InsuResilience
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Ecosystem-based Adaptation and Insurance: Success, Challenges and Opportunities

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Ecosystem-based Adaptation and Insurance: Success, Challenges and Opportunities

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Executive Summary

There are many opportunities for the greater integration of Ecosystem-based Adaptation (EbA) and insurance for risk reduction, and many challenges that remain. The substantive engagement between the insurance and environmental sectors is relatively new. Thus, it is hardly surprising that few fully integrated Climate Risk Finance & Insurance (CRFI) & EbA products (e. g., reef insurance) currently exist, and that such solutions face some challenges. That said, there are many common interests and significant opportunities which could help improve integration of CFRI with EbA and more broadly Nature-based Solutions (NbS), which will lead to innovations beneficial to both sectors and, most importantly, to improved resilience outcomes for vulnerable people and for nature.

Key findings from our review include:

- **Payments from private insurers and national governments are growing** and nearly exponentially for recovery from natural disasters;
- **There is strong interest in the donor and finance community for CRFI and EbA solutions** for risk transfer and ecosystem-based conservation and rehabilitation;
- **Quantitative adaptation benefits are identified for a few mainly coastal ecosystems**;
- **Wetlands (marshes and mangroves) already have been considered in industry risk models** as a risk-reducing feature. Reefs have not yet been included but could be;
- **There are some but very limited insurance incentives for conservation and restoration**;
- **Environmental and EbA solutions are not well understood by the insurance industry.** They are thus often perceived as too difficult and too slow and not offering bang for the buck;
- **Many governments subsidise coastal risk, which creates perverse incentives** for greater coastal development, loss of ecosystems, and reduced opportunities for private insurance;
- **The interest in joint insurance and EbA solutions is best explained by the opportunities** (i) to jointly meet client demands, (ii) to transfer and reduce risk from small to large magnitude events, (iii) to demonstrate risk reduction actions up front, (iv) while marshalling resources to transfer risks from more catastrophic events and (v) to achieve resilience dividends;
- **A growing number of projects are aligning interests between insurance and ecosystems**;
- **Yet only a limited number of EbA projects measure adaptation and risk reduction benefits**;
- **Even fewer risk reduction or insurance projects quantify conservation benefits**;
- **Very few organizations have experience supporting both EbA and CRFI projects**;
- **There are few if any fully implemented CRFI and EbA demonstration projects as of yet**.

Key recommendations include:

- **The adaptation and resilience benefits of EbA need to be better quantified in general and more specifically within the tools and approaches of the risk industry.**
- **EbA measures need to be reflected in risk (e. g., Nat Cat) modelling tools.** Risk modellers should include ecosystems in their models and environmental agencies should help them. The key data such as land use and bathymetry are included in many models. Industry assessment of these benefits could have wide ranging impacts on insurers, investors, and regulators.
- **Build from easier solutions to integrate insurance and EbA.** There are opportunities to expand integration by better incorporating risk reduction and EbA benefits in bonds. Green and social impact bonds that incorporate natural infrastructure and Nature-based Solutions are beginning to grow. A small number of these financial tools recognize risk reduction benefits and / or include insurance investors.
- **Insurance and EbA should continue to expand to reduce social vulnerability and exposure of public infrastructure and people.** Many of the opportunities to invest in integrated CRFI and EbA solutions will be driven and / or supported by donors, lenders and investors that have objectives for reducing the vulnerability of people and public infrastructure. These include for example development banks; special funds and programs (e. g., the InsuResilience Solutions Fund); and national disaster risk agencies such as the US Federal Emergency Management Agency (FEMA and the National Flood Insurance Program (NFIP) and in Mexico the National System for Civil Protection (SINAPROC) and its Fund for Natural Disasters (FONDEN).

In terms of next steps, we recommend:

- Better analyses of risk reduction benefits for more habitats;
- Advancement of existing nature-based data within risk industry modeling tools;
- Including these Nature-based Solutions in the assessment tools that underwriters surveyors, and others use to assess premiums and incentives;
- Greater inclusion of EbA and nature-based measures in cost effective analyses;
- Better financial and donor support for the development of CRFI & EbA demonstration projects including for concept development;
- Improvements in habitat restoration approaches to help meet risk reduction and environmental goals;
- More efforts on developing green and impact bonds that explicitly include risk reduction measures and benefits.

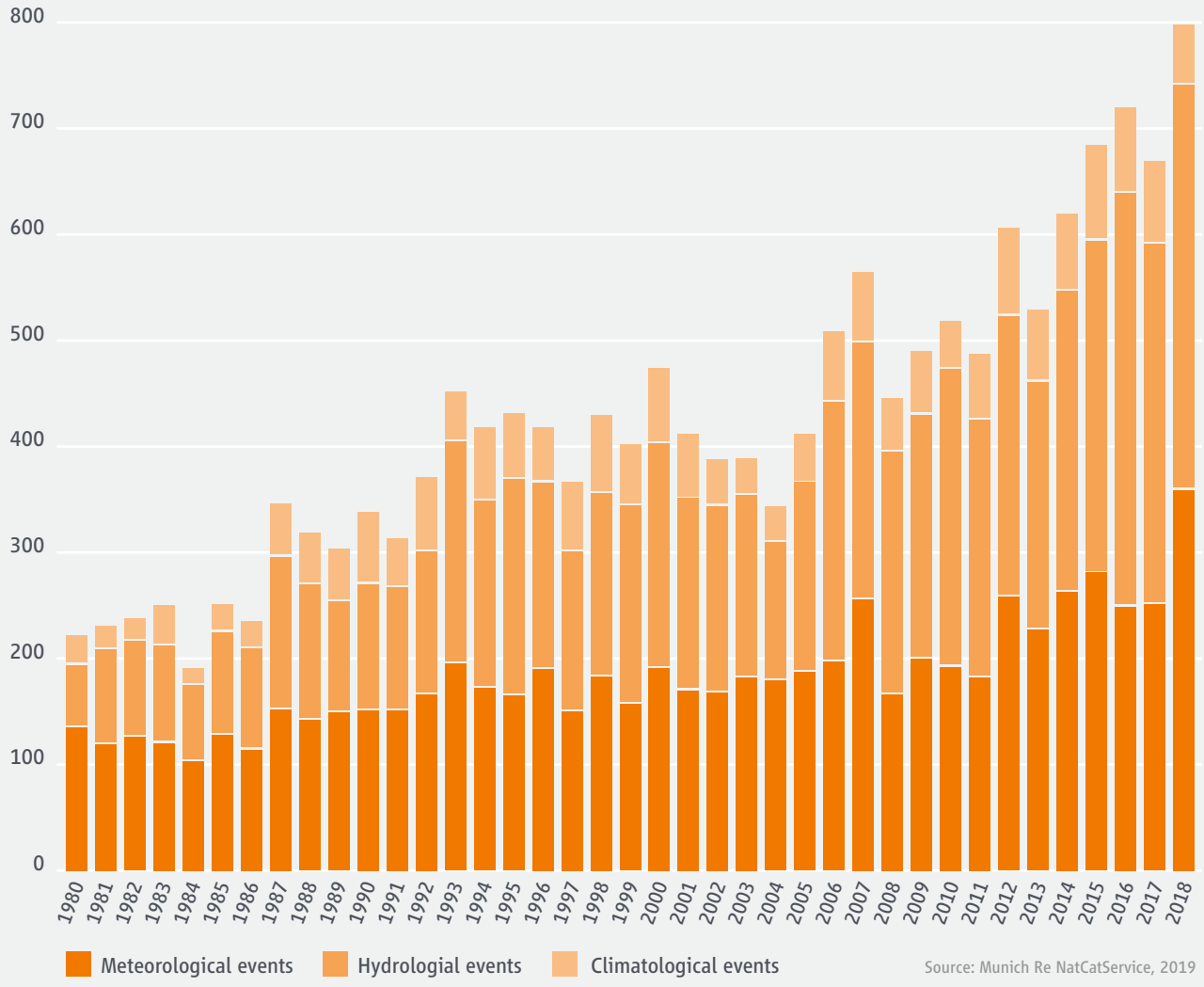
1. Introduction

The risks to people and ecosystems from natural hazards are growing with climate change, while their exposure due to urbanisation, economic development in risk-prone areas and natural degradation increases the risk even further. There is substantial interest in finding solutions that help to reduce these risks and help both people and ecosystems adapt to these changes. Separately both Ecosystem-based Adaptation (EbA) and Climate Risk Finance & Insurance (CRFI) have been used to aid adaptation, reduce and transfer risk, and build resilience to the growing impacts from natural and human-made hazards. There is a nascent and growing interest in where these strategies may intersect and be mutually beneficial for adaptation.

This review assesses the successes, challenges, gaps and opportunities around the nascent but growing efforts in EbA-CRFI as an approach to climate adaptation. Many studies refer separately to the effectiveness of EbA or insurance

Figure 1

Number of relevant weather-related loss events worldwide 1980–2018



Source: Munich Re NatCatService, 2019

measures for adaptation and risk reduction. Despite these overlapping objectives of EbA and CRFI approaches, these concepts have so far predominantly been considered separately in the past. Our study examines where these concepts align and identifies how this alignment could be further catalysed to reduce impacts to lives, livelihoods, property and ecosystems.

Climate Risk Financing and Insurance (CRFI) is defined as the ability of the insurance industry to support people to adapt to the adverse effects of climate change through knowledge or risk transfer or direct investment.

CRFI encourages climate risk assessment as a critical foundation for an integrated climate risk management and related financial and funding strategies, while it strengthens disaster risk governance by increasing financial response capacity of governments to meet post-disaster financing needs without compromising fiscal balances. If used to its full extent, it builds synergies with various stakeholders to develop risk financial and funding strategies.

However, CRFI strategies are no panacea. Their contribution to risk reduction and resilience building depends on the quality of the financial tool and whether it has been designed to respond efficiently to the needs of the final beneficiaries. If designed poorly or targeted inappropriately, finance tools not only may not contribute to risk reduction and resilience but may increase vulnerability or exposure (Le Quesne et al. 2017).

In terms of knowledge, the insurance industry's business model relies on understanding the causes and effects, mitigation and adaptation measures of climate change as the core business is to understand, manage and carry risk. Through risk prevention and risk reduction and by distributing risk, the insurance industry contributes to resilience. A sustainable CRFI strategy has an important role to play in disaster risk management. Not only do risk financing strategies reduce the economic burden following a disaster, but they can also be instrumental in reducing human suffering and preventing and mitigating losses through appropriate preparedness and early action measures before a climate-related hazard turns into a disaster. A risk assessment is essential to identify exposures and hazards that create vulnerability as well as estimating potential impacts. It also provides the basis for decision-making of cost-effective CRFI strategies to be applied. Consequently, the industry possesses large amounts of loss data and pricing models which help to analyse risk and resulting losses and is in constant exchange with internal and external experts.

In terms of direct investment, insurers invest large proportions of their assets on the financial markets: Corporate Social Responsibility (CSR) can also be seen on the assets side where environmental, social, and corporate governance (ESG) criteria are adhered to. UN's six Principles for Responsible Investment (PRI) and Principles of Sustainable Insurance (PSI, described below) are part of the insurance industry criteria to be included in ESG indices such as the Dow Jones Sustainability Indices or FTSE4Good. However, direct investments in EbA measures are the exception. More typically, insurers invest in "eco-friendly infrastructure", such as renewable energies. For example, Allianz invested € 6.8 billion with debt and equity investments.

In terms of risk transfer, the industry is equally active in CRFI. The United Nations Environment Programme Finance Initiative Principles of Sustainable Insurance (PSI) was adopted by more than 120 organisations worldwide, including insurers representing more than 25 % of world premium volume. Additionally, any type of traditional property insurance covers natural-catastrophe (Nat Cat) events, even if not aimed specifically at developmental gains – therefore, the industry's profits directly depend on the causes and consequences of climate change.

Ecosystem-based Adaptation (EbA) is defined as the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change.

Conceptually, EbA is one part of a broader set of Nature-based Solutions (NbS) which covers climate adaptation, EbA solutions, as well as the use of nature for disaster risk reduction or "Eco-DRR" (GIZ 2019, Cohen-Shacham et al. 2016 & 2019). The aim of Nature-based Solutions is to meet multiple management objectives including both conservation and other development goals (e. g., climate adaptation, risk reduction, food and water security). In this document, we will use NbS and EbA interchangeably; NbS is the umbrella concept and within that this review focuses on adaptation and risk reduction.

There are a rapidly growing number of EbA projects covering nearly all environments from mountains to oceans. All these projects face the challenge to develop and implement projects that use biodiversity conservation and restoration to

measurably reduce society's vulnerabilities and exposure to climate change impacts and other hazards.

Some of the most advanced examples of EbA projects are coastal where habitats are used to reduce risks of erosion and flooding from future storms and sea level rise. These projects make compelling examples as the exposure to climate hazards is increasing for 60 % of the world's population that live on the coast. This coupled with coastal development and coastal habitat destruction is dramatically increasing the risks of flooding, erosion, and extreme weather events for millions of vulnerable people, important infrastructure, and trade. The pay-outs from public agencies and private insurers for coastal hazards is increasing (Figure 1, on p. 8). In 2017, private insurers alone have paid out more than $ 133 billion[1] for weather related damages and most of that was from coastal storms.[2] Importantly, the benefits of coastal ecosystems to risk reduction and adaptation can be rigorously measured (Spalding et al. 2014, World Bank 2016; Beck et al. 2018, Losada et al. 2018, Menéndez et al. 2018).

Governments worldwide are dedicating billions of dollars to reduce risks from disasters and climate change. To date, most of these investments in coastal protection are for the creation and maintenance of "grey infrastructure", such as seawalls and breakwaters. These artificial structures are static, ecologically disruptive and often vulnerable themselves to future storm and climate impacts. In comparison nature-based defences, can be dynamic and they can grow and adapt to changing environments. For example, reefs and wetlands can grow up and keep pace with sea level rise.

We can rigorously value and quantify the benefits of Nature-based Solutions and EbA using tools and approaches from the insurance and engineering sectors (World Bank 2016, Narayan et al. 2018, Reguero et al. 2019). The benefits of wetlands and reefs for flood risk reduction can be clearly identified. The valuation of these services can provide a strong incentive for decision-makers to manage these ecosystems better and can be used to bolster cost effective financing from insurance, development and disaster risk reduction sources.

Despite the fact that coastal wetlands and reefs (e. g., mangroves, marshes, corals and oysters) offer significant coastal protection, these ecosystems are some of the most threatened marine ecosystems on earth. Coupled hydrodynamic and economic models have shown in global analyses that if mangroves were lost the costs of storms would increase by 25 % (Losada et al. 2018, Menendez 2018). Annual expected damages from flooding would more than double, and costs from frequent storms would triple without reefs (Beck et al. 2018). Coral reefs provide significant annual flood protection savings for people and property, particularly from the most frequent storms. Across the USA, high resolution assessments of flood risk and NbS benefits show that coral reefs reduce flood damages by $ 1.8 billion annually (Storlazzi et al. 2019). Using insurance industry-based tools and data from Risk Management Solutions (RMS), marshes in the Northeast USA have been estimated to reduce property damages from flooding by more than 16 % and reduced damages by more than $ 625 million during Hurricane Sandy alone.

Coastal NbS have also been shown to be cost effective compared to other artificial solutions for flood risk reduction (e. g., CCRIF 2010, Ferrario et al. 2014, Narayan et al. 2016, Reguero et al. 2018, Jacobsen et al. 2019). The Caribbean Catastrophic Risk Insurance Facility (CCRIF) found that, in seven out of the eight countries examined, reef and mangrove restoration were among the most cost-effective approaches for coastal risk reduction and adaptation (CCRIF 2010) (see Figure 2). Ferrario et al. (2014) found the reef restoration could be tenfold cheaper than the development of artificial breakwaters for flood protection. Reguero et al. (2018) used insurance industry-based models to show that every $ 1 spent on restoring marshes and oyster reefs on the American Gulf Coast reduces storm damages by $ 7 (i. e., B:C >7).

Many countries are already restoring these ecosystems for their natural coastal protection benefits. In Vietnam, for instance, the reforestation of 9,000 hectares of mangroves demonstrated cost-benefit ratios ranging from 3:1 in some communities to as high as 28:1 in others (IFRC 2011).

