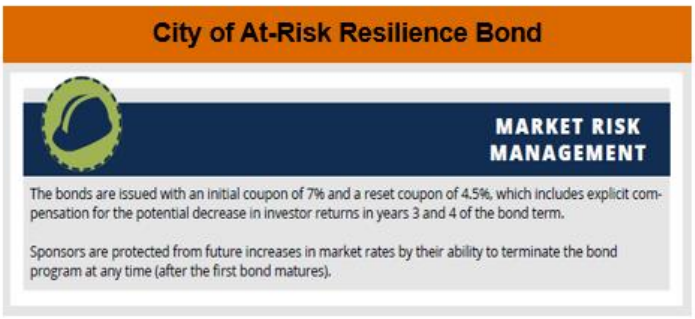
Even in instances where a legal framework is present for insurance coverage, sponsors may have little familiarity with the value of holding an insurance policy against natural disasters. In many regions of the world, insurance penetration is weak and even government actors who find themselves in the position of "insurers of last resort" may need to be educated as to the role that insurance can play in managing potentially devastating losses resulting from natural disasters.

Risk management

Market risk. Capital market dynamics create opportunities for risk reductions to be improperly valued in investor pricing. Resilience bonds face unique market risks relative to conventional cat bonds, because of the challenges of pricing both near-term changes in risk and long-term benefits associated with many types of resilience projects. The bond timing section above introduced two approaches for coordinating the issuance of resilience bonds with resilience project construction timelines—a short-term reset and longer-term sequence of issuances. While both of these approaches can be effective, they each face market risks when it comes to accurately valuing financial benefits of physical risk reductions within capital markets. It is important for potential sponsors to have a clear understanding of these market risks and adopt appropriate mitigation strategies as part of any transaction.

Resilience bonds structured according to the short-term reset approach may face pricing challenges because investors will naturally tend to anticipate risk reductions. This creates an opportunity for risk reductions and project benefits to be effectively undervalued by investor pricing.

Resilience bonds structured in longer-term sequences face different sets of market risks, such as the potential impacts of evolving capital market conditions over time. For example, if the market price associated with a particular level of risk decreases over time, then the cost of insurance will go down, but so will the value attributed to the project benefits and the rebate. Alternatively, if market prices for risk increase over time, then the financial value of physical protections will also increase. This reflects increasing project benefits; however, resilience bond sponsors could find themselves 'locked-in' to higher program costs reflecting the higher market value of the insurance benefits and resilience rebates.



Mitigation Strategy: Various strategies are available to mitigate these risks, depending on other aspects of the bond design. For example, resilience bond programs can integrate a variety of 'off-ramps' to future bond issuances, where sponsors elect not to re-issue a resilience bond, but instead choose to absorb project repayment costs separate from their insurance coverage. Another option is defining upper and lower bounds on the rebate value that may be realized through future bond issuances that protect both sponsors and project financing from risks associated with evolving market conditions.

Development risk. Resilience projects can take years to plan, funding is often uncertain, and schedules shift regularly. This can disrupt the issuance process, which is often structured to align with the annual cycle of insurance renewals. The result is a combination of factors that limit the potential to capture insurance savings. In order to capture these rebates, public entities, such as cities and utilities must have a clear, well-defined, and near-term pipeline of risk reduction projects that they can pursue. Local governments and public utilities must invest in thoughtful predevelopment both to design new infrastructure solutions and set clear insurance priorities.

Even in instances when the challenges above are overcome, some sponsors may realise that they do not have resilience projects that can be modelled in ways that support the development of a locally appropriate bond design or structure. Finally, some may find after an initial round of exploratory modelling that the resilience benefits of anticipated projects are far lower than expected.

Mitigation Strategy: Entities who wish to sponsor a resilience bond should start their planning with a rapid assessment of their near-term resilience project options and their associated disaster risk reduction potential, feasibility of integration in catastrophe modelling, availability of predevelopment funding, and alignment with nature-based solutions.

Environmental and social risk. Resilience projects, as infrastructure projects, can have severe and irreversible environmental and social impacts. In the case of grey infrastructure, projects also have the potential to amplify future environmental vulnerability to natural disasters.

Mitigation Strategy: Infrastructure projects are required to be the subject of a detailed environmental and social impact assessment in many countries. Many project financiers are signatories of the Equator Principles, requiring them to be mindful of the environmental and social implications of the projects they finance. Even in instances where this may not be a legal or financier requirement, resilience bonds should be structured such that sponsors cannot access rebate financing without the completion of an environmental and social impact assessment and management plan for the resilience project to be financed.

