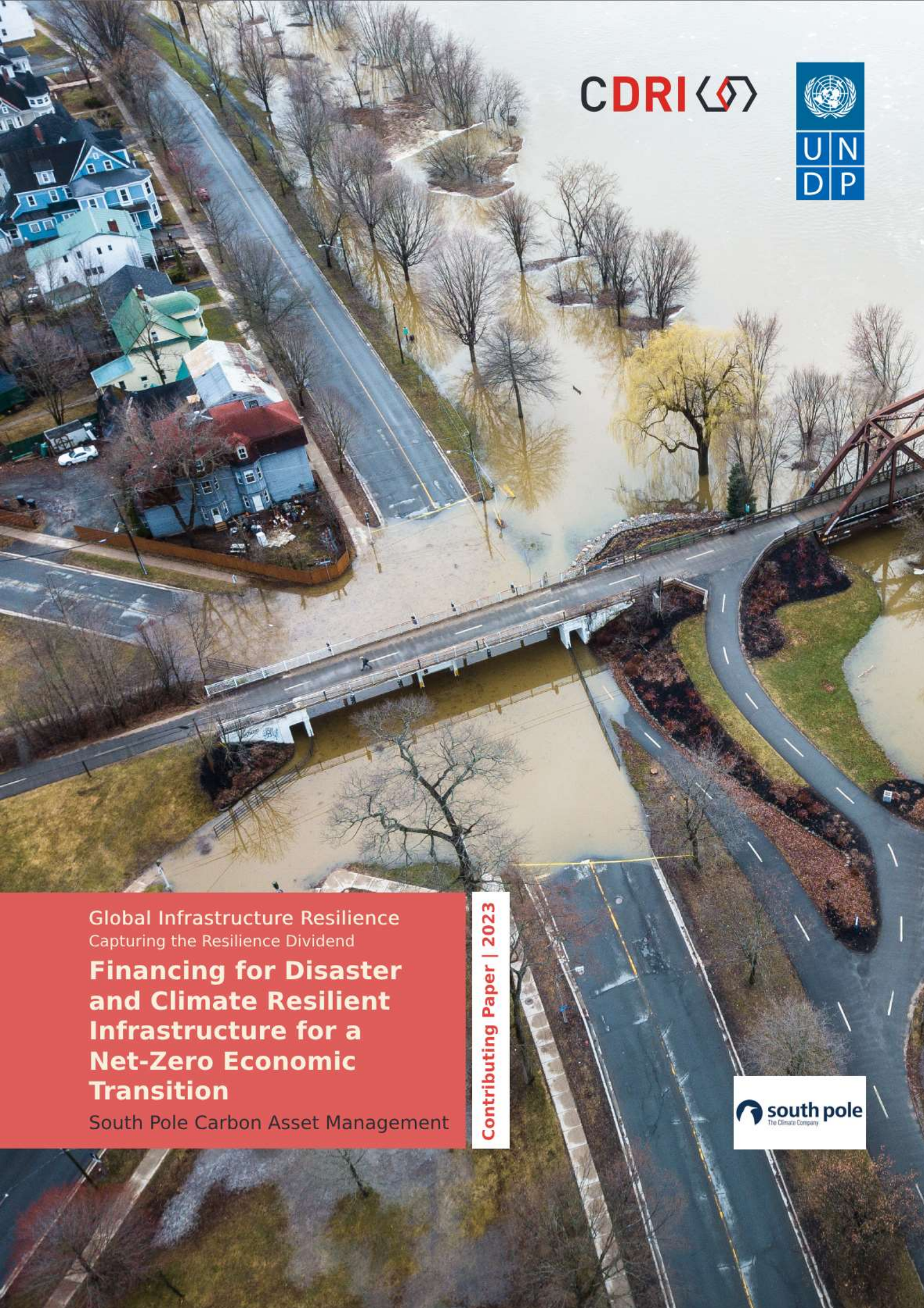

Global Infrastructure Resilience

Capturing the Resilience Dividend

Financing for Disaster and Climate Resilient Infrastructure for a Net-Zero Economic Transition

South Pole Carbon Asset Management

Contributing Paper | 2023

Position Paper- "Financing for Disaster and Climate Resilient Infrastructure for a Net-Zero Economic Transition"

Final

South Pole Carbon Asset Management Limited

BACKGROUND

The rise in global temperatures has already shown impacts in terms of economic as well as social losses in the cities, regions, and continents, if the world continued at current trajectory this impact would significantly widen in the coming years. The average surface temperature of the Earth has been rising at a rate not witnessed in the last 20,000 years over the last 40 years driven by increase in GHG emissions resulting in devastating impact in the form of disasters resulting from extreme weather events such as heat waves, droughts, and floods among others. Climate change will have devastating impact for every country around the globe if no concrete actions are taken in terms of reduction of decarbonisation and development of economy and infrastructure which is resilient to the impacts of climate change.