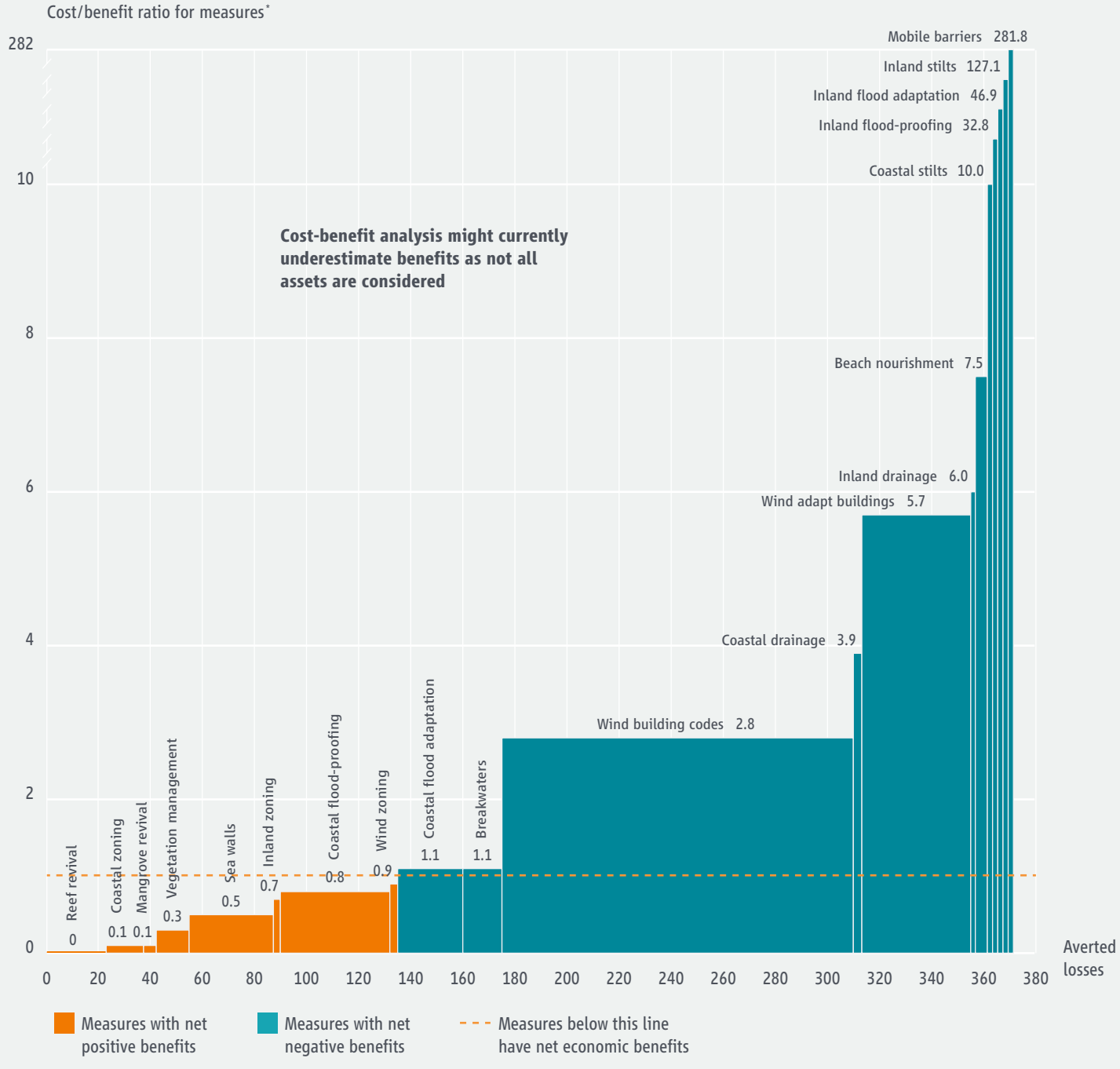
1 "$" refers to US dollar throughout the text.
2 Munich RE (2017): Hurricanes cause record losses in 2017 – The year in figures; available online at: https://www.munichre.com/topics-online/en/climate-change-and-natural-disasters/natural-disasters/2017-year-in-figures.html.

Figure 2

Cost-benefit ratio and loss avoidance potential for adaptation measures

in USD m, 2009

Results from analyses of the Cost:Benefit (C:B) ratios of various measures for flood risk reduction in Jamaica (CCRIF 2011). The most cost-effective measures (i. e., lowest Cost to Benefit) are on the left in this graphic and include reef and mangrove restoration. These results were similar for 7 of the 8 Caribbean countries examined by CCRIF.



* Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

A Review of EbA & CRFI: Scope of Work and Methods

Both EbA and CRFI are gaining attention as complementary approaches for climate change adaptation. Integrating approaches from EbA-CRFI has the potential to enhance adaptation and disaster risk reduction strategies. However, the synergies from these concepts have not been examined previously. Therefore, this study aims to close that gap and to present some first insights into how these mechanisms have been and could be combined better.

We gathered information for our review and analysis based on (i) literature reviews, (ii) case studies and (iii) semi-structured expert interviews. There is a very extensive literature on EbA and a growing literature on CRFI with a small literature on CRFI-EbA. This literature was used primarily to gather information on factors critical to developing and implementing CRFI-EbA such as advances in the assessment of climate risk, ecosystem risk reduction benefits and finance options (e. g., resilience bonds). The literature review was also used to identify case studies (demonstration projects) where CRFI-EbA projects are beginning to be implemented. We tried to identify case studies that best exemplified how CRFI-EbA could be combined with a focus on those that explicitly met key measurement criteria.

We gathered information on case studies from interviews with project proponents, the grey literature, and personal experience. We conducted many expert interviews with individuals across sectors in the insurance industry, conservation, science, and management. These interviews were used to get a focused examination of critical issues and where appropriate confidentiality was ensured.

We focused on coastal examples as noted above, because of our expertise and more importantly because many of the best EbA-CRFI examples have been done in coastal environments – and mainly on flood reduction benefits. But we also present key examples from non-coastal ecosystems.

Finally, we have reviewed the inclusion of climate risk insurance and EbA in National Adaptation Plans and Nationally Determined Contributions of the UNFCCC (see Annex).

3. Ecosystem-based Adaptation (EbA) from an Insurance Perspective

3.1 General Interest

Linking insurance products and services to EbA efforts may offer several financial opportunities for the risk industry. The following examples explain three areas, in which the insurance industry's financial objectives have a direct overlap with the benefits that EbA measures can provide, therefore highlighting currently underserved areas for the insurance industry:

(1) **Reducing Insured Losses**
If implemented correctly, EbA measures contribute to reducing the exposure of nearby assets and consequently the losses paid by insurers. In the context of coastal EbA, the assets on the shoreline are protected from hurricanes (waves and wind) as well as from coastal flooding caused by other perils (e. g. earthquakes triggering tsunamis). Besides the financial interest of the industry, social and ecological aspects need to be considered. If the above-mentioned reduction in loss expectancies are translated into premium reductions, these savings may serve as an incentive to invest in EbA structures. These "resilience dividends" are the basic concepts underlying resilience bonds, which are described later.

(2) **Creating New Insurance Opportunities**
With increased competition over the last years, the drive for innovation in the insurance industry to explore and search for ways to support innovation has grown significantly. While the present focus of the industry lies in gaining competitive advantages through a smart use of opportunities offered by new technologies such as artificial intelligence and the internet of things, EbA offers a different, currently underdeveloped innovation potential.

› **Post-loss Risk Protection**
The majority of insurance products are currently "indemnity-based" where the insurance is based on assessing expected losses and recovering actual losses. That is insurers take tariffs based on historical data to determine the technically adequate premium for the asset to be covered. After loss events, surveyors determine the actual loss sustained. This widely used approach leads to low margins in competitive markets.

A growing number of products are now parametric-based. These products do not pay out based on the measured damage of the insured asset itself, but on another parameter, which historically has proven to have a high correlation with a loss. For example, many products pay out if winds reach pre-determined catastrophic speeds at measurement stations. In this case, surveyors are not used, which can reduce costs and speed the delivery of pay-outs.

Parametric products can be useful for ecosystems as insurable assets, because it can be difficult to quickly survey damages to ecosystems, but there are strong correlations between ecosystem damage, wind speed and water height, which can be used to trigger risk transfer mechanisms. This provides opportunities to develop customised solutions and gain competitive advantages in the market, as there are fewer competitors in the market compared to traditional, indemnity-based solutions. Developing insurance solutions that provide financial protection for ecosystems and / or complement EbA efforts therefore offer opportunities to develop new markets and expand revenue sources while improving the response capacity through reliable and fast post-disaster reconstruction does not only save lives – a fast reaction also reduces the costs to reconstruct dramatically compared to a slow response.

› **Creating New Investment Opportunities**
Another opportunity for advancing CRFI and EbA solutions exist in the form of direct financial investments (asset side) by insurers. Insurers are amongst the largest investors in the capital market due to their need to invest premium payments to earn revenue for later pay out. The industry's expertise around risk modelling and assessment can strengthen its ability to invest in green / blue infrastructure, if it leads to an advantage in the evaluation of expected returns on investment compared to other investors.

(3) **Linking to Climate Change**
Climate change poses a big challenge on insurers' long-term financial sustainability, with climate-change related losses are expected to increase. Therefore, any efforts in adaptation (research, financial direct participation, etc.) can be considered an investment that reduces potential losses.

Investments in adaptation could help insurers to address investor concerns around the long-term impacts of climate change on the industry and the ability of insurers to find the necessary answers in their business and investment strategies. Although there may be no direct causal link between an investment in an adaptation measure and the pay-outs faced by the insurance industry in the future, these investments can certainly be considered a low-regret measure and will be compatible with the industry goal of contributing to the implementation of the Sustainable Development Goals.

Overall the industry could leverage the opportunities above and serve as a catalyst for the implementation of EbA measures. A deeper investment by the insurance sector could enable unlock new business potential and ultimately offer new revenue sources.

4. Entry Points for CRFI and EbA

There are at least five key entry points where insurance and Nature-based Solutions can align with one another through financial tools:

- **Bond-based incentives for EbA** wherein the uptake of insurance is linked to the implementation of specific EbA measures or when premiums can be reduced due to nature-based measures. Environmental and social impact bonds are financing mechanisms in which an investor is being given the opportunity to earn a return if a predefined target is achieved and paid by an outcome funder. In the context of EbA, this target is always related to the achievement of a goal related to an environmental impact (e. g., restored habitat). This mechanism is proving to be useful in many cases (see section 5.1).

  Resilience bonds are a mechanism that combines the idea of a classical cat bond (in which investors get a return on their investment if a certain, pre-defined natural disaster event does not occur and lose the return of the event occurs) and the impact of a resilience building measure: The idea is that money invested in resilience building reduces the investors risk and therefore the interest payments. Through that, the difference in interest paid to the bond investors (pre- and post a resilience measure) is a rebate, which serves as an incentive towards investing in resilience measures. The idea has been identified in previous work (re:focus, 2017), but there is not yet a specific demonstration project for this concept.

- **Insuring ecosystems** wherein insurance policies are taken out to provide funding for the restoration of lost services when ecosystems are damaged by natural or human-made hazards. For example, an insurance policy can be taken out to restore the flood protection benefits from reefs and mangroves if they are damaged in storms.

- **Supporting EbA with insurance pay-outs.** At present, there are usually few conditions on how clients should spend funds from insurance pay-outs. But insurance pay-outs could be tied more generally to developmental goals, which could include EbA restoration. International organizations and Multilateral Development Banks (MDB) could help by developing standards and frameworks that promote these types of arrangements. This could be particularly relevant in cases where insurance costs are partly supported by external donors such as development banks and their support is aimed at achieving risk reduction and broader social and environmental goals. Where EbA can be shown to be cost effective for meeting these multiple goals then there is opportunity to support it through prearranged disbursement plans for insurance pay-out.

- **Insurers as NbS investors** wherein (re)insurers invest in social impact bonds or green bonds that include actions to conserve and restore ecosystems for their financial returns and their benefits to society. Given the amount of assets that insurers invest in the financial markets, this opportunity is easy to achieve.

- **EbA market creation, off-setting and credit trading.** Following the same principle, as biodiversity offsetting or carbon emission trading schemes,[3] this example creates a market for an ecosystem-based service just that it is not for climate change mitigation but for climate change adaptation. The Washington D.C. Stormwater Credit Trading System below described this case. Here a mandatory storm water retention limit to be achieved in certain areas, can be off-set by buying "credits" for stormwater retention elsewhere. Through this quantified credit system, credits are priced and traded. This creates a market for an ecosystem service, i. e. storm water retention, which did not exist before. The trading of credits offsets regulatory needs between sites. The revenue for the investor is generated through maximizing available storm water retention opportunities and the difference between buying and selling price of the credits. It has been applied in Washington D.C. to develop underserved community areas leading to increased social equity.

3 European Commission (2019): EU Emissions Trading System, see: https://ec.europa.eu/clima/policies/ets_en.

5. CRFI and EbA Case Studies

There are a growing number of projects that aim to combine elements of financing and insurance mechanisms with EbA. These projects serve as developing case studies for CRFI-EbA projects, which we have examined in depth below and summarised in Figure 9 (p. 41) and Table 1 (p. 43). At present, we would not suggest that any case study represents a quintessential demonstration of CRFI-EbA, but these projects all incorporate critical elements of a CRFI-EbA project and there are important lessons to be learned from them.

In examining the case studies and discussing with interviewees, we found it useful to identify if and to what extent a number of critical elements had been addressed. The critical elements included whether or not:

(1) Climate risk identified (e. g., coastal flood, fluvial flood, fire)
(2) EbA solution identified (e. g., reef, wetland, forest, restoration and conservation)
(3) Ecosystem service function identified (e. g., flood reduction, erosion, fire reduction)
(4) Climate change-related risk rigorously valued / assessed (economic and / or social)
(5) EbA benefits (economic and / or social) rigorously valued / assessed
(6) CRFI product developed (Insurance policy, Cat Bond, Resilience Bond, Green Bond)
(7) Supply-side identified
(8) Demand-side identified
(9) EbA project designed
(10) EbA project implemented
(11) Project implementer identified
(12) Monitoring protocol developed
(13) Monitoring programme implemented

5.1 Case 1: Caribbean Oceans and Aquaculture Sustainability Facility (COAST)

Location & status	Caribbean; status open / exploration phase	**Overall goal**	Sustainable food production, promotion of sustainable fishery policy
EbA measure	n/a, however potential for measures increasing sustainable fishing (e. g. reefs)	**Climate hazard addressed**	Tropical cyclones
Sector beneficiaries	Fisheries, aquaculture	**Stakeholder lead**	Caribbean Regional Fisheries Mechanism (CRFM)
Other stakeholders	Caribbean Catastrophic Risk Insurance Facility (CCRIF)	**Financing instrument**	n/a
Financing volume:	n/a	**EbA insurance instrument**	Parametric storm triggered policy

Overview and Description

The Caribbean Oceans and Aquaculture Sustainability Facility (COAST) initiative aims to help to reduce the risk that climate change poses to food security and nutrition and to mitigate climate change impacts on the fisheries sector and to sustainable food production overall. Within the COAST Initiative, the Caribbean Regional Fisheries Mechanism

(CRFM) and the Caribbean Catastrophic Risk Insurance Facility (CCRIF) are collaborating to develop a sovereign insurance COAST product for the fisheries and aquaculture sectors in the Caribbean. This product aims to help governments in the region achieve CRFM's mandate to promote the Caribbean Community Common Fisheries Policy, specifically the Protocol on Climate Change Adaptation and Disaster Risk Management in Fisheries and Aquaculture. The insurance product aims to reduce the risks and uncertainties, as well as improve resilience of the fishing communities by enabling them to recover and rebuild without delay after disaster events.

Together CCRIF and CFRM are supporting the COAST product within CRFM Member States and explore other microinsurance products around the fisheries and aquaculture sector. They will also jointly promote climate-resilient fishing, fish farming and resource management practices among CRFM Member States. This fisheries/aquaculture product will be in addition to CCRIF's current suite of parametric insurance policies for tropical cyclones, excess rainfall and earthquakes for the countries in the region. The CRFM promotes and facilitates the responsible use of the Caribbean region's fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region. It is responsible for coordinating the implementation of the Caribbean Community Common Fisheries Policy, including the Protocol on Climate Change Adaptation and Disaster Risk Management in Fisheries and Aquaculture, which has the goal of ensuring development of regional fisheries and aquaculture sectors that are resilient to climate change and ocean acidification, and enhanced through comprehensive disaster management and sustainable use of marine and other aquatic living resources and ecosystems.

CCRIF aims to limit the financial impact of catastrophic hurricanes, earthquakes and excess rainfall events to Caribbean and – since 2015 – Central American governments by quickly providing short-term liquidity when a parametric insurance policy is triggered. It is the world's first regional fund utilizing parametric insurance, giving member governments the unique opportunity to purchase earthquake, hurricane and excess rainfall catastrophe coverage with lowest-possible pricing. CCRIF was developed under the technical leadership of the World Bank and with a grant from the Government of Japan. It was capitalised through contributions to a Multi-Donor Trust Fund (MDTF) by the Government of Canada, the European Union, the World Bank, the governments of the UK and France, the Caribbean Development Bank and the governments of Ireland and Bermuda, as well as through membership fees paid by participating governments.

An ultimate aim of the COAST product is to use insurance to reduce risk to fishers, fisheries, and fish and to use insurance to build resilience in the fisheries sector. If these resilience aims are achieved, then there will be significant EbA benefits as fish stocks improve and fishers gain food security through improved fisheries.

The first products were issued on July 1, 2019 to the governments of Grenada and Saint Lucia.[4] The COAST insurance policies provide coverage for fishers and others in the fisheries industry to enable them to recover quickly after weather-related events. Initial funding for COAST was been provided by the U.S. State Department. If one of these new policies is triggered, the funds will be provided by CCRIF to the Ministry of Finance, followed by a rapid transfer to fishers. To facilitate timely transfer of funds, the list of beneficiaries is defined at the time of policy inception by the government and is designed to include beneficiaries from the fisheries value chain, including fishers, crew members, captains, boat owners, fish vendors and processors.

Evaluation

There are several successes already for the COAST programme. First, buyers are interested. Caribbean governments are very interested in reducing risk to fishers and the support from the World Bank and US AID have helped to strengthen interest in the potential products. Furthermore, the involvement of CCRIF for insurance and CRFM for fisheries management have helped in the engagement of buyers and their confidence in the products. Second, the COAST project has supported efforts to develop a Registry of Fishers in multiple countries. This registry was required to clearly identify ahead of time who would benefit in a pay-out event.

There are several gaps and challenges. In particular, the first products are more traditional and focus on reducing storm risk to fishers. These products do not yet support resilience building or adaptation in the fisheries sector. There is even

4 The Caribbean Catastrophic Risk Insurance Facility (2019): Caribbean Countries to Benefit from Access to Insurance for the Fisheries Sector, available at: https://www.ccrif.org/content/news.

some risk that the present product could lead to further overfishing by ensuring capital to prosecute fisheries. The linkages between management actions, stock status and fisheries resilience are only weakly documented. Ultimately, a product that creates greater resilience in fisheries would allow them to recover when they are collapsed / collapsing by providing income to fishers when they cannot / should not fish. This would have benefits for the ecosystem, because more fish helps the whole ecosystem recover and benefits to fishers because they ultimately have better and more consistent fisheries.

However, the concept of using insurance-based incentives to reduce risk and build physical resilience for fisheries is less straightforward and relies on how effectively incentive structures actually trigger risk-reducing measures. One effective structure could be to apply changes in premiums based on fish stock status (higher premiums if fish stock is depleted). This requires long-term data on stock status to develop the risk curve, i. e., the relationship between stock status and the likelihood of fisheries collapse. These data are required to be able to estimate, for instance, variability in stocks over time and to develop frequency curves similar those for storm return periods and property damage. Unfortunately, these data are limited for most fish stocks and that is particularly true in developing countries.