4. The investment model

The financial instruments being sought to fund the business model

The resilience bond model is composed of two financial instruments:

1. **Insurance product.** The bond issuer, often an insurance company, sells an insurance policy to the bond sponsor who wishes to obtain protection against losses in the event of a natural disaster. The bond sponsor, as the insurance policy holder, pays regular premiums to the bond issuer in exchange of insurance protection. The bond issuer pays the sponsor to cover its losses in the occurrence of a natural disaster covered by the insurance policy. As resilience projects are complete and reduce the risk to bond investors, the bond issuer makes payments through a rebate structure to reflect the financial value of protection.

2. **Debt instrument.** The other financial instrument, a bond, links the bond issuer to investors. Investors buy bond from the issuer. The issuer deposits the bond proceeds into a collateral account and makes coupon payments to investors according to a pre-agreed schedule. It returns principal to investors when the bond comes to maturity, unless a qualifying natural disaster occurs in which case it uses this principal to pay out to the sponsor. Catastrophe bonds have typically been successful in attracting private investors expecting market-rate returns. However, securing concessionary finance from development finance institutions may be helpful in bringing the first resilience bonds to capital markets.

Grants are not a core component of the resilience bond model, although grant funding in the form of technical assistance for resilience project predevelopment and research in catastrophe modelling advances could be welcome to appropriately address technical and pipeline development risk.

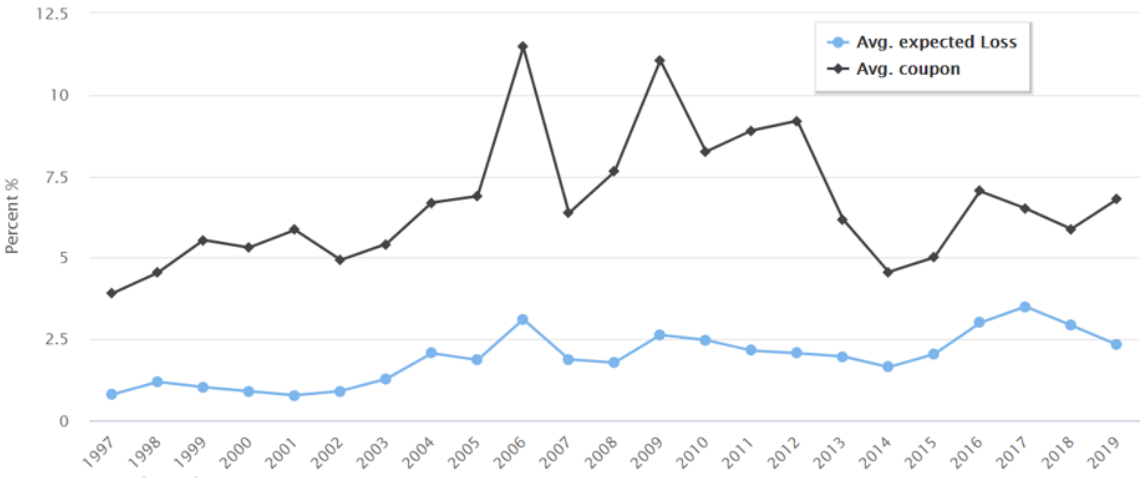
It is worth noting that annual rebates under a resilience bond are likely to be in the order of single-digit millions of dollars. This is not sufficient to fully fund most resilience projects, whose budget can often reach hundreds of millions. In this context, bond sponsors should make sure that the resilience project portfolio they are putting forward has secured the necessary co-funding to be implemented.

The relative size of these instruments and basic information on their terms

In principle, resilience bonds can be issued in a wide range of sizes, from several million U.S. dollars up to over a billion dollars; typically, issuances between one hundred and several hundred million dollars are the most common in current cat bond markets. The right size for sponsors will depend on a variety of factors. Adjustments to bond triggers and sizes enable resilience bonds to be tailored to target particular segments of the sponsor's risk exposure and complement a sponsor's broader insurance and risk management portfolio. The sponsor will also have to consider how much demand the bond is likely to be able to attract in the investor community, so as to ensure that the entire bond can be placed in the market successfully.