[1]Extreme physical climate events like floods, droughts, heat waves are becoming more common in countries around the world, and tropical illnesses are spreading at an increasing rate. It is anticipated that these changes will impact fundamental services, infrastructure, housing, income, way of life, food, health, and other areas. So, while planning, constructing, and building infrastructure, extreme climate change events and disasters must be given a due consideration. Hence parallel focus towards developing infrastructure which is resilient, and decarbonisation of economy is the need of the hour. This becomes even more daunting task for **low- and middle-income countries (LMIC)**[2]s- with limited resources balancing the need of decarbonisation, resilience, and economic development. According to a World Bank estimate emerging economies would need to invest around 4.5% of their GDP to achieve SDG 2030 targets, another estimate by IEA estimates a global investment of over US$ 2 trillion per year is required to achieve net zero by 2050. [3] Amongst the LMIC countries, least developed countries, the landlocked developing countries, and the small island developing states are the most vulnerable countries to extreme climate events and lack adequate public resources to develop infrastructure which is both net zero compliant as well as resilient.

CDRI, a multi stakeholder partnership of governments, UN agencies, development finance institutions and academia, has laid the vision to support development of resilience of global infrastructure systems through research, knowledge management and advocacy, communication, and partnership. In line with the vision, CDRI is working towards the development of "Flagship Report on Disaster and Climate Resilient Infrastructure" which would act as a principal vehicle to engage the focus of global audiences and policy makers to respond to various barriers and challenges faced in development of disaster and climate resilient infrastructure. One of the key pillars of the report is "Financing Infrastructure Resilience". The relevance of this chapter is even more as the Low- and middle-income countries who are at the forefront of climate and disaster vulnerability have limited public resources to invest in these projects as well as capacities to access external financing. This position paper on the theme "Financing for disaster and climate resilient infrastructure for a net zero economic transition" would be a key contribution to the Chapter 5 of the flagship report of CDRI.

This position paper is based on literature review and tools developed by the author. It outlines the quantum of financing required towards development of resilient infrastructure by LMIC countries towards net zero economic transition and identifies key barriers faced by these countries in mobilising financing. The paper also maps the key financing and funding tools along with sources of financing available to LMIC countries towards developing resilient infrastructure and presents case studies of using innovative financing and funding mechanisms towards overcoming key barriers. A conceptual financing model for Nature Based Infrastructure along with a draft structural framework is also presented in this paper.

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[1] CORPORATIVA, I. (n.d.). All about Climate Change Mitigation and Adaptation - Iberdrola. Iberdrola. Retrieved September 21, 2022, from https://www.iberdrola.com/sustainability/climate-change-mitigation-and-adaptation

[2] LMIC: Low and middle income countries- include middle income countries, least developed countries, small island development states and landlocked

[3] The Unequal Burden of Rising Temperatures: How Can Low-Income Countries Cope? (2022, September 14). IMF. https://www.imf.org/en/Blogs/Articles/2017/09/27/the-unequal-burden-of-rising-temperatures-how-can-low-income-countries-cope

INVESTMENTS REQUIRED BY LMIC COUNTRIES: CLIMATE & DISASTER RESILENT NET ZERO TRANSITION

LMIC countries would play a key role towards the global ambition to achieve net zero by 2050. Most of these countries through their NDCs have already committed towards net zero between 2050-2070. A recent assessment undertaken Mckinsey Sustainability division focusing on the investments required for net zero transition by 2050[4], outlines capital spending in physical assets, energy and land use amounting US$ 275 trillion or US$ 9.2 trillion per year would be required globally between 2021 and 2050 to achieve net zero. LMIC countries particularly those with lower GDP per capita and higher dependency on fossil fuel resources would require more investments relative to GDP for supporting the transition and at the same time would be more vulnerable towards output from the transition in terms of capital shock and employment. It is estimated these countries would have to spend~28% -32% of the global investment in physical assets and land use towards achieving net zero amounting to US$ 85 trillion cumulatively or US$ 2.76 trillion annually between 2021 and 2050 as shown in Figure 1: Investment required for Net Zero Transition, Mckinsey assessment, 2022 . The transition to net zero would also create opportunities for developing countries to harness their natural resources such as ample sunlight and wind, forestland, mineral resources, and CO2 sequestration potential, but mobilising investments and capital would be a key challenge for these countries.