Another challenge is that there is not strong spatial and management structure in the fisheries and among fishers. Approaches like COAST are easier to both implement with fishers and to affect fisheries when there is strong spatial structure in fish populations (e. g., less mobile) and the fishery (e. g., fishery co-operatives). That is, a market-based mechanism works best when it is clear who the buyers are and when they have clear stakes ('ownership' of the assets). These are relatively rare in Caribbean fisheries where fish migrate widely and fishers move readily between fisheries.

Finally, most individual fisheries are quite small across Caribbean nations (e. g., reef fish in Grenada) and thus it is difficult to muster the market support in building and selling viable insurance products.

5.2 Case 2: Forest Resilience Bond

Location & status	Yuba River Watershed, California, USA	**Overall goal**	Forest restoration, risk reduction
EbA measure	Forest restoration (15,000 acre)	**Climate hazard addressed**	Fire hazards, Water quantity
Sector beneficiaries	Yuba Water Agency, Tahoe National Forest, CAL FIRE, the Sierra Nevada Conservancy	**Stakeholder lead**	Blue Forest Conservation, World Resources Institue (WRI)
Other stakeholders	CSAA Insurance Group, Calvert Impact Capital, Rockefeller Foundation	**Financing instrument**	Loan
Financing volume:	$ 4 million	**EbA insurance instrument**	n/a

Overview and Description

Unhealthy and overgrown forests expose communities to heightened wildfire risk and diminished water supplies. For decades, the U.S. Forest Service (USFS) and others have taken the approach of suppressing fire. As a result, many

forests now contain up to 10 times as many trees compared to historical levels. The repercussions of this overgrowth can be catastrophic. The Yosemite Rim Fire, for example, burned more than 250,000 acres in 2013, cost $ 127 million to suppress, and resulted in hundreds of millions of dollars in lost tourism, infrastructure, and property damages. The fire was also estimated to have released over 11 million metric tons of carbon (Blue Forest Conservation & Encourage Capital 2017).

The USFS, which manages 193 million acres of public forests across the U.S., has identified many forests as "overgrown and unhealthy" and calls for action to "return forests to the way they were historically". Its forest restoration efforts aim to restore health by removing excess vegetation with benefits including reducing wildfire risk, improving water quantity and quality, avoiding carbon emissions, protecting habitats, and building community resilience.

Forest restoration can generate positive resilience impact and economic value for a wide array of beneficiaries including public utilities that rely on forested watersheds for water supply and hydroelectricity generation. Further, California supports carbon sequestration for climate mitigation and has designated carbon emissions from wildfires as a funding priority. Forest restoration can also generate significant rural employment opportunities as part of a restoration economy.

There is a compelling economic case for investment in forest restoration for these benefits, but previously few such opportunities existed. The Forest Resilience Bond (FRB) seeks to address this need by harnessing private capital to complement existing funding and facilitate investment in the management of public lands.

The FRB is a public-private partnership that enables private capital to finance much-needed forest restoration (Figure 3). The primary sources of cash flow for FRB projects are derived from monetizing water, fire, and other ecosystem services created by forest restoration activities.

Beneficiaries of the restoration work such as USFS, water and electric utilities, and state governments make cost-share and pay-for-success payments over time (up to 10 years) to provide investors competitive returns based on the project's success. Pay for Success (PFS) is an approach to contracting that ties payment for service delivery to the achievement of measurable outcomes. The movement towards PFS contracting is a means of ensuring that high quality, effective social services are working for individuals and communities. Traditionally, contracts or grants to support social service delivery are based on a volume delivered (e. g., trees planted). An outcome is a long-term, positive change (such as ecosystem services delivered). In a PFS contract, the payer agrees to provide funding if and when a pre-agreed-upon outcome is delivered. Typically, an independent evaluator determines whether the agreed-upon outcomes have been met.

The first Forest Resilience Bond for the forest restoration in the Yuba River watershed was announced in November 2018. The bond will support a forest restoration project protecting 15,000 acres of forestland in the North Yuba River watershed using ecologically based tree thinning, meadow restoration, prescribed burning, and invasive alien species management. The restoration aims to reduce the risk of severe fire, improve watershed health, and protect water resources. The restoration treatments are prescribed by the Forest Service and rely on the work of existing restoration crews.

The Yuba Water Agency has committed $ 1.5 million over five years to reimburse investors. In addition, the state of California has committed $ 2.6 million in grant funding to the project from the state's Climate Change Investment program. The Tahoe National Forest will provide in-kind support and services and has provided all the resources associated with planning and project permission.

Evaluation

Some of the successes include that there is very clear funding for important restoration activities that reduce risks and offer multiple additional benefits. There are clear buyers and sellers. In many senses, this is a bridge financing project that allows quicker investment in much needed actions with several sources of guaranteed return of funds and a range of public and private investors.

It is important to note that an insurance company (CSAA) is an investor in this bond, but there is not an insurance (i. e., CRFI) product per se. Indeed, while risk reduction is perceived by all parties as a benefit of the project, this ecosystem service is not directly monetized in this product. Nonetheless, insurers may look at these approaches as a means to transfer financial risk (if not hazard risk) with environmental benefits.

The project proponents examined if there could be more direct ties for fire risk reduction and insurance benefits, but several factors made this connection difficult. First, despite some extremely catastrophic fires in California, the overall risk of fire in any one time and place is relatively low (although clearly growing with climate change), so the gap in timing between management action and risk reduction benefit was long, which was challenging for insurance.

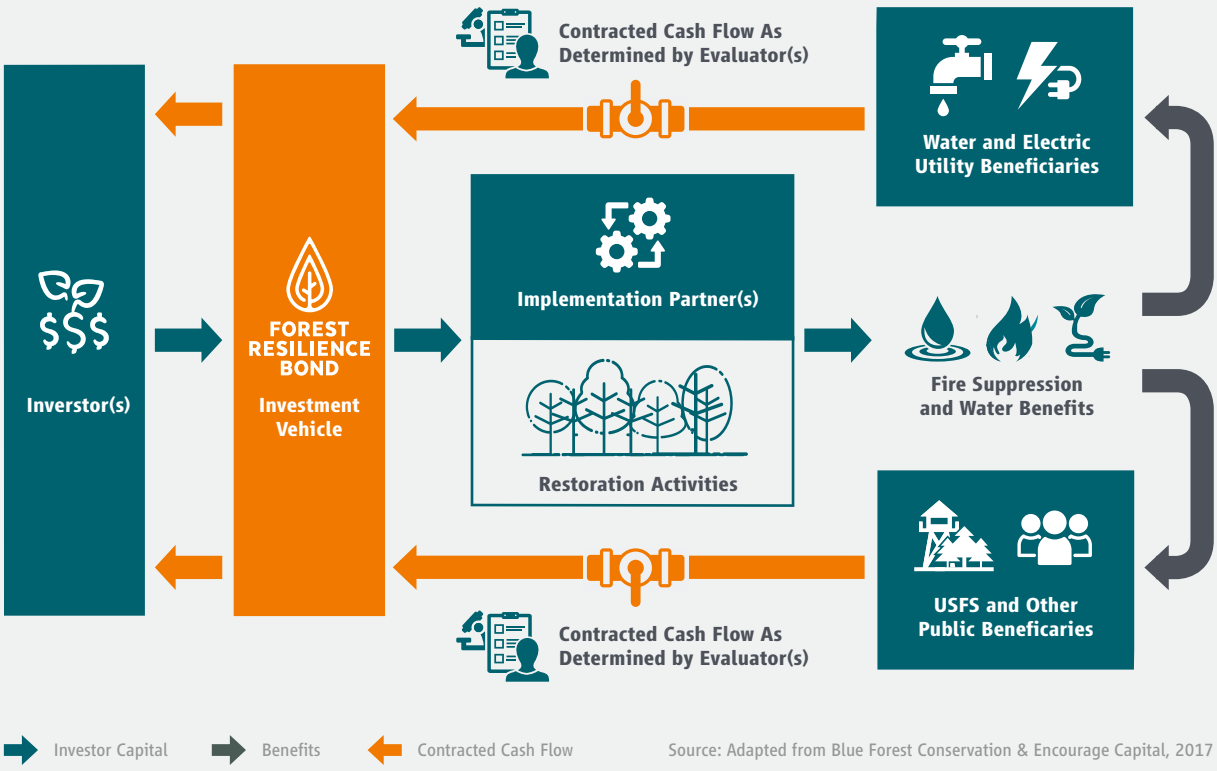
Second, the assets around most national or otherwise protected / managed forests tend to be quite low. These forests and their surroundings are often sparsely populated, rural communities where it can be difficult to develop a product with significant benefit to cost ratios for risk reduction. Although CSAA was interested as an investor in part because many of its members include retired military service men and women that are important community members in rural forested communities.

A third challenge is identifying the right balance of forest thinning (and other restoration actions) to jointly meet both conservation and disaster risk reduction goals. For example, risk reduction managers may be interested in much greater thinning of forests (to reduce fire risk) than desired by environmental managers seeking healthy forests.

Initial funding for project development was a fourth challenge but fortunately, philanthropic foundations stepped in to help. Even a concept with clear needs and funding opportunities demands significant up front support to develop the approach, assess ecosystem benefits, identify EbA actions, design the financing schemes, find potential investors and supporters, and obtain any permits and other permissions for action. These are non-trivial, front-end expenses that often take several years to finalize, which can be difficult for even large groups and companies to finance on their own. This is double challenging for smaller groups.

Figure 3

Structure of the Forest Resilience Bond



Source: Adapted from Blue Forest Conservation & Encourage Capital, 2017

5.3 Case 3: Louisiana Impact Bond

Location & status	Louisiana, USA; tentatively adjacent to Port Fourchon	**Overall goal**	Restore wetlands, reduce rate of other wetland loss; reduce flood damages
EbA measure	Wetland construction	**Climate hazard addressed**	Storms & sea level rise
Sector beneficiaries	Stakeholders living close to coast	**Stakeholder lead**	Coastal Protection and Restoration Authority / Coastal Protection and Restoration (CPRA / CPR) Financing Corporation
Other stakeholders	Local contractors securing wetlands	**Financing instrument**	Asset-backed performance-based bond against future Deepwater Horizon spill settlement revenues
Financing volume	$ 40 million	**EbA insurance instrument**	Environmental Impact Bond (EIB)

Overview and Description

Louisiana is facing a land loss crisis as coastal marshes subside, and seas rise. These losses are affecting local communities and the national economy. As coastal land disappears, so does the storm surge protection it provides, which puts people and industries at risk.

To combat this crisis, Louisiana's Coastal Protection and Restoration Authority (CPRA) developed a 50-year, $ 50-billion Coastal Master Plan to protect and restore the state's coastal areas and livelihoods and build a more resilient Mississippi River Delta.

CPRA has identified around $ 10 billion in coastal restoration funds. The challenges are using available restoration funds as efficiently as possible and in finding the rest of the approximately $ 40 billion in needed funds. Identified funding sources include billions of dollars in dedicated criminal and civil penalties associated with the 2010 Deepwater Horizon oil spill, which are being released over the next 14 years, as well as annual revenues from oil and gas production from offshore Louisiana.

One key opportunity is to issue a bond, which can be paid back by future annual revenues from the Deepwater Horizon spill (EDF 2018). This is an approach like the one Louisiana implemented with the settlement from tobacco companies. This involves reconfiguring a traditional municipal bond to allow for repayment not from project revenue streams, but from future, dedicated sources of revenue (a so called bridge financing approach).

In coastal Louisiana, these Environmental Impact Bonds (EIBs) could also include project performance incentives. EIBs are a form of pay-for-success debt financing in which investors purchase a bond, and repayment to the investors is linked to the achievement of a desired environmental outcome.

EIBs can provide incentives for sustainable wetland construction by creating a "performance payment" paid by local project beneficiaries and shared by investors and wetland restoration contractors if the wetland achieves a mutually-defined outcome. This ensures that all parties are aligned towards creating and maintaining sustainable wetlands that provide desired land loss avoidance and flood risk reduction benefits over time.

Ultimately, the Louisiana EIB aims to demonstrate how the private sector can partner with the government to implement coastal resilience projects while generating a financial return for investors attracting more private investment in coastal resilience to cope with sea level rise, land loss and storms.

Evaluation

In terms of successes, a seller (in this case the state) has been identified but has not yet confirmed if they will issue an EIB. The Environmental Defense Fund (EDF) identified potential cost savings to the State and that EIB could work with a public/private partnership to undertake a wetland restoration, both of which could help motivate the state as a seller of these bonds.

The flood risk reduction value of Louisiana restoration projects was identified as a marketing tool and has a clear benefit of which many stakeholders are aware. While the selection of coastal restoration sites identified as part of the Louisiana Coastal Master Plan, were not based on flood risk reduction value, but primarily selected for ecological reasons, EDF identified a sub-set of planned wetland restoration sites with high potential for flood risk reduction for local beneficiaries based on two independent studies. In Louisiana, the connection of wetland loss to increased risk and wetland restoration to risk reduction are clearly understood, but the primary funding sources do not require disaster risk reduction benefits. Consequently, there is less incentive to develop a CRFI and EbA project, but this could change as risks grow, insurance costs increase and the linkages between wetland restoration and risk reduction is more rigorously assessed.

EDF [and partners] looked closely to identify a restoration site from the Coastal Master Plan that was likely to offer some significant flood damage reduction benefits. In conducting their assessment, EDF and their partner Quantified Ventures, selected Port Fourchon in part because there are high risks and clear benefits exist to offshore oil and gas production stakeholders that the port services. In addition to flood reduction, there were other marsh restoration benefits including the protection from logs rolling into the port.

While ultimately flood risk reduction benefits were not directly factored into the proposed bond mechanism for wetland restoration, avoided wetland land loss – an essential outcome of restoration – was proposed as an easily measured performance outcome. Insurance opportunities were also evaluated, but most Louisiana coastal industries and land owners, which includes many oil and gas production and petro chemical companies, are self-insured. It is difficult to get self-insured parties to finance for a risk reduction benefit, because they do not see immediate reductions in (premium) costs. Nonetheless, they are still motivated for reducing their risk of flood damages and business interruption. Ultimately, the insurance industry is more likely to be a potential investor than a seller or project developer.

EDF has identified that for this concept to take off in the future, it will be necessary to reduce transaction costs; this was a common problem noted by a number of practitioners that were developing new and innovative products (i. e., that initial investments in development were high). They also indicated a need for a rapid and low-cost determination of performance, which could reduce transaction costs. This could ultimately tie performance to erosion reduction (protecting and reducing wetland erosion further inland), and identified, for this case, promising remote-sensed methods combined with machine learning to make such determinations efficiently.

5.4 Case 4: California SB30: Insurance and Ecosystems

Location & status	California, USA	**Overall goal**	Investing in and insuring natural solutions for risk reduction
EbA measure	To be Determined	**Climate hazard addressed**	Flood, Fire, Heat
Sector beneficiaries	To be Determined	**Stakeholder lead**	California Department of Insurance
Other stakeholders	To be Determined	**Financing instrument**	To be Determined
Financing volume	To be Determined	**EbA insurance instrument**	To be Determined

Overview and Description

California SB 30 looks towards "innovative" insurance and reinsurance businesses to provide opportunities for local communities and homeowners to reduce their risk to climate change-related impacts. The law focuses on finding incentives for investing in and insuring natural infrastructure to mitigate against climate change-related risks. Insurers are asked to recommend policies that create incentives for coastal wetland restoration for storm surges, and forests that are managed to reduce the risk of major fires.[5]

SB 30 requires the California Department of Insurance Commissioner "to convene a working group to identify, assess, and recommend risk transfer market mechanisms that promote investment in natural infrastructure to reduce the risks of climate change related to catastrophic events."

Additionally, the working group is required to recommend state policies to address these mechanisms. In support of this new insurance policy development, insurers are encouraged to ask: *"Can we reduce the exposure of insurance companies to climate change-related losses through innovative state policies or insurance pricing mechanisms that reward good behavior and charge premiums for actions that increase public safety risks or losses of property or environmental attributes?".*

Evaluation

It is a success that SB 30 was supported by the state legislature and the California Insurance Commissioner's office. This clearly creates some of the best enabling conditions for a CRFI and EbA initiative anywhere. It is important that experienced scientists, underwriters, and practitioners are working together across agencies, NGOs and insurers to identify potential opportunities and products.

At the same time, this bill represents the earliest stage of the development of CRFI and EbA initiatives by the State of California. There are as of yet no buyers or sellers identified and the specific climate change-related risks and EbA projects are not identified. There clearly is a focus on flood and fire risk since California is a state with many high value assets at risk as well as many sources of financing and funding including for payments for ecosystem services. California is looking for opportunities to advance coastal CRFI-EbA solutions but these are more challenging than on the East Coast as most wetlands have been lost and storm-related coastal flood risk is overall lower on the West Coast.

5 California Legislative Information (2018): Senate Bill No. 30; available online at: http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB30.

5.5 Case 5: MesoAmerican Reef Insurance

Location & status	Coastline of Quintana Roo, Mexico	**Overall goal**	Increase resilience and storm protection through reef-based ecosystem service
EbA measure	Repair of coral reef crest to restore resilience after storm damage; beach nourishment	**Climate hazard addressed**	Tropical storm
Sector beneficiaries	Tourism sector	**Stakeholder lead**	Local government of Quintana Roo
Other stakeholders	Local authorities, local communities	**Financing instrument**	Trust fund and tourism levy
Financing volume	Insurance cover $ 3.8 million (50 / 50 beach and reef)	**EbA insurance instrument**	Parametric cover to protect coral reef and beach

Overview and Description

This case study was chosen because it well combines EbA and CRFI: It is the first weather risk insurance placed in the market, which is based on protecting a marine ecosystem and maintaining its storm surge risk reduction value as an ecosystem service. The business case is built on ensuring that the reef reduces exposure to coastal flood risk from tropical storms and stabilizes beaches to protect a $ 12 billion per year tourism industry along the coastline of Quintana Roo. The insurance covers 167km of coastline, including several municipalities and their towns – Cancún, Puerto Morelos, Playa del Carmen, Tulum and Cozumel.

The local economy heavily depends on tourism related to the Mesoamerican Reef and the beaches behind it. From a conservation perspective, the reef is of high conservation value, and the second longest barrier reef system in the world.