Resilience bonds are likely to have similar terms to cat bonds. The latter are typically high-yield instruments, which means they provide investors with a high level of return compared to the market average. This is to compensate investors for the risk that they take in investing in a bond that puts their principal at risk in the case of a qualifying catastrophic event. They are typically fixed-rate instruments, providing a coupon to investors equivalent to a pre-agreed percentage of the bond principal at fixed intervals during the lifetime of the bond. As per Figure 6, the average yearly coupon rate on catastrophe bonds over the last ten years has been 6.8%, although the coupon level will depend on the specificities of each bond. A key feature of cat bonds is that both the coupon and the rate of return generally scales with the probability that a trigger event will occur or, more specifically, with the expected loss. In other words, a 'riskier' bond comes with a higher premium for sponsors and higher rate of return to investors.

Figure 6. Catastrophe bonds average expected loss and coupon per year



Source: Artemis Catastrophe Bond & Insurance-Linked Securities Deal Directory

Catastrophe bonds tend to be short-term securities (typically three to five years). This reduces the risk to investors that a catastrophe triggering a default (loss of principal) will occur over the life of the bond and lowers the risk profile of the bond to a level acceptable to investors. In the case of resilience bonds, this short maturity profile is disconnected from the lifecycle of typical resilience projects. In particular, major infrastructure projects can take a decade or more to complete in multiple phases and can remain in service for half a century or more. One way to coordinate the timing of resilience bonds with project development is to issue the bonds shortly before a resilience project is initiated and design it to mature several years after initial construction (of a given phase) is completed. A bond designed in this way could be initially priced with a coupon reflecting the baseline risk (before any project-generated risk reductions), with an opportunity for the coupon to 'reset' to a lower level once the project is completed. Another option is to issue multiple resilience bonds over time in a sequence of consecutive issuances. The first resilience bonds in a sequenced program would be priced with coupons that reflect the baseline risk, while bonds issued after project would reflect the residual risk.

Investor types and the finance they provide at different stages of project maturity

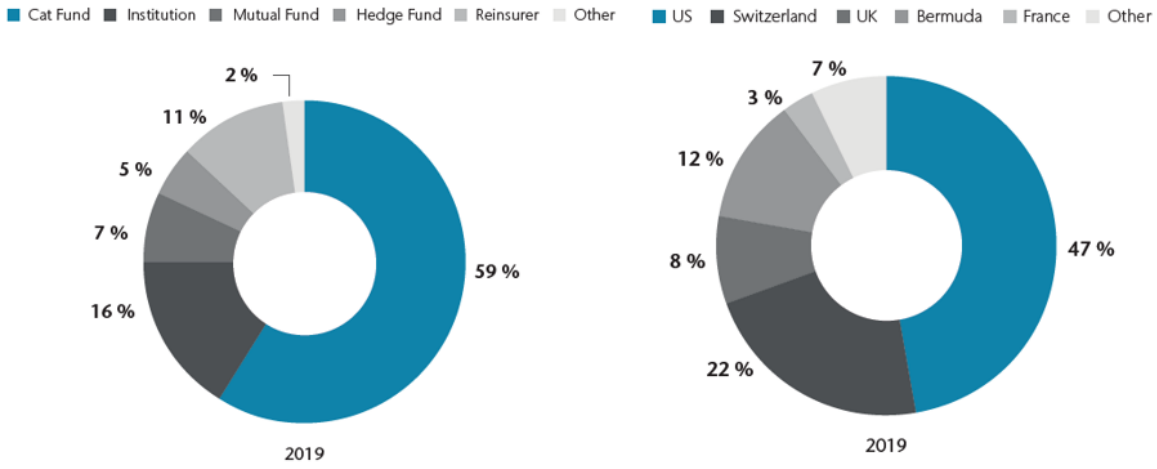
Over half of investors in catastrophe bonds are specialised catastrophe funds. The next category of investors that are most active in the cat bond market are institutional investors, who together with catastrophe funds provided over 75% of funding to cat bonds in 2019. Investors in cat bonds may find resilience bonds attractive not only as a high-yield financial instrument but also as a risk management tool:

a) The key risks that cat bonds, and by extension resilience bonds, face are natural disasters whose occurrence is driven by meteorological patterns. This is very different to most financial instruments found on capital markets, that are exposed to macro-economic, sector-specific or company-specific risks. Investing in resilience bonds can therefore be viewed by investors as an effective tool for diversifying risk at the portfolio level.

b) Some institutional investors such as pension funds may have direct financial interests in the assets which the resilience projects will seek to protect. Where this is the case, investors can manage the risks inherent in assets they own in their portfolio by investing in resilience bonds.