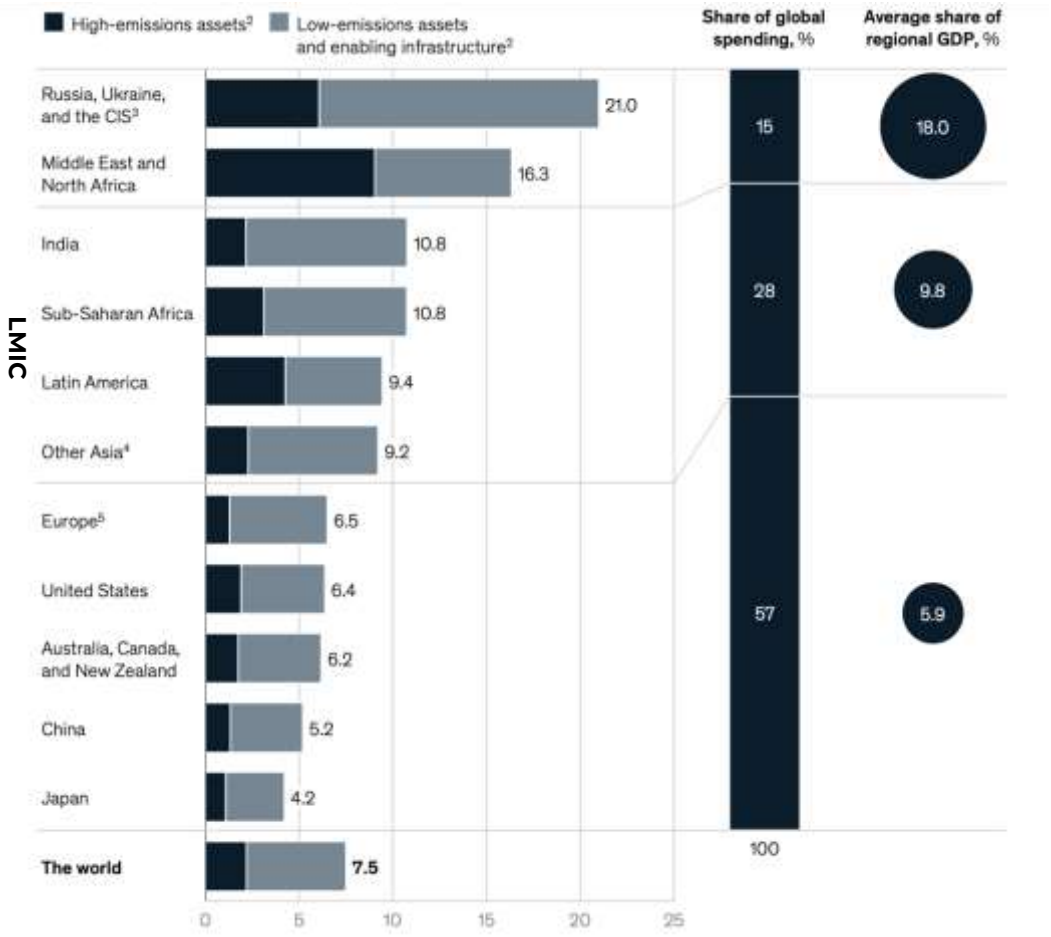


Figure 1: Investment required for Net Zero Transition, Mckinsey assessment, 2022; Source: Mcknisey Sustainability, 2022

Given the limited economic resources, institutional capacities, and trade-off between socio economic development, mobilising financial resources to this tune would be not possible for these countries without external support from

[4] https://www.mckinsey.com/capabilities/sustainability/our-insights/how-the-net-zero-transition-would-play-out-in-countries-and-regions

the developed world in form of development finance and private finance. This challenge could further compound for the LMIC countries which are at high vulnerability exposure due to the physical impacts of climate change.

Even though these countries have limited contributions to climate change, they will bear the brunt of its consequences. A global issue is also ensuring that climate change does not harm poor countries' economy and stability. The expected costs for some of these countries are already very high, the Figure 2: Poorer countries faces greater risks (Unequal costs of Climate Change) depicts the findings of a study conducted by IMF[5], showcases low- and middle-income countries are at greater risk to the extreme climate events and have lower adaptive capacity to these impacts in form of finances, capacities, and economic resilience.

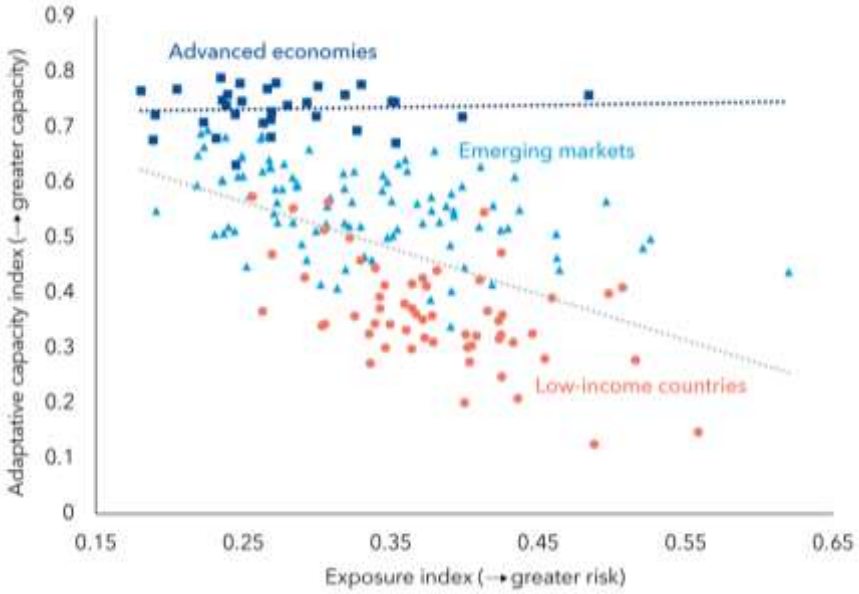


Figure 2:Poorer countries faces greater risks (Unequal costs of Climate Change)- Source: IMF, 2022

The latest IPCC report on Climate Change 2022: Impacts, Adaptation and Vulnerability, analyses the impact of extreme climate events on settlements and infrastructure, marine ecosystem, freshwater and terrestrial ecosystems, and economies around different global temperature rise scenarios. The report corroborates the risk and vulnerability for LMIC countries to extreme climate events like floods, storm, drought, heat, and wildfires under all scenarios as compared to the developed economies. Within the LMIC the small island states and least developed countries are most vulnerable to the impact of climate change facing relatively serious challenges as showcased in the Figure 3: : Excerpt from IPCC Report on Climate Adaptation, 2022.