The EbA part of this combined approach builds on the ecosystem service of a reef which protects the shoreline from tropical storms. Rigorous science led by the University of California Santa Cruz (UCSC), Institute of Hydraulics University of Cantabria (IHC), Autonomous university of Mexico (UNAM) and The Nature Conservancy (TNC) have shown the value of the MesoAmerican reef for risk reduction (Beck et al. 2018, Reguero et al. 2019). The reef's quantified risk reduction value to properties and people protected along the coastline behind it is the foundation of the CRFI part of the approach (Figure 4). Additional benefits of the reef lie in tourist value and benefits to fish habitat, however to date only some of the indirect loss has been considered (Reguero et al. 2019).

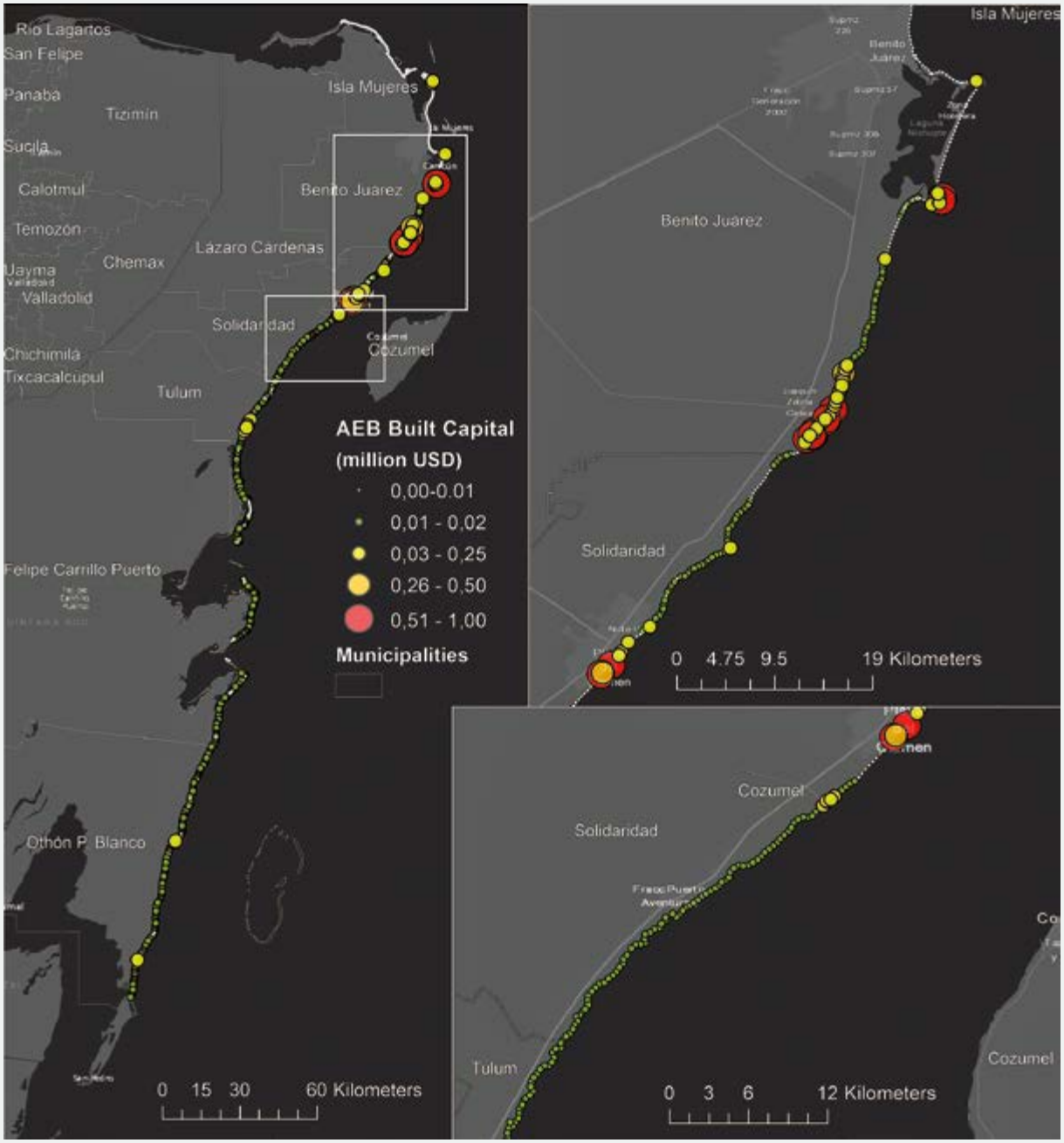
The CRFI component consists of a finance and an insurance element. This insurance against tropical Cyclone covers damage to the coral reef and beachfront along the coast. Mexico's state government of Quintana Roo, formed the Coastal Zone Management Trust with the participation of hotel associations, municipalities and civil society, with the mandate to finance reef and beach restoration and conservation. Figure 5 on p. 26 shows the institutional structure. The source of finance is an existing fee levied from beachfront property owners. It can be supplemented with other contributions. The financing structure is designed to make the insurance policy fully self-financed for the state government via the fee levied. The insurance product itself is structured with a parametric pay-out trigger based on wind speed.

This EbA and CRFI project is a pilot initiative between TNC, the Mexican state government of Quintana Roo and other partners. The intention of TNC is to use this pilot to demonstrate how to insure coastal ecosystems that provide much needed services for local communities, to transfer the risk of damages from hurricanes and provide for reef management and protection. TNC has established and tested protocols to repair damaged reefs after extreme weather events. This is essential to ensure that the full protective potential of the reef is restored. The priority of these actions is

Figure 4

The benefits of the MesoAmerican Reefs for averting damages to built capital on the Caribbean coast of Mexico

Annual Expected Benefit (AEB) in averted flood damages to built capital protected per year.



Source: Reguero et al., 2019

to protect the reef so that it continues to protect the population from the effects of severe weather events and climate change-related impacts, such as extreme hydro meteorological events.

In parallel it aims to increase the resilience of the country's infrastructure and of the ecosystems that harbour rich biodiversity and provide important ecosystem services.

Evaluation

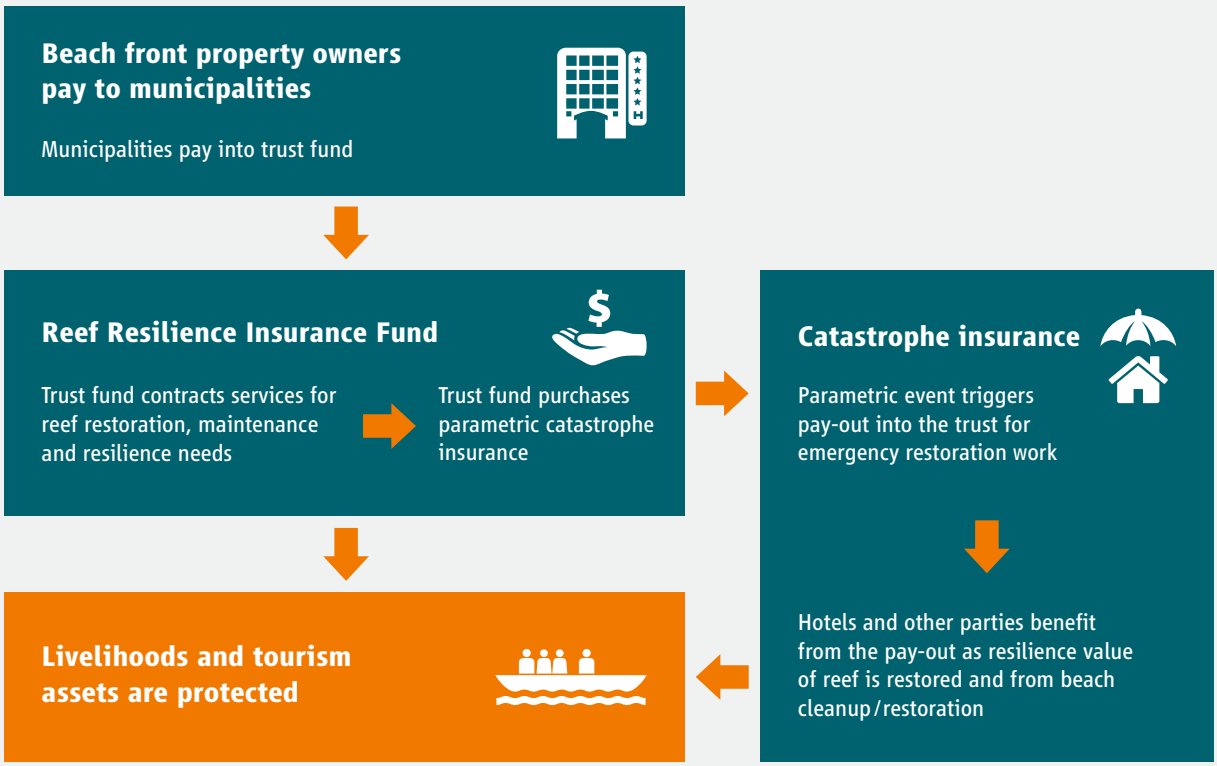
This project is quite advanced in terms of fulfilment of the criteria of combined EbA-CRFI projects as identified by the authors of this study.

In terms of successes, a buyer had been identified at an early stage of the project development; however, the actual finalisation of the deal took longer than expected due to institutional and financial challenges. After all, this is an entirely new insurance where none existed prior and which requires the allocation of government funding towards premium payments. This project clearly showed that securing funding for premium payments is a non-trivial matter. Furthermore, public procurement rules needed to be observed for the purchase of the risk transfer product.

Another strength of this project is that the insurance industry (i. e. SwissRe) was highly involved from the very beginning and contributed with structuring knowledge. In fact, the involvement of SwissRe was critical to the success of this project, as well as the endurance of TNC to remain committed to following through

Figure 5

Institutional structure of a reef insurance



Source: Adapted from TNC

and not giving up despite challenges arising along the way required consistent and close involvement to form the necessary alliance between all parties involved. In particular, because this is a public-private cooperation between hotel owners and hotel association, state and federal government agencies, as well as the civil society (TNC and others). The private sector is fully engaged in this insurance product as they recognise the value of beaches and reefs, despite the fact that it does not hold ownership of these natural systems (the federal government is the "owner") and control. This is a challenge that is discussed in detail in the "common goods" problematic among environmental economists (e. g. Bradbury and Seymore "Coral reef science and the commons", Coral Reefs 2009, Springer).

Certainly, a pre-requisite to develop this insurance product was TNC, UCSC, UNAM and IHC's cutting-edge science which rigorously assessed the flood risk and EbA benefits, i. e. the extent to which the reef is able to reduce the risk to properties and people. These data sets allowed for the discussions with key stakeholders (government, tourism industry, hotel associations, insurance industry etc.) and the development of core financial and environmental plans. While assessing the risk reduction value of the reef was key, introducing the concept to transfer the risk of damage was also an innovative game changer.

A further strength, which contributed to success was the existence of additional philanthropic support for product development and to develop restoration and first responder protocols and training of first responders. The first responders are called brigades and are responsible for the reef's initial repair, assessing the damage and the response plan.

TNC data also allowed not only to quantify the benefits in terms of risk reduction but also the cost of reef repair. At the time of publication of this report, 60 "brigadists" had been trained to repair damages to reefs. Building this capacity to implement projects is a key component of success, including development of an immediate response protocol, forming of brigades to respond after a storm, creation of reef restoration and beach erosion management guidelines. Mexico and the Mesoamerican Reef also have a monitoring protocol in place since 2008.

This monitoring programme, which tracks changes in reef health over time, allows to assess if the anticipated risk reduction benefits materialise and resilience increases.

Through the project and the introduction of the insurance contract, institutional governance was strengthened around the management of the Trust Fund. This fund is designed to be able to accept different forms of funding for the protection and repair coral reefs and the adjacent beaches – a source of finance that did not exist before in this transparent manner.

In the Quintana Roo example, the amount of reef maintenance, including ongoing coral planting etc., that will be carried out before and in between major hurricane events, will depend on the available funding. Repair work on the reef will be funded by the insurance following a triggering event. Under current policy, the insurance cover is $ 3.8 million (50 / 50 for the beach and reef). It is expected that $ 1.9 million, would be enough to have the reef brigades work on up to 40km of reef and pay for up to 25 km of replanting etc. along the reef crest. However, it would not be enough to cover the whole 64 km of reef protected by the insurance. One also needs to appreciate, that the actual damage from a hurricane is very hard to predict in advance and damage would likely vary considerably over the length of the reef which is spread over 160 km. Basis risk is reduced due to the funding going into the trust fund that is not used for the insurance purchase and by setting the attachment point of the insurance at a relatively low wind speed. The Quintana Roo reef insurance is not a stand-along project but part of a larger strategy. TNC is working with government partners and the hotel industry to restore and conserve the reef. But those efforts would be lost if a strong hurricane hits the area. Therefore, in parallel to managing the reef, it is critical to transfer the risk of severe damages, as is done with any important asset at risk.

5.6 Case 6: Washington D.C. Stormwater Retention Credit Trading Programme

Location & status	Washington D.C., USA	**Overall goal**	Reduction of stormwater flood risk and improvement of water quality
EbA measure	Stormwater reduction through soil absorption	**Climate hazard addressed**	Urban flash flood (potentially)
Sector beneficiaries	Urban residents, urban water authorities	**Stakeholder lead**	Washington D.C. Department of Environment and Energy
Other stakeholders	Local land owners, local building companies, local authorities	**Financing instrument**	Stormwater credit trading market, via regulation of stormwater retention levels
Financing volume	$1.7 million loan capital	**EbA insurance instrument**	No insurance instrument; however, potential exists

Overview and Description

The DC Stormwater Credit Trading Program of the Washington District Department of Energy and Environment (DOEE) is separate from the DC Environmental Impact Bond issued by DC Water. Both were meant to meet compliance with Federal regulatory requirements under the U.S. Clean Water Act. However, the credit trading programme is the more innovative and more effective initiative and we hence focus on this example in our case study.

This case was selected because it presents a highly developed EbA project with great potential to be combined with an insurance product.[6] Most of the criteria that the authors of this study identified have been fulfilled. This is one of the few cases where both the EbA and the finance case are clearly defined and there is proof of concept being implemented in practice. Replication is also currently already underway in two further counties in the USA (L.A. County and Cook County). This example has not yet been carried beyond the USA but has

6 Conservation Finance Network (2018): Focus on Investors Boosts DC's Stormwater Credit Market; available online at: https://www.conservationfinancenetwork.org/2018/08/27/focus-on-investors-boosts-dcs-stormwater-credit-market.

the potential in places with the right regulatory and policy framework and strong institutional governance. Although in practice there is no link to an insurance product yet, the approach itself is suitable for a resilience bond model.

In urban centres around the world, stormwater is the fastest growing source of freshwater pollution and a cause of urban flash floods. In 2013, in order to meet its Clean Water Act obligation, Washington D.C. implemented new regulations requiring new construction projects and major renovations to capture stormwater runoff from their property through unsealed land areas / surfaces, construction of green swales, raingardens etc. To maximize design flexibility for developers, the city has instituted a first-of-its-kind Stormwater Retention Credit (SRC) Trading Market. Under this programme, space constrained developers can meet their stormwater retention requirements by purchasing SRC credits. Credits are generated by stormwater retention projects in other areas of the same district (off-site). The DDOE sees the off-site provisions as having the potential to result in a relatively large amount of retention best management practices being installed in less affluent parts of the district, meaning that these amendments also have the potential to improve environmental justice outcomes in the district.[7]

TNC, through its impact investment arm NatureVest, established District Stormwater, LLC (DS) with an initial 3-year, $ 1.7 million loan from the Prudential Insurance Company. This company finances and develops SRC-generating projects. TNC is the equity investor and expects sales of credits over a 12-year period will generate a market-rate return on its investment. DS works with landowners and community groups to develop credit-generating projects. These sites are chosen so that they bring highest benefits from green infrastructure. Among the criteria are: improved water quality of fragile ecosystems, reduced heat island effect, increasing green spaces in underserved communities, and job creation opportunities. TNC's work in DC focuses on the separate sewer system, which channels polluted water directly into rivers and streams. Therefore, the main emphasis has been on water quality improvement and not as much on flooding. Flood mitigation benefits have therefore not been scored, however the approach as such, has the potential to be applied to flood mitigation as well.

For local landowners, DS supplies 100 % of the capital necessary to develop the off-site greening projects in exchange for a 12-year equity share worth of SRCs. DS compensates landowners for the use of their land and takes full responsibility for operating and maintaining the site through its SRC ownership period (12-year contracts). DS is responsible for negotiating credit sales to willing buyers (on-site developers), thereby generating a return for investors. DS estimates that it will mitigate 7 million gallons of runoff annually during its first phase of projects and another 26 million p.a. will be mitigated during its second phase (starting from 2020).

The Chesapeake Bay provides more than 500 million pounds of seafood per year worth hundreds of millions of dollars to the economy. Management and mitigation of stormwater reduces nutrient and sediment runoff into the bay and tributary rivers improving water quality. Mitigating flooding that results from major storms, will ease economic burden for business owners affected by these disruptions. There are a number of factors that contribute to poor water quality in the Chesapeake Bay, stormwater is one of many. These projects are a small piece of the overall conservation effort. This work is important, especially to the communities where the projects are, however they are still at a small scale relative to the water quality challenges in the Bay. In addition, off-site trading creates opportunities for investments in green infrastructure enhancing environmental equality in poorer communities where property values tend to be lower. They also create jobs to build and maintain green infrastructure sites. The model as such is equally suitable for reduction of urban pluvial flood risk, heat islands effects and air pollution.

This is a transformative project, which has created a local EbA solution for D.C. and the Chesapeake Bay. The Nature Conservancy's support of DS and the SRC market is to create a model for other cities worldwide to replicate. This is a unique approach to attract private capital to leverage public funds for green infrastructure development in urban areas.