Resilience bonds focused on protecting ecosystems and using green infrastructure to strengthen resilience should be especially attractive to investors who have green and SDG-linked financing commitments, and are looking for new types of financial instruments to fulfil these commitments.

Figure 7. Catastrophe bond investors per type and country



Source: Aon ILS Annual Report 2019

Catastrophe bonds can be structured using multiple tranches, to accommodate investors with different levels of risk appetite. The most senior tranche is associated to a lower expected loss, whilst the subordinated tranche takes the highest level of risk by accepting a lower trigger/higher probability of qualifying natural disaster in exchange for a higher return.

Risk mitigation instruments used and how these were incorporated into the investment structure

Probability of event occurrence has been found to be a significant determinant in investors' pricing of risk for catastrophe bonds[10]. Sponsors should be mindful of these factors when they plan a resilience bond, so that they can offer a financial instrument that private investors find attractive.

A key feature of cat bonds is that both the coupon and the rate of return generally scales with the probability that a trigger event will occur or, more specifically, with the expected loss. In other words, a 'riskier' bond comes with a higher premium for sponsors and higher rate of return to investors. This is a feature of cat bonds that has been found to work effectively in attracting private sector investors in the cat bond space. The challenge for resilience bonds will be to successfully demonstrate to investors that expected loss, regardless of the probability of event occurrence, will be lower after resilience projects are implemented. Robust research on and modelling of the effectiveness of resilience projects in lowering expected loss will be critical in achieving this.

Proceeds from cat bonds are deposited into an account, which serves as collateral for the bond. There are strong existing industry guidelines in place requiring funds in collateral accounts to be invested in liquid securities with very low risks (e.g., in secure structured notes, such as IBRD notes issued by the World Bank, or in money market funds that invest in U.S. Treasury Bills) so investors can be confident that their principal is safely managed[11].

It should be noted that while cat bond investors take on considerable financial risk, cat bonds can be seen as an effective tool for risk diversification in the context of a portfolio-level strategy. This is because the risk associated with natural disasters is generally uncorrelated with the risks inherent to other types of investments.

The exit strategy employed

Catastrophe bonds are typically short-term securities, to reduce the risk to investors that a catastrophe triggering a payment default occurs over the life of the bond. This lowers the risk profile of the bond to a level acceptable to investors. They typically return the principal of the bond at maturity, unless an event in the meantime has triggered a default in which case only a portion or nothing at all of the principal will be returned to investors.

[10] Ciumas, C. and R.A. Coca. Analysis of Risk Premium Determinants on Cat Bonds. *Procedia Economics and Finance*. Volume 32, 2015, Pages 1487-1493. https://reader.elsevier.com/reader/sd/pii/S2212567115015300?token=3264F256927DEC4315972A5A73D2342F294DC0B2CB2CBE62E97C91A6C041D3E92481DB3443D934F9509965A66E2D3A85

[11] Some issuers may enter into derivative contracts with a financial institution that will guarantee a certain return on the collateral. When this is the case, the financial strength of the financial institution on the other side of this contract should be separately assessed, as under this structure the issuer is exposed to counterparty risk.

As a publicly traded financial instrument (unless the bond is privately placed), investors can sell catastrophe bonds they already own on the bond secondary market. Whilst cat bonds have at times experienced price volatility on secondary markets, most cat bond investors consulted as part of the resilience bond model development have expressed low levels of concern regarding liquidity prior to a bond's maturity.

Innovative features of the investment model

Resilience bonds offer a new pathway for resilience project financing. Resilience bonds offer a new approach for systematically linking catastrophe bonds and conventional project finance to support large-scale resilience projects. This provides a breakthrough to address the fact that, despite the growing interest in investing in resilient infrastructure, the pipeline of projects remains stubbornly stuck in traditional, direct revenue models. These projects can take years to plan, funding is often uncertain, and schedules shift regularly. The result is a combination of factors that limit the potential to capture insurance savings. For all of these reasons, resilience bonds offer public officials who have visibility and control over resilience projects a new way to leverage private capital to speed along the design, funding, and implementation of high-priority projects.