5 https://blogs.imf.org/2022/03/23/poor-and-vulnerable-countries-need-support-to-adapt-to-climate-change/

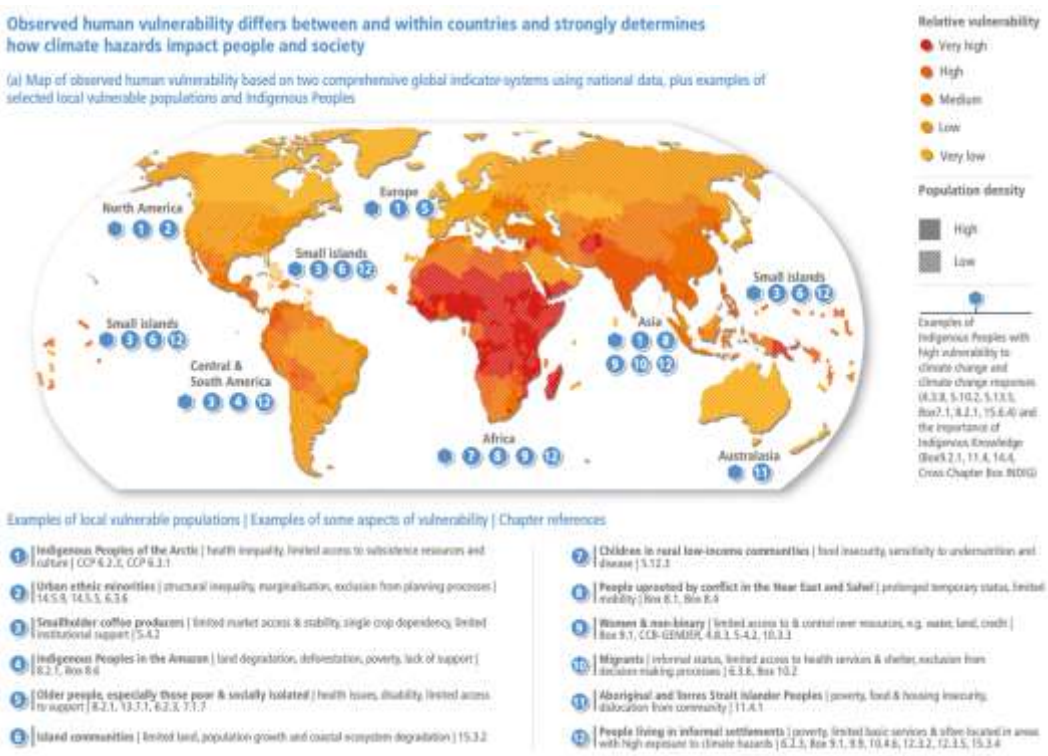
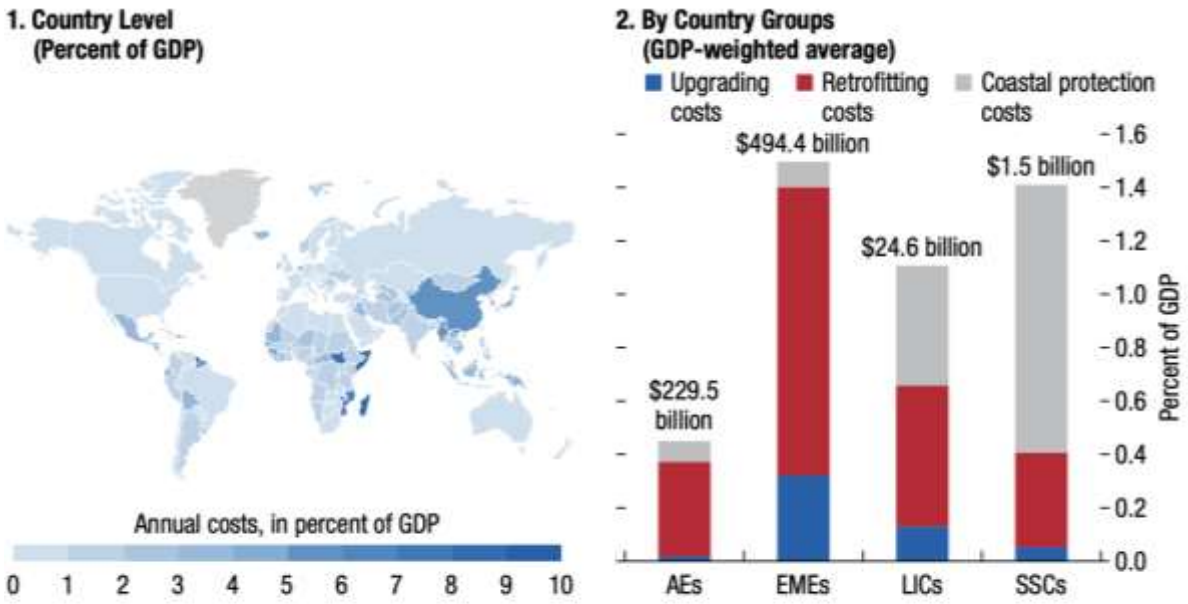