Evaluation

The Washington D.C. Stormwater Credit Trading Program is an advanced EbA and CFRI Project, as many of the criteria identified by the authors of this study are in place: The climate risk is identified (water quality, local flood risk and heat island effect), the EbA solution is very clearly identified and the EbA benefits are assessed and monitored. Flood risk and water quality are connected, as more rain means less clean water without a solution to stormwater pollution. Each stormwater retention credit has a quantified physical retention volume and a specific market price. This is a very clear price tag on an

7 District Department of the Environment Notice of Final Rulemaking (2013): Stormwater Management, and Soil Erosion and Sediment Control; available online at: https://doee.dc.gov/sites/default/files/dc/sites/ddoe/page_content/attachments/2013%20SW%20Rule.pdf.

ecosystem service. On the financial side, buyers and sellers are clearly identified and connected via a credit trading market. It is not a traditional market and was created with very adaptive management to meet a regulatory purpose. This market puts a price on stormwater in a very transparent manner through an online stormwater credit database. Monitoring and market administration is conducted by the local environmental regulator, DC Department of Energy and the Environment. Both environmental and social impacts are being observed. It encourages private economic activities and project construction in administratively, socially underserved areas.

In terms of success factors, this project developed the first ever stormwater retention credit trading programme. The credit trading system reduces the EbA cost and reduces the amount of required onsite stormwater retention, which then frees up space for developers to include other aspects of amenity value. The credit trading establishes a business case to create greening in socially and administratively underserved areas. It also reduced the regulatory burden for the developer. The regulatory liability is shifted to the credit seller off site.

The SRC programme clearly quantifies the EbA case, it provides a measurable metric to quantify and price stormwater retention: 1 SRC corresponds to 1 gallon of stormwater retention for one year; value of 1 SRC $ 2.05. $ 2.05 is roughly the weighted average sale price of privately purchased credits to date. This price fluctuates with the market and is currently closer to $ 2.00. DOEE purchases credits through its Price Lock Program at $ 1.95.

It is a transparent system, as all credits are certified and verified by the Department of Energy and Environment, who created an online database for transparency and market trading. The programme drives a gradual transformation of DC's impervious land cover – reducing pluvial flood risk and improving water quality.

One of the challenges is that investments are based on a regulatory market such as the SRC programme present risks to investors (compared to traditional market investments) which is in turn based on the potential for policy change (politics). For engaging investors upfront, the opportunity has to be on a large enough scale to be compelling (minimums $ 10–20 million). It is not easy to reach this volume with off-site projects, which may not be readily available and need to be developed over time. SRC was only able to achieve this by putting $ 11.5 million into the SRC Price Lock Program (guaranteed sale of 12-years' worth of credits to government for a fixed price).

The Department of Energy and Environment sees this as long-term strategy to turn grey into green infrastructure, which saves cost but comes with some performance risks. Setting up a stormwater retention credit market is a non-trivial exercise and quite complicated. It requires a strong regulatory framework upfront to work and set the right incentives. It is therefore not fit for countries with weak institutional governance and regulatory enforcement.

5.7 Case 7: Restoration Insurance Service Company (RISCO)

Location & status	Global, potentially Philippines	**Overall goal**	Flood / cyclone risk reduction and carbon sequestration / storage
EbA measure	Mangrove restoration and conservation	**Climate hazard addressed**	Storm flooding and tropical cyclones
Sector beneficiaries	Coastal residents and asset holders, Insurance companies	**Stakeholder lead**	Conservation International
Other stakeholders	Climate Finance Lab, key advisors across the insurance, lending and government sectors	**Financing instrument**	Social enterprise; pay for success financing structure
Financing volume	n/a	**EbA insurance instrument**	Property insurance

Overview and Description

Mangroves are important for climate change adaptation and mitigation, and yet half of the world's mangroves have been lost in the past 50 years. The value of mangroves for risk reduction and carbon sequestration is increasingly well known scientifically but this knowledge is not often leading to tangible action to conserve and restore them. They continued to be converted to other uses such as shrimp ponds.

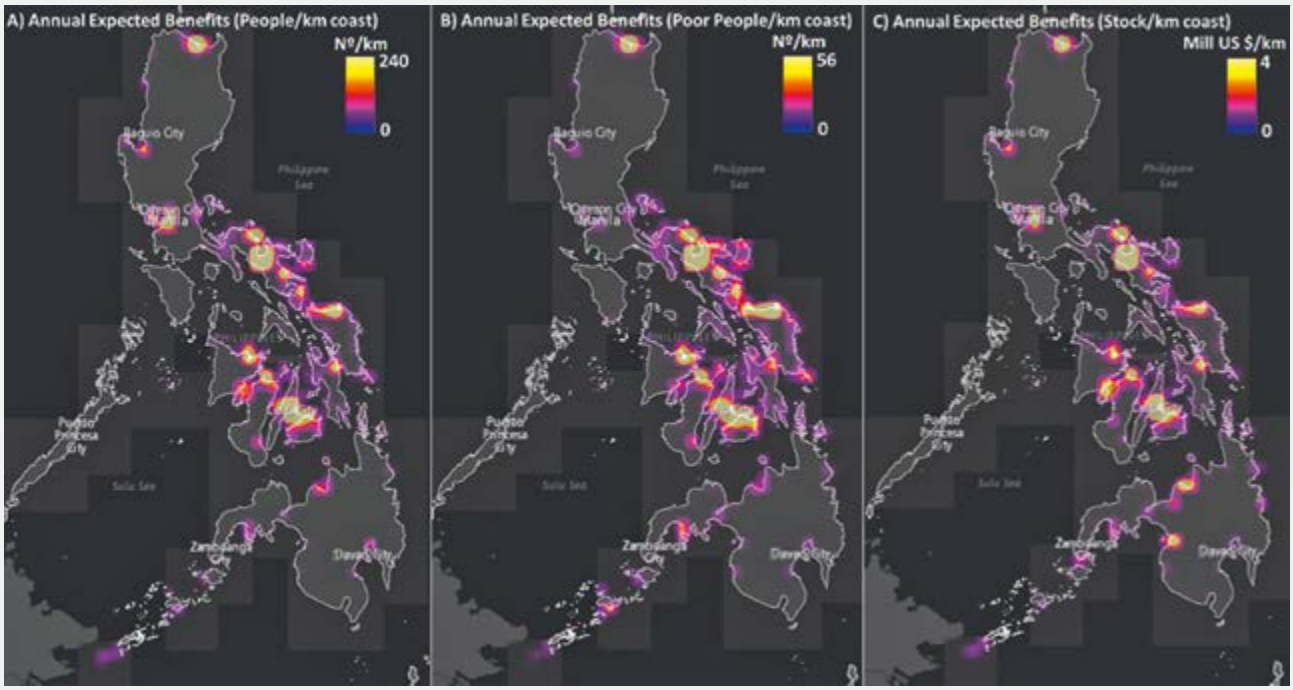
The Restoration Insurance Service Company (RISCO) is proposed as a social enterprise that finances mangrove restoration and conservation to reduce property damage risks and sequester carbon in coastal ecosystems. This instrument aims to drive financing for mangrove restoration and conservation by monetizing mangroves' (i) risk reduction benefit to insured coastal assets and (ii) climate mitigation benefits through the development of blue carbon credits. The project is being led by Conservation International with involvement from key advisors across the insurance, lending and government sectors. It is now being accelerated with support from the Climate Finance Lab. The type of insurance product is likely to be a property insurance that incorporates the risk reduction value of mangroves.

The Philippines has been chosen as a likely key first country for development because of its high flood and typhoon risks; the documented benefits of mangroves for flood risk reduction (Menéndez et al. 2018, Figure 6); interest from local insurance groups; and a strong Conservation International presence. There is also a high interest from the government and multi-national lenders in supporting mangrove conservation and restoration (Beck et al. 2017). Techniques for mangrove restoration are well known and they have been done at large scale in the Philippines. Other countries with high potential for RISCO include Mexico, Colombia, Indonesia, and Malaysia.

Figure 6

The annual expected benefits of mangroves for flood risk reduction

for (A) People, (B) People below Poverty and (C) Property by km of coastline in the Philippines.



Source: Adapted from Menéndez et al., 2018

The Philippines is a focal country for a variety of innovative insurance tools because there is a nascent but growing insurance market and strong social and environmental needs. There is one public insurance provider and around 60-70 private insurers. Around 95 % of all industrial property policies currently include natural catastrophe cover. The Philippine City Disaster Insurance Pool will provide parametric insurance cover against typhoons and earthquakes (not floods). The Philippine Crop Insurance Corp provides insurance protection against losses for unharvested crops or stock in fisheries farms.

Evaluation

There are successes and opportunities for RISCO. The project proponents have significant experience with mangrove restoration and conservation. In general, mangrove restoration is well known and done at very large scales although there are certainly still challenges. Mangrove restoration is less expensive than most other coastal protection measures and if done adequately it can be particularly cost effective.

Figure 7

Successes of the R4 programme

Planting year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Payouts			$17,000	$320,000	$24,000	$38,000	$450,000	$74,000	$1.5 m	$9,800
Value of premiums	$2,500	$27,000	$215,000	$275,000	$283,000	$306,000	$362,000	$770,000	$1.1 m	$1.7 m
Total sum insured	$10,200	$73,000	$940,000	$1.3 m	$1.2 m	$1.5 m	$2.2 m	$4.9 m	$6.6 m	$10.3 m
Cash contribution							$43,000	$86,000	$78,000	$128,000
R4 Farmers insured through WFP (percent of women)	200 (38)	1,308 (39)	13,195 (33)	19,407 (21)	1,308 (31)	24,970 (33)	29,279 (32)	37,419 (40)	51,955 (50)	87,557 (55)
Non-R4 Farmers insured*							3,918	4,448	6,603	5,763
Countries	Ethiopia	Ethiopia	Ethiopia	Ethiopia Senegal	Ethiopia Senegal	Ethiopia Senegal	Ethiopia Malawi Senegal Zambia	Ethiopia Malawi Senegal Zambia	Ethiopia Kenya Malawi Senegal Zambia	Ethiopia Kenya Malawi Senegal Zambia Zimbabwe

Source: Adapted from R4 quarterly report October-December 2018, April 2019

Both public and private interests in the risk sector are growing rapidly in the Philippines. Though the insurance market is nascent, there is room to grow, which is drawing interest and investment from risk modellers to donors. Another benefit of the RISCO project is that a focus on mangroves opens opportunities to two revenue streams: one through the insurance sector, with the idea that coastal asset owners or insurers would pay RISCO to reduce their risk exposure, and another through carbon credit buyers (companies or governments) that would purchase blue carbon credit produced by RISCO. These two streams allow for a financially sustainable model for investing in mangroves.

There are several key challenges that are being addressed by the RISCO project proponents. These include that in the Philippines, the government-mandated minimum insurance premiums for private flood/typhoon cover are very low (0.05 % of asset value), and given market competition, the premiums are set at or close to the minimum. This means that even though the risk reduction benefits of mangroves are quite high, these benefits are not yet incorporated into market pricing and thus the total premium savings are limited. Therefore, the project proponents are considering a model where insurers would pay RISCO directly to reduce their risk exposure. The financial viability of the RISCO product may require both insurance-related and blue carbon revenue streams. The methods for issuing blue carbon credits for mangrove conservation and restoration are under development but should be available soon.

The development of mangrove restoration projects envisioned as part of RISCO requires potentially complicated negotiations and agreements with the entities that have property rights over mangroves. In the Philippines, mangroves are considered public property. The carbon they sequester is also owned by the government. Two legal instruments exist to transfer or lease mangrove rights to a private entity or a community: Foreshore Lease Agreement (FLA) and Community-based Forest Management (CBFM). RISCO would need to partner with either holders of an FLA or CBFM rights to implement the mangrove restoration and conservation activities.

5.8 Case 8: R4 Rural Resilience Initiative

Location & status	Active in Ethiopia, Senegal, Malawi and Zambia; and pilots in Kenya and Zimbabwe	**Overall goal**	To enable vulnerable rural households to increase their food and income security in the face of increasing climate risks
EbA measure	n/a	**Climate hazard addressed**	Weather-related losses
Sector beneficiaries	Rural farmers	**Stakeholder lead**	World Food Programme
Other stakeholders	Oxfam America, Relief Society of Tigray (REST)	**Financing instrument**	n/a, but with access to insurance farmers get access to credit
Financing volume	$ 10.3 million (total sum insured)	**EbA insurance instrument**	Weather index insurance

Overview and Description

The programme was launched in 2011, building on the success of the Horn of Africa Risk Transfer for Adaptation (HARITA) initiative in Ethiopia. It is based on a comprehensive risk management framework for rural farmers taking several aspects into account, i. e. risk reduction, risk transfer, prudent risk taking and risk reserves.

R4 is underpinned by the concept of Insurance-For-Assets (IFA) and built on existing social safety nets. Here, farmers are

encouraged and supported to "pay" for insurance with labour, building up assets through risk reduction (e. g. flood diversion channels are built by farmers, trees are planted and roof rain water systems are being installed). Herewith encouraging more environmentally friendly farming activities, which then enable the farmer to access parametric weather index insurance. With the protection of insurance, when weather related events adversely impact crops, farmers receive a pay-out as financial indemnification, not forcing them to sell their assets or sacrifice family well-being (e. g. stop paying school fees) to get the farm back up and running. This then results in more resilience to weather shocks and household asset ownership, not putting farmers in the poverty trap. Through this stability it then becomes easier for micro-lenders to extend credit to farmers, allowing them to expand or participate in other economic activities, ultimately being able to save and build up financial assets.

Evaluation

The programme appears to have been successful in most of the areas it has been launched, showing steady growth in terms of farmers participating in the programme:
The real success factor of the initiative is the holistic view of the problem of reducing hunger and not simply offering an insurance product but also other factors, including training and a reward system. This exactly is what makes the programme unique: The combination of EbA measures (at least similar, e. g. drainage systems around fields) and the access to insurance as well as the incentivising of resilience building behaviour by rewarding farmers financially.

Moreover, all measures are adapted to the local conditions. Women are heavily involved, microfinance set ups are often being done in the communities, while local rice storage banks allow farmers to store food in years with a good yield for harder times or sell the goods on the market when prices are high while new farming techniques increase revenues. Index-based insurance, as one of the components of the holistic concept adds in a way that Nat Cat events do not lead people into a poverty trap. The insurance has already paid out several times, with overall ratios between pay-outs and premiums indicating a sustainable business model.

However, many gaps and challenges remain including that the overall goal of the project is not to continue being heavily funded and move towards farmers paying for insurance premiums in cash versus labour. As much as the programme caters for a farming value chain, it is focused on individual farmers as opposed to entire ecosystems. Therefore, it can only be assumed that current farming practices are not threatening biodiversity, however there is no clear objective regarding that being implemented. Clearly, the overall goal is the reduction of hunger, escaping the poverty trap, and resilience building.

5.9 Case 9: Mangrove Plantation and Disaster Risk Reduction Project

Location & status	Coastal provinces of Vietnam, on-going	**Overall goal**	Restoration and rehabilitation of mangrove forests
EbA measure	Protective benefits and ecological benefits through mangroves	**Climate hazard addressed**	Natural disasters including storm surges, flooding and droughts
Sector beneficiaries	Coastal communities	**Stakeholder lead**	Vietnam Red Cross
Other stakeholders	Danish Red Cross, Japanese Red Cross	**Financing instrument**	n/a, funding provided to implement DRR initiatives
Financing volume	n/a	**EbA insurance instrument**	n/a

Overview and Description

Probably the single largest collection of projects that explicitly use nature for disaster risk reduction are the mangrove restoration projects in Vietnam. These projects have restored hundreds of thousands of hectares of mangrove and some of the most significant have been carried out by the Red Cross. While these projects do not include insurance per se, we have included this example because it is an important demonstration of the "scale-up" potential of EbA projects for risk reduction. It is also quite important that the key project proponents of these nature-based projects are not environmental but rather DRR groups.

The coastal communities of Vietnam have been increasingly affected by extreme weather events, leading to loss of live, livelihoods and ecosystem services. As such, 17 years ago it was ascertained that one of the ways to reduce the effect of these extreme weather events was to rehabilitate and restore mangroves as part of community-based mangrove plantation and disaster risk reduction (MP/DRR).

The programme has grown and evolved from when it was started in 1994, increasing from a pilot in one province to being launched in eight provinces, all of which are still active. The project also has developed and included disaster preparedness training and afforestation with bamboo and casuarina trees in communes along rivers. In order to achieve the intended success, the involved NGOs have managed to raise over $ 8.9 million since the projects inception, impacting the lives of 350,000 beneficiaries, 166 communes as well as planting nearly 9,000 hectares of mangroves.

Evaluation

Particularly impressive has been the effort placed in quantifying the difference the project has created by comparing events prior and post the intervention (Figure 8). For example, a longitudinal comparison was done for *"two level 11 typhoons*

Figure 8

Estimated benefits of Mangrove Plantation and Disaster Risk Reduction Project.

Estimated benefits and coasts in selected communes 1994–2025

Commune	Dai Hop	Thai Do	Nam Thinh	Giao An	DienBich
District	KienThuy	ThaiThuy	TienHai	GiaoThuy	DienChau
Province	HaiPhong	Thai Binh	Thai Binh	Nam Dinh	Nighe An
Population	10,955	6,087	7,240	10,496	10,521
Sea coast-line (km)	3.9	5.5	5.9	3.2	3.5
Dyke line (km)	4.0	7.5	5.9	3.2	3.5
Timeframe of planting	1998–2005	1994–2005	1997–2005	1997–2005	1998-2005
Planting input (ha)	835	1,010	1,287	2,403	145
Planting output (ha)	450	900	380	678	100
Planting-related costs, USD	425,866	858,373	362,424	646,641	95,374
Protective benefits, USD	676,868	15,330,243	n/a	37,818,545	n/a
Direct economic benefits, USD	628,094	672,436	4,799,476	6,748,533	344,931
Ecological benefits, USD	10,989,000	32,730,828	12,307,055	23,308,814	3,437,879
Total identified benefits, USD	12,293,962	48,733,507	17,106,531	68,375,892	3,782,810
Benefit/cost ratio 1*	3.06	18.64	13.24	68.92	3.61
Benefit/cost ratio 2*	28.86	56.77	47.20	104.96	39.66

* 1: excludes ecological benefits; 2: includes ecological benefits.
Source: IFRC & RCS, Case Study Mangrove plantation in Vietnam: measuring impact and cost benefit, 2011

that hit a commune in 1996 and 2006. In 1996, when the mudflats were mostly bare and only partially covered with newly planted mangroves, the typhoon caused severe damage to the sea-dyke, and four km of it needed to be repaired at a cost of $ 400,000. In 2006, the dyke damage was much less severe; a mere 1.6 km stretch needed to be repaired at a cost of $ 180,000. The difference in damage of $ 220,000 can be attributed to the project. Damage to private property was even more significantly reduced: whereas 90 per cent of shrimp farm value was destroyed in 1996, (total damage of $ 5.7 million) only 25 per cent were swept away ten years later $ 793,260." [8]

One of the stand-out successes of this project has been the effort put into developing a sound methodology to provide quantifiable protective and ecological benefits. This has in part been enabled by the longevity of the project, having existed at least 17 years when the study was conducted. This allowed for the comparison of the impacts of similar events over time.