Resilience bonds leverage a financing mechanism and valuation approach already widely accepted on capital markets. Cat bonds have been present on capital markets since the 1990s and have been successful in offering market-rate returns to investors. They are typically priced using catastrophe models that are widely used in the insurance industry to evaluate the risk of a disaster and the potential resulting damages. Instead of relying on uncertain forecasts or waiting decades to measure a project's social and environmental performance, resilience bonds would therefore use the insurance industry's own approach to estimating risk, which relies on quantitative models and simulations, and applies it to generate up-front measures of project-based risk reductions. By focusing on the direct financial benefits of resilience projects—rather than hard-to-measure physical benefits or abstract proxies for social and environmental benefits (e.g., ecosystem services or community cohesion)— resilience bonds demonstrate how catastrophe modelling can serve as a resilience planning tool to open up access to a broad pool of private capital.

Resilience bonds do not significantly affect sponsors' balance sheet. Because resilience bonds are insurance products—not municipal bonds—sponsors are only responsible for paying premiums, not for repaying bond principal, which can help public-sector sponsors, such as municipal governments, avoid concerns about debt capacity limits or credit rating impacts.

Resilience bonds provide a new investment option for investors interested in "green" outcomes. Through its low correlation with other financial instruments, resilience bonds can attract capital from impact investors who are interested in investing in "green outcomes" but who are looking to diversify risk from other types of green financial products that are more sensitive to systematic risk (risk caused by macroeconomic factors and that affects the entire market).

Replicability and Scalability

Typically, issuances between one hundred and several hundred million dollars are the most common in current cat bond markets. The right size for sponsors will depend on a variety of factors, but generally speaking, resilience bonds can be scaled in three ways:

1. they can be scaled so that premiums fit within the available budget for insurance purchasing;
2. they can be scaled so that they meet particular insurance requirements; or
3. they can be scaled to offer a specific level rebate to help finance particular resilience projects.

At a global level, a significant insurance gap exists, leaving many local, state, and national government agencies unprepared in the face of ever more frequent and severe natural disasters. Resilience bonds provide a sustainable approach to driving insurance penetration in underserved regions by not only promoting financial protection against natural disasters but also financing increased resilience to future losses.

Scaling up "green" resilience bonds will be dependent on advancements in catastrophe modelling methodologies to robustly link expected loss to natural capital assets and expected loss reduction to green infrastructure projects. To start with, resilience bonds may tackle natural disasters that have a track record of catastrophe bond financing and for which green infrastructure has been proven to work.

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Unless otherwise specified, this document draws largely on the re:focus partners publications "Leveraging Cat Bonds for Resilient Infrastructure Project Finance" (2015) and "A Guide for Public-Sector Resilience Bond Sponsorship" (2017). For more information visit http://www.refocuspartners.com/.

Appendix: Demonstrating clear and measurable impacts on biodiversity conservation

These impacts can happen through interventions that are designed to ameliorate threats to biodiversity, at the species or ecosystem level. Influence over the delivery of ecosystem flows that benefit people is also desirable.

Threats to biodiversity can be assessed at a spatial scale using the Integrated Biodiversity Assessment Tool (https://ibat-alliance.org). The first step is to assess what biodiversity assets exist in proximity to project sites using the proximity tool of IBAT. Once threatened species, Key Biodiversity Areas and protected areas in the vicinity of the site are identified, then each of these have listings of threats to biodiversity that can be influenced by the investment opportunity. An example would be the reduction in pollution of biodiversity-rich rivers from investments in reforestation.

A clear statement of the planned reduction in threats to biodiversity that will be generated by the investment is necessary to justify priority status as a CPIC blueprint. In the first stage of project development, a simple assessment of the project proximity to biodiversity asset and the link between the impacts of investment and the reduction of threats is sufficient. Once investment activity is confirmed, a more detailed assessment of potential return on investment for biodiversity is required. A module to calculate this is under development for IBAT. This biodiversity return on investment can be calculated ex-ante, as a means of assessing opportunities for impact, and ex-post, once the investment is confirmed and management starts.

A first assessment of the impacts of the investment on ecosystem services to people can be made through the use of the TESSA tool (http://tessa.tools). A more detailed assessment of the tools available for conservation assessments, forest landscape restoration planning landscape assessment generally, and biodiversity management is available in the full Conservation Investment Blueprints: A Development Guide available on the CPIC website (http://cpicfinance.com/related-reports)."