Figure 3:Excerpt from IPCC Report on Climate Adaptation, 2022; Source: IPCC: Report on Climate Change 2022: Impacts, Adaptation and Vulnerability[6]

The report also highlights the significance of the investments in climate resilience to adapt to the potential extreme climate scenarios, but the cost of climate change is unequally distributed. An assessment by IMF estimates at a global level around 1% of the GDP is required to be invested in resilient infrastructure and ecosystems to build resilience to climate induced disasters in the form of integrating resilience in new infrastructure, retrofitting existing infrastructure and coastal protection. The cost is unequally distributed and relatively higher for LMIC countries over the next ten years, 50 low-income and emerging nations would require an investment of more than 1% of their GDP towards building resilience. The investments would be much greater in relative terms to GDP for small island nations that would require to invest as high as 10% of their GDP. The Figure 4: Annual Upgrading, Retrofitting, and Protection Investment Costs, IMF, 2022 below shows the amount of annual investments required by different country groups for building resilient infrastructure, in terms of absolute numbers the maximum investments would be required Emerging Market Economies (EME) followed by advanced economies (AE). The estimate is drawn following a bottom-up approach and consider all aspects of building resilient infrastructure i.e., building resilience in the new infrastructure in form of upgrading cost- estimated on an average 15% of the project cost; retrofitting existing infrastructure to build resilience in form of retrofitting cost- estimate on an average 50% of asset value; and building coastal protection for countries exposed to coasts in form of grey and green infrastructure like dikes, mangrove restoration among other in form of coastal protection cost. Disparities amongst different countries is huge in terms of adaptation investments with low income and small states facing greater challenges and relative cost in terms of GDP for building resilience. In case of Emerging market economies most of the investments in resilience would be required to be targeted towards retrofitting. Low-income countries (LIC) and small state countries (SSC) would require an additional investment to the tune of 1 to 2% of their GDP annually, the majority of which would be targeted towards coastal protection.

[6] https://www.ipcc.ch/report/ar6/wg2/



Sources: Nicholls and others 2019; Rozenberg and Fay 2019; IMF Investment and Capital Stock Dataset 2019; IMF World Economic Outlook database: and IMF staff estimates.

Figure 4: Expected investment in financing resilience, world economic outlook, 2020

In absence of such investments these countries are at high risk to significantly disrupt their infrastructure and development pathways resulting in a very high exposure to the human population. According the UNDEP AGR, 2021[7] The adaptation financing required by 58 developing countries in line with their National Adaptation Plans (NAP) and Nationally Determined Contribution (NDCs) is US$ 70 billion per year between 2020 and 2030. The report further extrapolates this figure to all LMIC countries and estimates the need of US$ 250 billion per year by 2050 in adaptation and resilience financing.

Mobilising investments for net zero transition coupled with investments required for building resilient infrastructure would be a key challenge for LMIC countries given limited public resources, institutional capacity, relative smaller size of the economy and limited access to information, awareness & technology. Hence, these countries would require large scale external support from developed countries, multilateral and bilateral development finance institutions, climate funds among others in form of technical assistance, development finance and private sector finance to achieve climate resilient net zero transition. Arranging these resources would be a key to avoid unprecedented impact on the economy and resources required post disasters in form humanitarian assistance and reconstruction.

[7] https://www.unep.org/resources/adaptation-gap-report-2021

EXISTING LANDSCAPE OF CLIMATE FINANCE: RESILIENT INFRASTRUCTURE

[8]Despite recent slowdowns in flows, overall climate finance has increased steadily over the past ten years, reaching USD 632 billion in 2019/2020 The annual rise in climate finance flows from 2017/2018 to 2019/2020 was barely 10%, compared to preceding periods when it increased by more than 24% due to the COVID induced impacts on public expenditure. CPI report on global climate finance estimates a yearly increase of climate financing by 590% to achieve net zero and develop climate and disaster resilient infrastructure. Almost 2/3 of the total climate finance is focused on mitigation activities, in terms of climate finance targeted towards development of resilient infrastructure for climate adaptation the share of adaptation finance in total climate finance increased by 53% from USD 30 billion in 2017/2018 to USD 46 billion in 2019/2020.

As per the recent OECD report[9] as shown in Figure 5: Aggregated adaptation finance till 2015-2020-OECD Report on climate finance trends, 2020 on "Aggregate Trends of Climate Finance Provided and Mobilised by Developed Countries in 2013-2020" in relative terms the adaptation finance account for 30% of the total climate flows for LMIC countries and 50% of the total climate flows for low-income countries. Almost half of the global adaptation climate finance flows to SIDS and LDCs was targeted towards adaptation between 2015-20. Over the five years, a total of USD 3.6 billion were provided and mobilised for adaptation in SIDS and USD 28.6 billion in LDCs, i.e., an annual average of USD 0.7 billion and USD 5.7 billion. However more than 40% of total adaptation finance for LDCs was directed to only 5 of the 45 least developed countries and 39% of adaptation finance was directed to 5 of the 40 SIDS clearly representing an inequity in access to finance.