In terms of gaps and challenges, this has been a heavily funded project with significant Red Cross intervention, which may affect the projects' sustainability. Even though in the benefits tables of Figure 8 there are dollar amounts associated with the project activities, these are not necessarily an indication of cash generated that can be reinvested to expand or continue the project. Therefore, the question remains if the experienced benefits will remain enough to attract donor funding over a long period or are they enough to warrant either being included in government budgets or attracting private sector financing.

Also, there do not seem to be financial or insurance products to bolster the efforts or provide additional coverage. Considering the proven case of the protective characteristics of the mangroves, an insurance product could be introduced for when Nat Cat events occur to cover costs associated with any damage experienced (which is significantly less than prior to projects) due to the reduced basis risk.

5.10 Case 10: Global Ecosystem Resilience Facility (GERF)

Location & status	7 sites in Mexico, Belize, Guatemala and Honduras in the Mesoamerican Reef Region (AR)	**Overall goal**	Incentivise ecosystem stewardship and asset maintenance on the one hand as well as post-loss insurance and plans for swift recovery.
EbA measure	n/a, however potential for measures fishing community resilience and coral reef retainment	**Climate hazard addressed**	Threat of hurricanes to coral reefs, mangroves and seagrass
Sector beneficiaries	Fishing communities	**Stakeholder lead**	Willis Towers Watson
Other stakeholders	Cefas, University of York	**Financing instrument**	Catastrophe bonds, resilience bonds, grants, and loans
Financing volume	n/a	**EbA insurance instrument**	Risk pooling

Overview and Description

In cooperation with partners from academia (University of New York, Cefas), "leading risk carriers", Willis Towers Watson announced the establishment of the Global Ecosystem Resilience Facility (GERF) in March 2018.

8 IFRC (2011, p. 5–8): Mangrove plantation in Viet Nam: measuring impact and cost benefit; available online at: https://www.ifrc.org/Global/Publications/disasters/reducing_risks/Case-study-Vietnam.pdf.

The area of focus are seven sites in Mexico, Belize, Guatemala and Honduras in the Mesoamerican Reef Region (AR) and specialises in the protection of coral reefs, mangroves and seagrass against hurricanes and coastal erosion.

The GERF's objective is to incentivise ecosystem stewardship (coral reefs, mangroves and seagrasses in the Caribbean to support resilience of fishing communities at threat from hurricanes and coral decline) and asset maintenance on the one hand as well as post-loss insurance and plans for swift recovery.

Evaluation

The publication of the GERF facility by Willis CEO has sent out a strong signal towards the insurance industry. The programme has clearly defined the target to protect EbA measures through a variety of measures and aims at building local capacity for climate mitigation and adaptation while providing a facility to finance resilience-building at a global scale.

Whilst the overall target therefore is a combination of EbA and CRFI, the facility was only launched last year and still appears to be in a conceptual stage in terms of looking at how pooling risk and financing could ensure the restoration of both marine and terrestrial ecosystems. However, it is a clear and strong message to the insurance industry that one of the most known insurance brokers has launched the initiative. This marketing effect will act as a catalyst for further awareness of the importance of the blue economy, thereby encouraging the use of commercial financing instruments to capacitate ecosystem stewardship.

However, for the facility to work there is a need to provide guidance as to which facility "offering" are recommended for which ecosystems or problem areas. In its current form the GERF programme is only mentioning potential instruments that could be used, with no concrete examples or identified pilots to test these instruments in the context of ecosystem stewardship. The next step, launching a pilot, to demonstrate the applicability of the facility in a few cases would give first evidence and data for the concepts' success, as opposed to a discussion point.

There is also a lack of clarity as to whom the facility is targeted at specifically, providing a rather generic beneficiary description. This can lead to difficulties in identifying stakeholders in terms of the public, private and NGO sector. Making it a near impossible task to start the work of structuring any solutions.

Should the concept manage to provide some tangible results in the near future, it can be expected that other brokers / insurers follow Willis step to actively promote how EbA and CRFI can work hand in hand.

5.11 Case 11: US FEMA: Community Rating System (CRS) and Benefit Cost Analysis (BCA)

Location & status	1,000+ communities across the USA (for CRS)	**Overall goal**	To reduce the impact of flooding on private and public structures
EbA measure	Open space preservation	**Climate hazard addressed**	Flood
Sector beneficiaries	Communities / Municipalities	**Stakeholder lead**	US Federal Emergency Management Agency FEMA
Other stakeholders	n/a	**Financing instrument**	Insurance
Financing volume	n/a	**EbA insurance instrument**	Premium Incentives for open space preservation

Overview and Description

The mission of the US Federal Emergency Management Agency (FEMA) is to help people before, during, and after disasters.[9] They aim to reduce the loss of life and property and to protect institutions from all hazards by leading and supporting the nation in a comprehensive, risk-based emergency management programme of mitigation, preparedness, response, and recovery.

FEMA administers the National Flood Insurance Program (NFIP), which aims to reduce the impact of flooding on private and public structures. It does so by providing affordable insurance to property owners, renters and businesses and by encouraging communities to adopt and enforce floodplain management regulations. These efforts help mitigate the effects of flooding on new and improved structures. Overall, the programme reduces the socio-economic impact of disasters by promoting the purchase and retention of general risk insurance, but also of flood insurance, specifically.[10]

The Community Rating System (CRS) promotes comprehensive floodplain management and encourages communities to go beyond the minimum standards of the National Flood Insurance Program (NFIP). CRS is a voluntary programme administered by the Federal Emergency Management Agency (FEMA) that rewards communities by providing policyholders with discounts on their flood insurance premiums for activities that reduce flood risk.

Separately FEMA also provides technical and financial assistance to state and local governments to assist in the implementation of hazard mitigation measures that are cost effective and designed to substantially reduce injuries, loss of life, hardship, or the risk of future damage and destruction of property. FEMA requires a Benefit-Cost Analysis to validate cost effectiveness of any proposed hazard mitigation projects prior to funding. FEMA's Benefit-Cost Analysis (BCA) is the method by which the future benefits of a hazard mitigation project are determined and compared to its costs. The final result is a Benefit-Cost Ratio (BCR), which is calculated by a project's total benefits divided by its total costs. The BCR is a numerical expression of the "cost-effectiveness" of a project. A project is considered to be cost effective when the BCR is 1.0 or greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs. There are two drivers behind this requirement: (1) the Office of Management and Budget's (OMB) Circular A-94 Revised, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs" and (2) the Stafford Act.

Evaluation

Importantly for this review, the CRS offers a direct incentive for open space preservation and thus NFIP is one of the few and possibly only insurer that presently offers a premium reduction for Nature-based Solutions.

FEMA is also actively considering Nature-based Solutions for disaster recovery funding. They are actively assessing Nature-based Solutions with their BCA tool. More importantly, they have made policy changes such that NbS only need to have a B:C ratio > 0.75 for flood mitigation, if additional measured co-benefits (such as fish production and recreation) could achieve a combined B:C ratio of 1 or greater. Here again FEMA is taking a leadership role among disaster recovery agencies in promoting Nature-based Solutions.

These policies and approaches also have challenges. While the CRS is widely used with more than 1,000 communities across the USA participating, it is still underutilized in that more than 10,000 communities are eligible to participate. Many communities simply do not have the capacity to measure and apply for premium reduction credits such as the open space credit. The Nature Conservancy has developed a tool that can help communities gather the required information to apply for credits and more importantly to identify where further open space preservation could enhance credits.

The recent changes in BCA are promising for Nature-based Solutions but they also have challenges. Primarily, completing a BCA for flood mitigation is challenging for any project proponent and possibly doubly so for a Nature-based Solution as many of the flood mitigation parameters and models may be new to these project proponents.

While lowering the BCA requirements for flood mitigation alone is beneficial, this then means that project proponents must also measure a second ecosystem service at the same time. So in many regards, the policy signals a very important conceptual shift and acceptance of NbS while practically being difficult to implement. Indeed, for the most part if an NbS project can be identified with a likely B:C > 0.75 for flood mitigation then it is highly likely that with some adjustments that the project could achieve B:C >1 on flood mitigation benefits alone.

9 US Federal Emergency Management Agency (FEMA; 2019), further information available online at: www.fema.gov.
10 FEMA (2019): National Flood Insurance Program, available online at: https://www.fema.gov/national-flood-insurance-program.

6. Findings

6.1 Overall Findings

The findings arise from our review of the literature, the case studies and interviews with key experts from across relevant sectors. We focus mostly on findings that are specifically relevant in a joint CRFI and EbA context. The findings are grouped by general context; science and modelling; demonstration projects; and constraints.

General Context

- **Payments from private insurers and national governments for recovery from natural disasters are growing nearly exponentially.**
- **High-level interest and key funding are available for solutions that meet multiple objectives** in adaptation, risk reduction, risk transfer, and conservation. There is momentum for solutions that combine risk transfer (insurance) and resilience building measures for risk reduction.
- **The interest in joint insurance and EbA solutions is best explained by** (i) the opportunities to jointly meet donor / buyer demands, (ii) to transfer and reduce risk across the spectrum from small to large magnitude events, (iii) to demonstrate some risk reduction actions up front, (iv) while marshalling resources to transfer risks from more catastrophic events.
- **The present volume of EbA based investments that offer marketable risk reduction benefits is small.** These projects will need to grow to attract significant investor interest.
- **(Micro) Insurance has been applied in a variety of environmental contexts** and though it is difficult to quantify this may be most common in the agriculture sector to reduce climate impacts to farmers. In this case, the benefits to ecosystems are unclear and could even be detrimental if there are (unintentional) incentives to expand farming in to more natural areas.
- **Insurance penetration in developing countries is low** in part because risks are high, funds are limited, the experience / understanding with insurance is low, and there is some wariness among buyers (particularly governments) about the likelihood of regional / national benefits.
- **Although developed countries (e. g., Germany) have a large insurance market, there are so far no insurance products that incorporate an EbA measure leading to premium reduction**; i. e., EbA is also new in developed countries, and market creation and pilot testing is necessary.

Science and Modelling

- **Quantitative adaptation (risk reduction) benefits are identified for only a few coastal ecosystems and are not yet broadly valued.** These flood protection benefits have mainly been quantified for reefs and mangroves and a little less so for marshes and seagrasses.
- **However, there is a rapidly growing body of science that identifies benefits from wetlands for reducing both riverine and stormwater flooding** and these may provide substantial benefits in many developed countries.
- **EbA solutions are most effective at reducing risks for lower magnitude more frequent events.** For example, mangroves and reefs can provide some protection from even the largest events, but they often have their greatest benefits (in terms of % risk reduction) at 1 in 25-year events and less.
- **EbA solutions are most effective for reducing risks in coastal, tropical, developing countries.** Mangroves and reefs are the most effective ecosystems at providing risk reduction benefits particularly for flooding and erosion.
- **EbA measures are often more cost effective than grey measures.** EbA measures can adapt over time. For example, reefs and wetlands can grow naturally and keep up with sea level rise, a seawall cannot (unless there is additional investment). EbA measures usually have more co-benefits (e. g., fish production) than grey measures.
- **EbA and insurance will not protect fully from storm risk.** EbA and insurance are only parts of a comprehensive risk reduction strategy and will often need to be coupled with hybrid solutions, early warning systems and other measures for risk reduction.
- **Industry risk models rarely incorporate ecosystems at present.** Standard insurance industry tools do not make it easy to assess EbA measures though they could. With improvements to tools it would be possible for surveyors / underwriters to assess the benefits of coastal habitats and other coastal protection measures.
- **Wetlands have been considered in industry risk models.** Wetlands are often already included as a land use parameter in insurance industry models. Reefs can be included if the underlying bathymetry data sets (which describe the depth contours or bottom topography) are at high enough resolution. Nonetheless, the consideration of ecosystems is far from standard practice in the insurance industry.

Demonstration Projects

- **Only a limited number of EbA projects measure adaptation and risk reduction benefits.** There are a growing number of EbA projects across all ecosystems, but only a small proportion of these projects quantify the direct social and economic benefits to people for adaptation and risk reduction. Some of the best measures of success come from large-scale mangrove restoration projects and particularly those in Southeast Asia. There are a growing number of oyster reef projects that demonstrate erosion reduction at scale particularly in the US Gulf of Mexico.
- **Even fewer risk reduction or insurance projects quantify conservation benefits.** There are few insurance projects that clearly show ecosystem benefits. And possibly only one project that can truly demonstrate both CRFI and EbA working together.
- **There are few fully integrated EbA-CRFI pilot projects**, which demonstrate how EbA and insurance can work together to reduce and transfer climate related risks and increase resilience. There are projects in the pipeline, but the integration of EbA and CRFI is new and none of them are yet fully implemented with metrics.
- **No fully CFRI and EbA demonstration projects have been implemented yet.** First, there are very few EbA demonstration projects that clearly show quantitative adaptation (or risk reduction) benefits. Second, there are few climate risk finance and insurance projects that clearly show conservation benefits, and possibly only one that demonstrates both CRFI and EbA.
- **However, there is a growing number of projects that begin to integrate risk financing and ecosystems to varying degrees.** These projects create the basis for a growing opportunity of projects in this interface.

Constraints

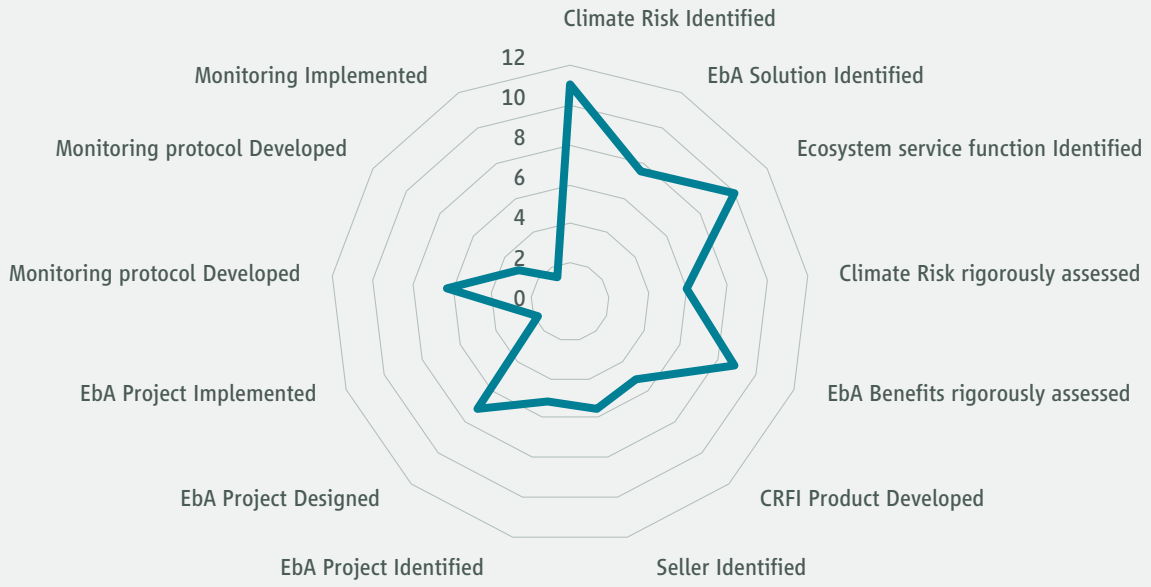
- **Integrating EbA and CRFI projects generally requires complex, multi-stakeholder and -sectoral relationships.** These are difficult to handle from a public policy and institutional governance perspective. As new, innovative tools are offered, these relationships constantly change and need to be re-negotiated.
- **Both insurance and EbA will often require external support to be viable.** Thus, both EbA and insurance will need to meet the objectives (e. g., social vulnerability reduction) of public donors, investors and lenders often as part of a Public-Private Partnership (PPP).
- **Meeting multiple objectives is difficult.** In the case of CRFI and EbA that means projects that are meeting at least conservation and adaptation (risk reduction benefits); few groups, businesses or agencies do it well.
- **There is a knowledge gap between insurance and environment sectors.** Few in the insurance industry understand ecology and few in the environment community understand insurance. There needs to be greater cross-fertilisation between these fields to develop effective, integrated approaches. The motivations, funding mechanisms, timelines, and expertise for the groups and agencies typically involved in EbA are often very different from those in CRFI.
- **EbA solutions are not well understood by the insurance industry.** They are thus often perceived as too difficult and too slow or not offering the biggest bang for the buck for a profit driven industry. The insurance industry is conservative and new solutions will be slow to gain understanding and acceptance.
- **Insurance is designed to transfer risk for more severe, less frequent events.** Often for events that occur at greater than 1 in 50 years.
- **The delivery of near-term benefits in CRFI and EbA projects fall disproportionately on ecosystems.** Insurance aims to provide long benefits but though short-term (e. g., 1–5 year) policies. This means that if a joint CRFI-EbA project aims to provide benefits in the near term, that these benefits must be delivered disproportionally by the EbA measures. This is not a simple challenge to overcome.

- **Very few funders have experience supporting both EbA and CRFI projects**; this represents a challenge for integrating these fields. Even when they occur in the same institution or agency, the programmes that support EbA are often quite different from those supporting risk reduction and finance. The World Bank would be a classic example with very separate programmes in environment and DRR.
- **Ownership of ecosystems can represent a challenge for implementing projects.** Wetlands often have a mix of ownership from public to private depending often on national (but also state and provincial) policies. Offshore ecosystems such as reefs and fisheries are more likely to be public goods but not always (Beck et al. 2004). In the context of a joint CRFI and EbA project, this means that approvals will need to be sought by both risk and environmental agencies and that PPPs are required in most cases.
- **Many government policies on coastal risk increase impacts to ecosystems and reduce opportunities for private insurance.** Many governments subsidize risk (particularly coastally) and do not assess the true costs of these risks. These public subsidies reduce opportunities for private insurance. These policies also increase the likelihood that ecosystems such as wetlands, which are in the lowest-lying, high-risk areas, can be developed and thus destroying a first line of coastal defence. Ultimately, these public subsidies also make it challenging to implement CRFI and EbA projects because they artificially raise the bar for cost effectiveness.
- **Both Insurance and EbA are subject to policy risks**, which can influence projects at levels from financial incentives to permitting approvals. These can create challenges for investors.

Figure 9

Maturity criteria of case studies analysed

Criteria Analysis – all 11 case studies



Source: Own illustration

6.2 Criteria-based Case Study Analysis

We have defined, for the purpose of a comparative analysis of the case studies, a set of 13 criteria that would need to be in place for a fully developed combined EbA and CFRI project. We evaluated the eleven case studies against this set of criteria that was developed. A case which would have all criteria fulfilled, including the monitoring of results (ecosystem services lead to the expected benefits, resilience is increased, insurance gap is reduced), would be at the most mature stage. The results of our evaluation are shown in Figure 9 (p. 41).

All 11 cases have identified the climate risk (Figure 9), and most cases (10 out of 11) have identified the ecosystem service function as well (the exception is case study 3). Whereas 8 out of 11 cases have also an EbA solution defined (except case studies 1, 4 and 10), and EbA benefits rigorously assessed (except cases 3, 7 and 8) only 6 cases have then also the EbA project designed (except cases 1,2, 5 und 7) and only 1 has an EbA project also implemented (this is case 6). The results show, not surprisingly, that implementation is a limiting factor. Whereas more cases have EbA benefits assessed (8) and an EbA project designed (6), very few have developed a corresponding CRFI product (only 4 out of 10 cases; these are the cases 5, 9, 10 and 11.

There are very few buyers clearly identified. It is not a simple thing to find a buyer interested in (i) insurance (ii) EbA and (iii) a novel product. Given how difficult it is to identify buyers, funding that requires buyers to be identified first are likely to be less catalytic and more likely to be useful after funding for innovation has been developed for more accepted solutions. A buyer has been identified in only 4 out of 10 cases (these are cases 5, 6, 8 and 9).

Almost no cases have rigorously monitored their impact and the degree to which a resilience increase really takes place – although we have assigned half a point for monitoring to case studies 2 and 6, because some initial steps of monitoring implementation have been undertaken by these projects, but none of these cases monitors the resilience increase. Whereas in two cases (case 2 and 11) we found that at least a monitoring protocol was developed it was however not (yet) implemented. There are few insurance projects that clearly show ecosystem benefits, and possibly only one project that can truly demonstrate both CRFI and EbA working together.

Table 1

An overview of the successes, challenges and gaps across the 11 case studies

#	Case Study	Successes	Challenges	Gaps
1	COAST – Fisheries Risk Insurance	› Incentivised the updating of National Register of Fishers in several countries. This register is critical to improving fishery management in general. › Buyers (Gov'ts) are not difficult to identify as the needs of and benefits to fishers are clear to governments. › World Bank co-financing is important for buyers and sellers.	› Largely relies on traditional disaster risk insurance; it is a parametric insurance that covers fisher's infrastructure from storms. › Data on both fishers (registry) and fisheries (e. g., stock status) is rare. › Little science that connects fish stock status and fisher's risk / adaptive capacity.	› A key aim is to create incentives to make fishers and fisheries more resilient and increase their adaptive capacity. That will take significant time. › Will be very difficult to fill fisheries data gap and ultimately create incentives to improve fish stock status and adaptive capacity.
2	Forest Resilience Bond	› Climate risk identified (fire). › EbA project identified; specific forest restoration approaches. › Funders / Buyers identified including public agencies, private foundations and insurance.	› Potential EbA benefits only broadly identified, but there is a team set up to subsequently measure benefits. › Directly combining EbA and insurance is difficult because assets and overall risk are relatively low in forested areas.	› Insurance is an investor only (there is not an insurance product). › Measured benefits likely will not include risk reduction, but it could in the future. › This is not a Pay for Success product (i. e., outcome based) in this round, but it could be in the future. In this round the utility preferred a cost share.
3	Louisiana Environmental Impact Bond (EIB)	› Inclusion of Project Performance payments or incentives can help maximize environmental outcomes. › There is a dedicated revenue stream for the environment (e. g., from Gulf oil spill and revenues associated with oil and gas extraction); bond aims to accelerate this work. › Project identified a pilot site (Port Fourchon) that could deliver environmental and flood damage reduction outcomes.	› Seller (state of LA) is exploring several financing options; has not committed to EIB. › Insurance financing was explored but most LA coast companies (e. g., petro chemical) are self-insured and there were challenges in companies realizing incentives.	› Climate Finance and insurance is only indirectly addressed in this example. › Currently wetland restoration projects are identified first and foremost for environmental outcomes; not (directly) flood reduction benefits, which can make them less ideal for meeting joint objectives.
4	California State Bill 30-Insurance: climate change	› Establishes policy framework for jointly assessing CRFI and EbA by the State. › Creates formal study group to identify and evaluate opportunities.	› Buyers not yet identified. › May be little overlap in climate risks and EbA solutions in California.	› No EbA projects identified. › EbA benefits not yet rigorously assessed. › No EbA demonstration project in place.

#	Case Study	Successes	Challenges	Gaps
5	Mexico Reef Insurance (Quintana Roo)	› Buyer(s) identified. › Additional philanthropic support for product development, restoration and first responder protocols and training of first responders. › Flood risk and EbA benefits rigorously assessed. › Financial and ecological plans fully developed. › Swiss Re provided valuable support in developing the insurance product. › Quantified reef repair costs and trained locals for reef monitoring and recovery. › Strengthened institutional governance around trust fund management. › The fund is designed to coordinate and unlock public and other capital for the protection and restoration of coral reefs and beaches.	› Securing finance for premium payments is non-trivial. › Challenging to form the necessary alliances between all parties involved (e. g., hotel owners & association; state and federal agencies, TNC and others). › Building capacity to implement projects is a key challenge: development of an immediate response protocol, forming of brigades to respond after a storm, creation of reef restoration and beach erosion management guidelines.	› While resources for reef management are being used from the Trust Fund, the main EbA project (large scale reef restoration) would only happen after a disaster and pay-out.
6	Washington DCs Stormwater retention credit (SRC) program	› New and first ever DC stormwater retention credit trading program developed. › Credit trading system reduces EbA cost and reduces amount of required onsite retention (freeing space for developers). › Less regulatory burden for the developer and liability is shifted to the offsite credit seller. › The SRC program provides a measurable metric to quantify stormwater retention. › All credits are certified, and trades are tracked. › Driving gradual transformation of 43 % DC's impervious land cover.	› Investments based on a regulatory market such as the SRC program present risks to investor base related to policy changes (politics). › For engaging investors upfront, the opportunity has to be on a large enough scale to be compelling (e. g., $10-20 million). › SRC was only able to achieve this by putting $11.5 million into the SRC Price Lock Program (guaranteed sale of 12-years' worth of credits to government for a fixed price).	› This is a long term strategy to turn grey into green infrastructure, which saves cost but comes with some performance risks. › Complicated and therefore not fit for countries with weak institutional governance, because it requires strong regulatory framework upfront to work.

#	Case Study	Successes	Challenges	Gaps
7	RISCO	› Project evaluated by Climate Finance Lab. › Potential Philippine mangrove sites identified. › Rigorous analysis of EbA benefits available. › Offers potential finance options through both carbon mitigation and adaptation (insurance). › Mangrove restoration for adaptation a well-established practice.	› Buyer unclear. › Government regulations limits (subsidises) risk costs.	› Product not yet developed (under review). Unclear if this will be an insurance incentive, Cat Bond or Resilience Bond.
8	R4 Rural Resilience Initiative	› Overall broad resilience programme involving many resilience building aspects instead of one (e. g. financial support, insurance, gender equality, etc.), however not losing focus (i. e. increase food security). › Continuous growth of initiative. › Programme very well adapted to local market conditions. › Cooperation between several players.	› Transition to pay for insurance aspect in cash could become challenging.	› Biodiversity / ecosystem protection not focus.
9	Mangrove Plantation and Disaster Risk Reduction Project	› Growth of project. › Quantification of benefits done extensively, comparing past effects of Nat Cat events ex EbA measures to.	› Project heavily dependent on subsidies, so that long-term financial self-sustainability is questionable.	› Quantification of benefits done, however not translated into mechanisms that would reward the efforts financially. › No full insurance mechanism in place.
10	Global Ecosystem Resilience Facility (GERF)	› Strong marketing effect by one leading broker stating that insurance of EbA is a focus area, leading to potential followers.	› Strong evidence of successfully established projects still missing.	› Lack of clarity on specific target groups and stakeholders.
11	FEMA CRS & BCA	› Insurance premium incentive for reducing flood risk with natural solutions (CRS). › More than 1,000 communities use CRS. › Established a mechanism where natural flood protection and ecosystem co-benefits can be considered in Benefit-Cost Analysis (BCA). › BCA creates opportunities for funding nature-based projects with flood mitigation and disaster recovery sources.	› Only 10 % of eligible communities participate in CRS. › Even though measures are not complex, few communities have capacity to make the measurements required.	› Not a climate change project per se. › The BCA policy on NbS has not yet been fully implemented in a project.

7. Recommendations

There are many challenges to the greater integration of EbA and insurance for risk reduction, and there are many opportunities as well. The substantive engagement between the insurance and environment sectors is only around a decade old. Thus, it is hardly surprising that fully integrated CRFI and EbA products (e. g., reef insurance) are new and challenging. That said there are many common interests and opportunities that could help improve integration and lead to innovative approaches beneficial to both sectors and that improve resilience for people and nature.

Based on our analyses we have identified several key recommendations below. We have put some of the most significant recommendations at the beginning, but priorities will vary by target group. We identified key target groups for each recommendation across a spectrum including Insurance, Environmental NGOs, Academia, Government, Donors / Investors.

More pilot and demonstration projects are needed.

Target group for recommendation	
Insurance	***
Academia	*
NGOs	***
Government	***
Donors / Investors	***

These projects should include more (i) fully integrated CRFI-EbA projects as well as (ii) EbA projects where risk reduction benefits to people and property are fully assessed and (iii) insurance projects where the benefits and impacts to nature are fully assessed. There are projects growing in scale where nature is having real benefits for risk reduction such as the tens of thousands of hectares of mangrove restoration in Vietnam or the kilometres of oyster reef restoration in the Gulf of Mexico. More projects are needed like these, where actions occur at large scale and are followed by pre- and post-hazard monitoring.

Nature and nature-based measures need to be reflected in risk (Nat Cat) modelling tools.

Target group for recommendation	
Insurance	***
Academia	**
NGOs	*
Government	*
Donors / Investors	

Risk industry modellers do not normally provide analysis of the risk reduction benefits of habitats, even when they could. There needs to be broader quantification of the risk reduction benefits of ecosystems and whenever possible within the tools and approaches most familiar to the risk industry.

These analyses have been done for example by RMS in considering the benefits of marshes during Hurricane Sandy (Narayan et al. 2016, 2017). Previously RMS had not provided such results, because “no client had ever asked them to”. These analyses are not yet standard practice, which will entail real costs in terms of new modelling and analysis. Many of the best coastal flood risk models could report out on the flood protection benefits of wetlands (salt marshes and mangroves) and reefs. These models (can) capture some of the most critical flood reduction aspects of wetlands by parameterizing the frictional benefits with Manning coefficients for land use. These models may be able to assess the benefits of reefs if they use high-resolution bathymetry, which they are likely to do in well developed markets.

These tools / results should then be made more user friendly within the risk industry.

Target group for recommendation	
Insurance	***
Academia	**
NGOs	*
Government	*
Donors / Investors	

Where the benefits of nature have been rigorously quantified (as for coastal protection benefits) and incorporated in risk industry models then they should be more widely available in the insurance industry. That is technical departments provide cutting-edge assessment of risk and benefits and

then make a subsample of these results / tools available to underwriters and others. The consideration of nature and nature-based measures could then have wide ranging impacts on insurers, investors, and regulators with positive benefits for ecosystems.

Surveyors doing annual inspections should take EbA measures into account.

Target group for recommendation	
Insurance	***
Academia	*
NGOs	*
Government	
Donors / Investors	

Typically, insured assets are being evaluated by third parties in fixed intervals. The objective of these site visits is to give the insurers an impression of the exposures and risk mitigation measures of insured assets in order to individualise loss expectancies. Whilst they always take into account aspects like building materials and Nat Cat related protection measures like mobile floodwalls, EbA measures are not mentioned in inspections and a premium discount is not quantified within the tools that these surveyors use. Hence, underwriters are missing the opportunity to take these into account.

There should be more insurance incentives for ecosystem conservation and restoration.

Target group for recommendation	
Insurance	***
Academia	
NGOs	*
Government	**
Donors / Investors	***

Small incentives could send big signals to individual stakeholders and to other governmental decision-makers on the values of conservation and restoration. These incentives do not need to pay for themselves (indeed most do not). Surveys have shown that even small incentives to coastal landowners could cause them to shift from hardscapes (e. g., bulkheads) to natural solutions such as wetland restoration (Scyphers et al. in review).

FEMA, one of the largest insurers, already offers premium incentives for environmental conservation. These incentives could expand in private insurance. Environmentalists and insurers should work together on a pilot offering for such incentives.

An EbA alternative should be considered in all risk reduction cost effectiveness analyses; and co-benefits should be included.

Target group for recommendation	
Insurance	*
Academia	**
NGOs	***
Government	**
Donors / Investors	***

The risk industry, NGOs and government agencies have all shown that nature-based measures can be readily incorporated in Benefit-Cost Analyses (BCA) are often among the most cost effective options for risk reduction. The consideration of EbA in such analyses should be standard practice. EbA projects also have many co-benefits beyond just direct risk reduction including recreation / tourism, job creation, and fish production that increase the adaptive capacity of vulnerable populations. These benefits should be included more often in assessing the cost effectiveness of EbA-CRFI projects. FEMA already allows for the incorporation of co-benefits in its BCA analyses, which can help pave the way for broader inclusion.

Focus more on insurance and EbA measures that cover more frequent events.

Target group for recommendation	
Insurance	*
Academia	**
NGOs	***
Government	***
Donors / Investors	***

The visibility and acceptance of insurance and the benefits of EbA measures increase with the likelihood of pay-out and direct risk reduction. EbA approaches can provide benefits across the frequency distribution from common to

catastrophic but they often have their greatest (%) benefit for more frequent events (Beck et al. 2018, Losada et al. 2018, Menéndez et al. 2019). Insurers also increasingly recognize that they need to provide coverage for more common events if they are to penetrate developing markets (e. g., events more frequent then say the 1-in-25 year event). In this regard, combined tools can be mutually beneficial by providing visible insurance investments in Ecosystem-based Adaptation strategies for frequent events and "reserve" insurance pay-outs for more catastrophic events.

Green and Social Impact Bonds may offer good routes for integration of nature and risk transfer.

Target group for recommendation	
Insurance	*
Academia	*
NGOs	**
Government	***
Donors / Investors	***

Green, infrastructure and social impact bonds that incorporate natural infrastructure and Nature-based Solutions are beginning to grow rapidly. A small number of these tools recognize risk reduction benefits and / or include insurance investors. There may be real opportunities to expand integration from this base for example to better incorporate risk reduction benefits in bonds like the Louisiana Environmental Impact Bonds. There is also opportunity to grow from risk-based insurance schemes to recognize how ecosystem condition contributes to risk reduction as the COAST programme aims to do.

Solutions such as resilience bonds and resilience insurance are some of the most innovative and complex ways to combine CRFI and EbA; it is not surprising that these have not been developed yet. It will take time to develop and then test them.

CRFI and EbA projects can expand by better recognizing common goals.

Target group for recommendation	
Insurance	***
Academia	*
NGOs	**
Government	***
Donors / Investors	*

Both the environment and risk sectors have common goals in reducing risk and pricing risk correctly, which has market and ecosystem benefits. Both sectors have interests in rigorously valuing risk reduction benefits. EbA project proponents should recognize that investing in insurance partnerships can have significant value in national policies and investing including for disaster recovery funding.

There needs to be better support for project concept development.

Target group for recommendation	
Insurance	**
Academia	*
NGOs	
Government	*
Donors / Investors	***

Funders should recognize the need to support project concept development. There are very few projects that meet joint objectives for CRFI and EbA. There are very few donors that have programmes that support CRFI and EbA and thus little support for the substantial legwork required to develop the projects from concept to the identification of potential pilot sites. The concept and needs of insurance are foreign to most of the environmental groups. Environmental concepts and needs are foreign to most companies in the insurance industry. Much work needs to be done then to align projects together. In these situations, companies in the insurance industry and environmental organisations must look to their Boards to support such efforts.

Create opportunities to share capacity between the risk and environment sectors.

Target group for recommendation	
Insurance	**
Academia	*
NGOs	**
Government	**
Donors / Investors	***

Currently there is a lack of joint expertise across the environment and insurance industry sectors and consequently a lot of misunderstanding and missed opportunity. Resilience Fellowships that directly target insurance industry professionals to work in the environment sector and vice versa could catalyse new tools and create greater understanding and

opportunity. There are a variety of resilience opportunities (e. g., grant support for city-based Resilience Officers) but these do not directly address the interface of the risk and environment sectors.

EbA projects will get greatest support from insurers where economic benefits are greatest.

Target group for recommendation	
Insurance	**
Academia	**
NGOs	**
Government	***
Donors / Investors	***

To advance integrated projects, EbA measures will have to be identified where (private) economic benefits are greatest. This represents a substantial shift for environmental groups as it means implementing projects within and around areas of significant development, which is not where most have previously focused their efforts. For example, in the case of coastal EbA measures such as reef restoration will get greatest traction in areas with high-revenue and significant infrastructure instead of other more remote or rural areas.

Insurance and EbA should continue to expand to reduce vulnerability and exposure of public infrastructure.