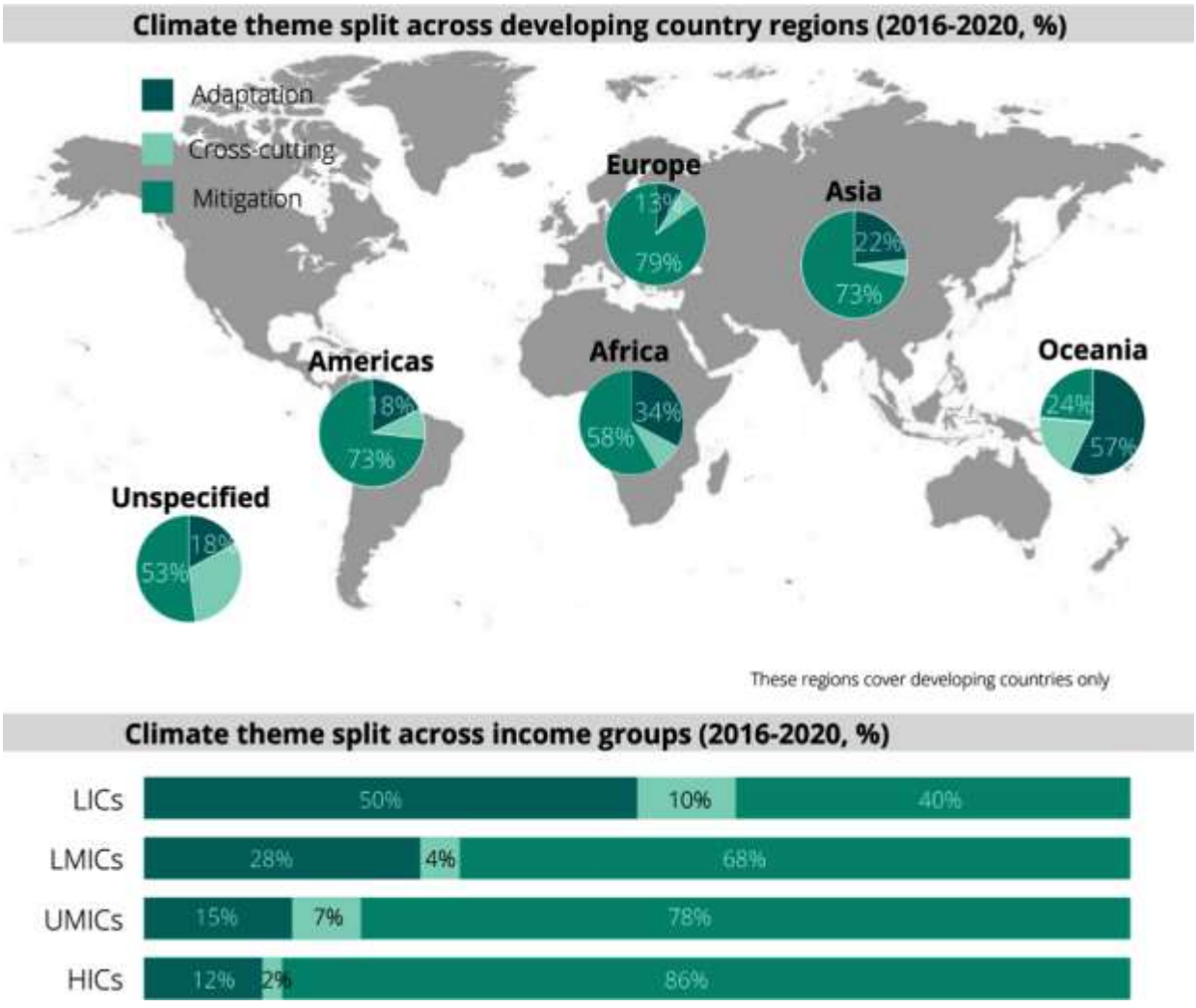


Figure 5: OECD Climate finance flows, 2020

[8] Global Landscape of Climate Finance 2021 - CPI. (2021, December 14). CPI. https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2021/

[9] https://www.oecd.org/environment/statement-by-the-oecd-secretary-general-on-climate-finance-trends-to-2020.htm

In terms of sources of financing almost 90% of adaptation finance to LMIC, LDC and SIDS are from public finance sources particularly through multilateral development banks, bilateral public funds, and local public funds.

Multilateral development banks (MDBs) are the most important public sources of money for adapting to climate change. According to the latest Joint Report on Multilateral Development Banks' Climate Finance (AfDB, ADB, AIIB et al., 2019), the MDBs targeted a total of US$ 14.9 bn towards adaptation finance mostly in form of loan instruments for LMIC countries- South Asian countries and Sub Sharan countries accounting for 50% of the committed investments. The report also highlights the ambition set by MDBs in line with climate action goals to increase adaptation finance to LMIC countries by US$ 18 billion and development of eco-system to mobilise private sector financing in adaptation. Multilateral climate funds have also emerged as a key source for adaptation finance to LMIC countries, the flows from such funds have also reached ~USD 1 billion in 2019, unlike MDBs these funds provide financing for adaptation financing mostly in the form of grants. In 2019, 53% of the adaptation finance from climate funds went to LDCs. Bilateral public adaptation finances another important source of public adaptation funding for developing countries, the investment flows have doubled in the last decade reaching 15.1 bn in 2019 mostly in the form of grants and loans.

Private financing for adaptation is difficult to track, [10]There are several financing flows supporting private sector investment in climate adaptation, but only a subset of these flows can be evaluated. The private sector engages in adaptation utilising either internally generated resources or funding given by either public or private bodies, including external intermediaries such as banks, private equity, and multilateral development banks. However, it is conceivable to quantify the resources contributed to the private sector by national governments, development finance institutions, and climate fund intermediaries (international public adaptation finance). The overall climate finance leveraged through the private sector has been relatively stable i.e., annual average of US$ 14.4 billion (2021), almost 90% of this finance is focused on mitigation and ~10% i.e., US$ 1.4 billion is targeted towards adaptation. Despite limited private sector flows in adaptation, there is a significant scope of development of innovative financing and funding tools which can enable flows from the private sector and help closing adaptation financing gap. Some of these instruments and tools have been discussed in the later section of this position paper.

Domestic budgets of the countries are an important source of adaptation finance. In some of the countries the domestic budgets far exceed the international climate finance. For instance, the domestic finance used for small countries towards building resilient infrastructure range between ~2-5% of their GDP[11]. There is a growing recognition and acceptance that domestic budgets should account for revenues and expenditure that enhance resilience to climate and disaster related risks in line with article 2.1(c) of the Paris Agreement, which states that all countries need to make their finance flows consistent with low-carbon and climate-resilient development pathways.

Despite the steady growth, total adaptation funding is still much below the level required to address both current and future climate change. As per the Annual Adaptation Gap Report, 2021 published by UNEP the gap in global adaptation finance has widened particularly for LMIC countries, to address the gap the international climate finance in adaptation to be increased to five to ten times greater than current international public adaptation finance flows at the same time enabling environment needs to be developed to create opportunities for leveraging private sector finance. But the problem further exacerbates with the barriers faced by LMIC countries to mobilise finance for resilient infrastructure owing to various factors. The next section of the position paper discusses some of the key barriers faced by LMIC countries.

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[10] https://www.climateinvestmentfunds.org/sites/default/files/7544-wb_cif_ppcr_report-v5.pdf

[11] https://www.unep.org/resources/adaptation-gap-report-2021

BARRIERS FACED BY LMIC IN MOBILISING FINANCE FOR RESILIENT INFRASTRUCTURE

Investing in higher resilience can lessen the impact's severity, which has advantages such as reducing asset damage and accelerating post-disaster economic recovery. By reducing risk, increased resilience also boosts corporate confidence, which in turn encourages innovation and economic growth. The sources of financing for resilient infrastructure as outlined in the last section of the paper vary from public to private and national to international. The ability of a LMIC countries to mobilise resources from these sources is highly dependent on the capacity of these countries to develop projects and create an enabling policy/ institutional environment. This is due to several barriers faced by these countries resulting from the nature of resilient infrastructure investments, limited institutional capacities, limited buoyancy in public capital, revenue sources and infrastructure governance. Some of the key barriers faced by LMIC countries can be broadly categorised as below, the detailed barriers are summarised in the Table 1: High-level Barriers faced by LMIC in mobilising financing for resilient infrastructure

- Unquantified risk and misperception of investment in climate resilience
- Infrastructure governance- institutional and policy
- Public finance and capacity to innovate

Table 1: High-level Barriers faced by LMIC in mobilising financing for resilient infrastructure

Key Barriers	Detailed Barriers
Unquantified risk and misperception of investment in climate resilience	
Additional cost, uncertain benefits	Building resilience often requires higher upfront costs, while bringing potentially uncertain, heavily discounted long-term economic benefits given the deferred benefits investments in resilience is often conceived as more expensive.
Externalities - the broader resilience dividends	Typical cost-benefit analysis may adopt a limiting view of the benefits of resilience, making such investments appear unattractive. Cost-benefit analysis may focus only on the lens of avoided physical asset damages, not the other externalities. The scope must be broadened to quantify the risk into the analysis.
Information Asymmetries	There is no effective or common way to measure resilience or its wide-reaching benefits; infrastructure owners rarely share information on vulnerabilities due to security concerns; most infrastructure managers have sparse experience with disasters.
Infrastructure governance- policy and institutional capacity	
Commitment and ownership of risk issues	Identifying key stakeholders and interests in resilient infrastructure on the ground is difficult, often the infrastructure is owned and managed by multiple stakeholders and requires a proper institutional mechanism to aggregate or take ownership of the associated risks.
Institutional, technical and enforcement capacity	Resilience requires additional technical capacity and an enabling environment to enforce resilience measures, which may be lacking in some of the LMIC countries most exposed to catastrophe risks. A policy framework integrating these measures in the bye laws can help mobilise investments by the private sector at origination.
Maintenance	Resilience is not just delivered at the point of construction. It requires ongoing maintenance. This brings a host of further funding and misalignment of incentives issues.
Institutional capacity to develop “fundable” resilience proposals	Most development finance/ climate finance sources of financing climate resilient infrastructure require host countries to develop “fundable” proposals clearly quantifying the risks and impact. LMIC countries often lack institutional capacity to develop such proposals restricting access to international sources.