Target group for recommendation	
Insurance	**
Academia	
NGOs	**
Government	***
Donors / Investors	***

Many of the opportunities to invest in integrated CRFI and EbA solutions will be driven and / or supported by donors, lenders and investors that have objectives for reducing the vulnerability of people and public infrastructure. These include for example development banks, ISF and national disaster risk agencies such as FEMA and the NFIP and in Mexico the National System for Civil Protection (SINAPROC) and its Fund for Natural Disasters (FONDEN). In order to expand opportunities for integrated solutions there will need be a greater focus on measuring and aligning projects that meet both social and economic goals.

Financial support of EbA projects can improve Corporate Social Responsibility (CSR).

Target group for recommendation	
Insurance	***
Academia	
NGOs	
Government	
Donors / Investors	***

From a marketing perspective, the insurance industry faces the challenge to innovate and to be actively involved in measures to fight climate change. An involvement in the insurance / financing of an EbA measure by any investor could serve to satisfy shareholders CSR expectations in addition to potential financial benefits. One caution is that sometimes, environmental projects are only seen as fulfilling social or corporate responsibility goals. These (and other environmental) projects are then not considered within the business practice at the company, which can severely limit opportunities for collaboration and investment.

Insurers should invest Reasearch and Development funding in understanding of how ecosystems can reduce Nat Cat risks and increase resilience.

Target group for recommendation	
Insurance	***
Academia	
NGOs	
Government	*
Donors / Investors	***

Whilst EbA measures offer great opportunities for insurers from an investment, marketing and risk transfer perspective, it appears as if the overall benefit has not been completely understood. An investment in research by the sector in the segment could lead to an overall better understanding.

8. The Way Forward

There is a great interest in projects that link climate risk finance and insurance to Ecosystem-based Adaptation and more broadly Nature-based Solutions. The integration of these sectors is still quite new; even just the awareness and work in the interface between the environment and risk sectors is nascent. That said there have been significant advances for CRFI and EbA in the last few years, which lays the groundwork for this interdisciplinary field to take off. There are some critical limitations, but there are also solutions. We recommend:

- Better analyses of risk reduction benefits for more nature-based measures, i. e., beyond the flood reduction benefits of reefs and wetlands;
- Use of existing nature-based data within risk industry models. This work can start by fully using the environmental data and parameters already within advanced industry models;
- Then including these Nature-based Solutions in the assessment tools that underwriters surveyors, and others use to assess premiums and premium reductions (incentives);
- And using these to build more incentives for conservation and restoration and moving beyond the open space incentives in FEMA NFIP;
- Greater inclusion of EbA and nature-based measures in cost effective analyses so that more particularly post disaster funding can go to these cost-effective solutions;
- Better financial and donor support for the development of CRFI and EbA demonstration projects and concept development;
- These CRFI and EbA demos are going to need advances in habitat restoration approaches to help meet risk reduction and environmental goals;
- Proponents should focus some more efforts on developing Green and Environmental Bonds that explicitly include risk reduction measures and benefits.

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Annex:
Climate Risk Insurance and Ecosystem-based Adaptation within NDCs and NAPs

By Marie-Isabell Lenz, GIZ

The Paris Agreement, adopted in 2015, demands concerted efforts to mitigate global temperature increase, strengthen resilience, increase adaptive capacity and reduce vulnerability to climate change. In the Post-2015 Agenda, Ecosystem-based Adaptation (EbA) and Climate Risk Insurance (CRI) have emerged as innovative and promising approaches to help countries build long-term resilience. In the early 2000s, the Convention on Biological Diversity (CBD) highlighted that sustainable ecosystem management necessitates an adaptive approach accounting for long-term changes (CBD 2004). In 2008 the term EbA was then picked up by UNFCCC at COP14 (CBD 2009a) and officially defined by CBDs' COP10, outlining its benefits for climate change adaptation and mitigation activities (CBD 2009b).

In 2010, UNFCCC launched, under the Cancun Adaptation Framework, a support mechanism for parties to identify medium to long-term adaptation needs through National Adaptation Plans (NAPs) (UNFCCC 2011). To date, UNFCCC has received 13 NAPs (UNFCCC 2018 & 2019a).

In the run-up to COP21 in 2015, parties submitted their Intended Nationally Determined Contributions (INDCs) to UNFCCC, which presented countries´ efforts to reach the Paris Agreement's long-term goals (Boyd et al. 2015; UNFCCC 2015). Once the agreement is ratified, they are translated into Nationally Determined Contributions (NDCs); 183 NDC country documents have been submitted (UNFCCC 2019b). With the Paris Agreement, both mitigation and adaptation are incorporated and parties are encouraged to address both equally (Adamo 2015). Though, NDCs still currently focus more on mitigation commitments, some however additionally communicate adaptation commitments; NAPs mainly focus on adaptation strategies and actions (Dazé et al. 2019). Both NDCs and NAPs are part of national parties' policy process to formulate national commitments, strategies and goals for achieving the established objectives of the global Post-2015 agenda.

EbA has been increasingly incorporated in national and global strategies[11] and countries have been encouraged to integrate EbA within their NDCs (CBD 2018). CFRI has also been included in the Kyoto Protocol and more specifically in the UNFCCC with the establishment of the Fiji Clearinghouse for risk transfer to facilitate parties efforts on comprehensive risk management strategies within an overall adaptation agenda, in Article 4.8 of the UNFCCC Convention (UNFCCC 2006) and Article 8 of the Paris Agreement, and within the Lima Paris Action Agenda (LPAA) through the G7 InsuResilience Initiative (Linnerooth-Bayer & Mechler 2006; UNFCCC 2015).

Methodology and Results

To assess the current uptake of the Ecosystem-based Adaptation and Climate Risk Insurance approaches in national climate change mitigation and adaptation strategies within the 183 NDC and 13 NAP documents submitted to UNFCCC, a keyword-based research, based on two data sources[12] and two additional ones which were reviewed[13], was undertaken.

11 E. g. within the Aichi Biodiversity Target 15 of CBD, Sustainable Development Goal 2.4, Resolution XII.13 of the Ramsar Convention, Priority 3 of the Sendai Framework (CBD 2010; Ramsar Convention 2015; UN 2015; UNDRR 2015).

12 Climate Watch (2018) NDC Content. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org (last accessed 05/13/2019). UNFCCC (2019a) National Adaptation Plans. – NAP Central. Available online at: https://www4.unfccc.int/sites/NAPC/News/Pages/national_adaptation_plans.aspx (last accessed 05/22/2019).

13 The NDC Explorer of the German Development Institute (DIE-GDI) identified countries that included climate risk insurance within their NDCs (GDI 2019). Seddon et al. (in review), contributors to the Nature-based Solutions Policy Platform of the International Institute of Environment and Development of Oxford University, reference an "explicit vision for EbA" or an "implicit vision for EbA" within the broader NbS concept, and based on a sophisticated keyword search methodology.

First, 194[14] country documents of the NDCs of the data platform Climate Watch (2018) and all 13 NAPs on NAP Central (UNFCCC 2019a), were manually screened for selected keywords in English, or in adjusted form in Spanish and French: "insurance", "risk transfer",[15] "eco(-)system(-) based", "nature(-)based", and "natural capital". Then, the identified documents were manually screened to confirm the context the keywords occurred in provided a clear connection between ecosystem protection or restoration and helping people adapt or build resilience to climate change.

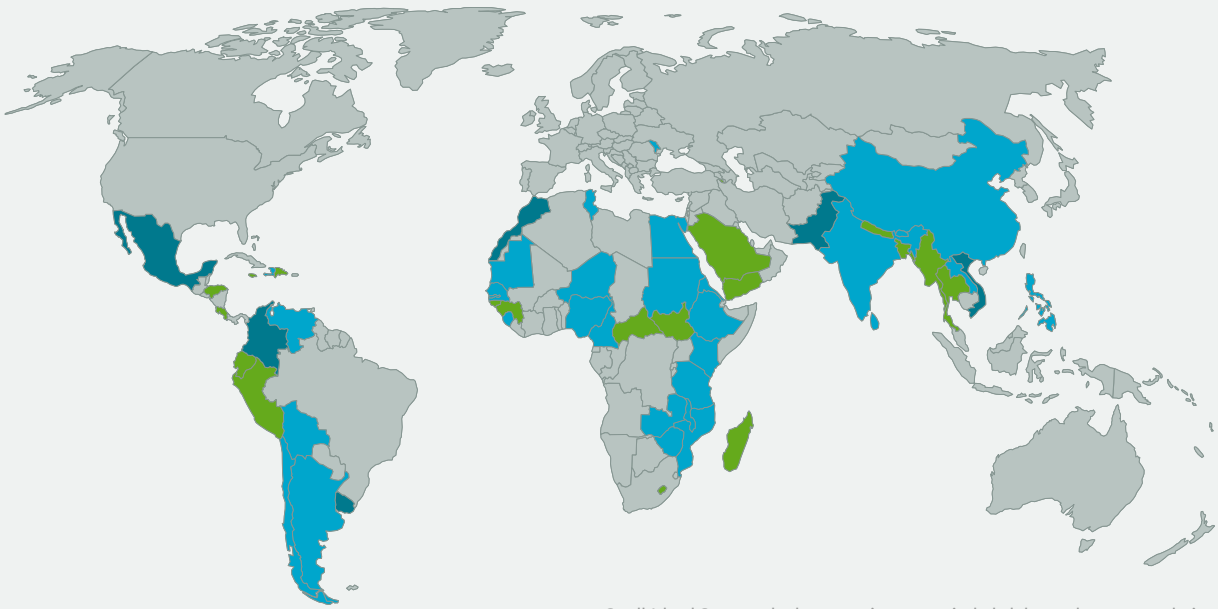
Altogether, 59 countries were identified of which 35 reference solely insurance, 18 solely Ecosystem-based Adaptation and additional six mention both approaches within their NDCs (Climate Watch 2018). Countries reference Climate Risk Insurance in diverse forms within 21 % of the 59 identified NDCs. The NDCs name different established or planned market development schemes or identify international cooperation needs for financing and insurance mechanisms (e. g., climate index-based schemes or catastrophe bonds in Kiribati). The most commonly referenced sector was agriculture where the impacts of climate change on risk to exposed and vulnerable people is clear. At the same time, there was often not a clear connection between the agriculture sector and conservation or EbA. Some countries focused on specific hazards (e. g. droughts in Zimbabwe), habitats (e. g., coastal ecosystems), and other

14 The higher number results from additionally translated NDC documents and the inclusion of Taiwan's and EU´s NDCs (Climate Watch 2018; Seddon et al. 2018b).
15 The selection of keywords related to "insurance" was, besides others, based on Kreft et al. (2017) methodology.

Figure A1

Incorporation of Climate Risk Finance and Insurance (CRFI) and Ecosystem-based Adaptation (EbA) in Nationally Determined Commitments

Figure A1 and A2 highlight the leading role countries of the Global South are taking in incorporating EbA and insurance in their NDCs and NAPs. Some countries incorporate just EbA (green); other countries only incorporate CRFI (light blue) and some countries incorporate both (dark blue).



Small Island States and other countries are not included due to the maps resolution (e. g. Antigua and Barbuda; Seychelles; Sri Lanka). Source: www.freeworldmaps.net

key sectors (e. g. tourism). In a few cases, countries include strategies with specific timelines (e. g. Vietnam). Timor-Leste and Sri Lanka name insurance as a specific mechanism to cope with loss and damage.

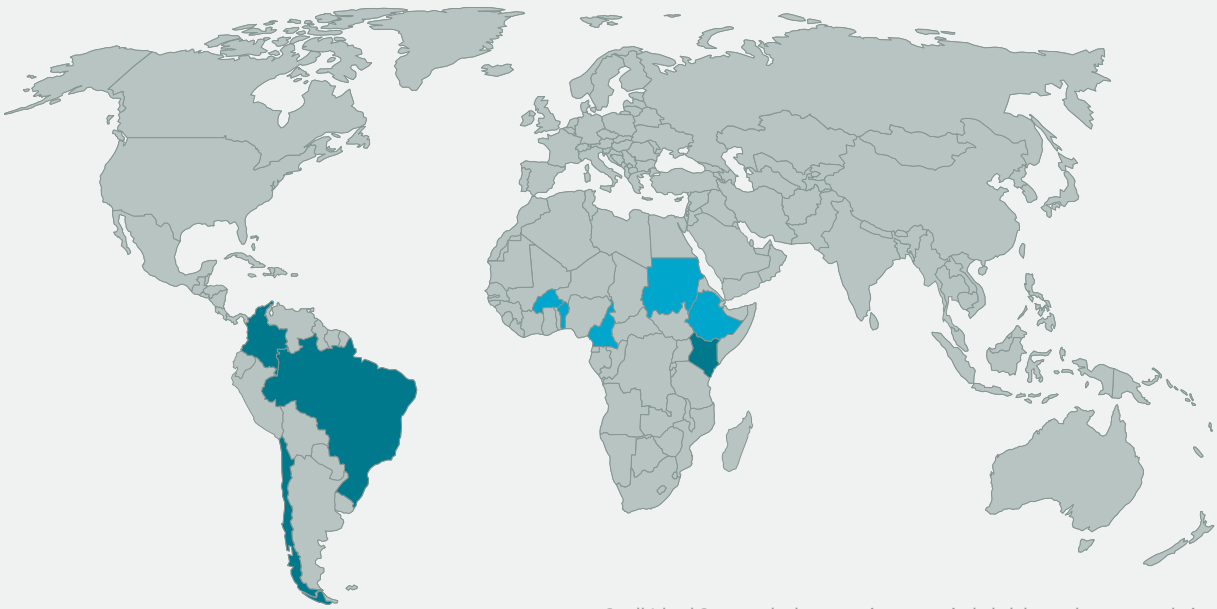
Many NDCs include the broadly accepted definition of EbA (CBD 2009b) and mention the approach briefly (e. g., in relation to conservation). However, EbA is rarely incorporated into strategies with measurable targets. Some countries do identify specific pilot projects (e. g. an urban EbA project in Kingston, Jamaica). Others, such as Grenada aim to mainstream climate change adaptation (CCA) activities, including EbA, into its national development planning by linking local action with national policies. Laos included EbA specifically in regards to the forest sector and wetland conservation, pointing out several barriers to implementation, and specific support required overcoming this challenge. Madagascar formulated a specific mid-term target of actions to be undertaken between 2020 and 2030, and highlights notable benefits of EbA for mitigation. Also, in the case of Uruguay, EbA is seen as a successful approach in reducing vulnerability and exposure to extreme climate change-related events along its coast (Oriental Republic of Uruguay 2016; Carro et al. 2018). Altogether, EbA is incorporated explicitly in 12 % of the NDCs, many of which are Small Island Developing States.

Only six countries clearly identified both EbA and insurance in their NDCs, but with no explicit link or overlap of specific measures or projects. However, the Seychelles NDC did include both, EbA and insurance, in its intended targets for food security. The NDC document of Vietnam included both within its strategies for CCA from 2021-2030, focusing on ensuring social security.

Figure A2

Incorporation of Climate Risk Finance and Insurance (CRFI) and Ecosystem-based Adaptation (EbA) National Adaptation Plans

Visualising developing countries and countries of the Global South are leading the way. Some countries incorporate just EbA (green); other countries only incorporate CRFI (light blue) and some countries incorporate both (dark blue).



Small Island States and other countries are not included due to the maps resolution (e. g. Antigua and Barbuda; Seychelles; Sri Lanka). Source: www.freeworldmaps.net

All 13 NAPs address "insurance". Agriculture appears as a key focus in most and "Ecosystem-based" Adaptation appears in seven of these NAPs. Several NAPs outline both approaches within detailed strategies with specific targets or indicators (e. g., Brazil) for the operationalisation of adaptation actions.

Whereas, both terms appeared once or twice on average within the respective NDCs, insurance and EbA are identified extensively in the NAPs for Uruguay, Saint Lucia, Brazil and Colombia. For example, Brazil highlights the importance of EbA and insurance within the CCA strategies for its disaster risk management sector with overlapping responsible agencies. Saint Lucia also focuses on EbA's contribution to reducing climate change-related risks. In relation to insurance, the country targets to facilitate the development of partnerships for an active engagement of the private sector in community climate resilience building. In this context, it further plans to develop legislation reforms and to continue its membership in the Caribbean Catastrophe Risk Insurance Facility. However, Saint Lucia highlights the countries financial limitations and feasibility of risk transfer mechanisms. It proposes additional climate risk management actions regarding risk retention and hereby the establishment of contingency financing.

Of note, this analysis solely includes all NDCs that directly reference either one of the keywords. However, many countries may mention the terms implicitly, particularly EbA (e. g. within the broader NbS concept). For example, Peru and the Philippines include EbA implicitly within their NDCs under terms such as "ecosystem management" or "development of climate and disaster-resilient ecosystem(s)" (GIZ 2018 a & b). The actual number of countries referring to the use of ecosystems for adaptation within their NDCs is likely higher than estimated in this review. For example, Seddon et al. (2018a) found 66 % of signatory parties of the Paris Agreement include Nature-based Solutions in some way within their respective NDCs. The same applies for insurance, which may not be listed directly, but countries may already have according financing policies in place. Nonetheless, most NDCs are still more focused on mitigation. Even though, very few NAPs have been submitted to UNFCCC, many countries already have corresponding policies and plans in place (e. g. Philippines (GIZ 2018b)), and many countries are currently in the process of laying the groundwork to formulating their NAPs (UNFCCC 2018).

In light of this, countries undergoing this process should aim to align their mitigation and adaptation policies, further highlighting more the significant role of climate risk insurance and ecosystems for adaptation, resilience building and disaster risk reduction / transfer.

Key Findings

- Climate change adaptation strategies need to be further integrated into NDCs thought along with the country's respective mitigation commitments, and aligned with NAPs.
- CRFI and EbA are not conceived together yet within national NDCs and NAPs.
- When insurance is considered, it is mainly in regards to specific climate risks or sectors, e. g. agriculture.
- Countries of the "Global South" with a high vulnerability to climate change-related impacts have incorporated both concepts with varying degree of detail.
- Many countries may have integrated EbA implicitly in their national policies without utilizing the specific terminology.
- Therefore, countries laying the groundwork for their NAP formulisation should engage different government agencies and sectors to formulise coherent policies.
- Coordination of CCA action could be led by Ministries of Finance, which can hold other Ministries more accountable than e. g., Ministries of Environments in many countries, forming an entry point for more coherent policies incorporating both CRFI and EbA.

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