Public finance and capacity to innovate	
Limited public capital	Most of the LMIC countries have limited public capital to be invested, striking a balance between economic development, climate mitigation ambitions as well as building resilience. Often due to limited upfront capital "additional" upfront financing for resilience emerges as a key barrier.
Public Investment Planning	The public investment planning should take in consideration the impact of climate and disaster related risk quantified into the social return assessment for the investments. Most LMIC countries lack the processes of risk quantification as a part of public investment planning decisions and methodologies to incorporate resilience in public investment planning.
Credit rating of public agencies and vibrancy of local capital market	Low credit rating of the public agencies impacts the access to the local and international debt capital markets. This is often coupled with a limited revenue base which can be escrowed to mobilise financing from upfront investments. Additionally. In most of LMIC the local debt capital market is at the inception phase of development, resulting in a limited investor base.
Knowledge and flexibility to access funding from innovative tools	Most LMIC countries have limited knowledge of innovative financing tools such as carbon offsets, event-based insurance and reinsurance, cat bonds and their potential. Often accessing funding from these tools requires flexibility in policies and regulations as a prerequisite.

Source: South Pole analysis, 2022

INNOVATIVE FINANCING AND SERVICING MODELS FOR RESILIENT INFRASTRUCTURE

Investing in resilience can lessen the impact's severity, which has advantages such as reducing asset damage and accelerating post-disaster economic recovery. By reducing risk, increased resilience also boosts corporate confidence, which in turn encourages innovation and economic growth. Since LMIC countries are facing the dual challenge of mobilising unprecedented amounts of investments to support net zero transition at the same time build infrastructure, which is disaster resilience, it is prudent these countries work on innovative funding and financing structures and instruments which can be used to develop resilient infrastructure. These structures combined with technical assistance can help these countries overcome some of the key barriers identified in the last section of this position paper. It is a common misconception that such innovative solutions must necessarily be expensive. Often, the key is to use innovative financing and funding methods and operate in such a way as to harness the capital that is already accessible, rather than raising money and putting up millions of dollars upfront.

The Figure 6: Innovative sources to finance/fund resilient infrastructure Source: South Pole Analysis, 2022 below summarises some of these sources and innovative instruments which may be used by LMIC countries for mobilising resilience financing which can be used by LMIC countries.

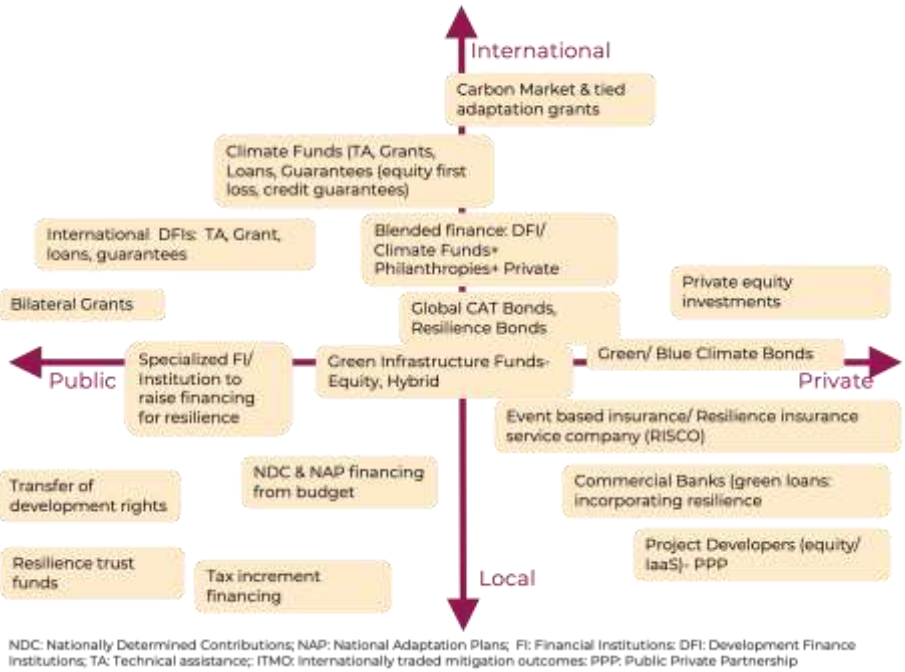

Figure 6: Innovative sources to finance/fund resilient infrastructure Source: South Pole Analysis, 2022

Since funding models for financing resilience is not yet proven, public financing needs to structure innovative products to leverage private financing. One good example of ***Innovative Blended Financing*** is by Green Climate Fund (GCF), wherein the fund contributed approximately 14% of **First Loss Equity** to private sustainable infrastructure fund. These initial public funding by GCF made possible for the Fund to raise remaining 86% of equity from marquee institutional equity investors which otherwise would not have participated. Also the special purpose vehicles incorporated to implement projects at downstream level were able to debt finance for remaining 70% of the project cost. So the innovative blended structure from GCF was able to stimulate and leverage private financing for approximately 30 times the capital that GCF contributed.

Mobilising finance and funding from the sources and instruments outlined in the Figure above would be dependent on the amount of financing required, political will to charge, ease of access and vibrancy of the local market among others. These factors would further determine the appropriateness of use of the instrument, the table below provides a matrix of suitability for some of the identified innovative instruments from perspective of LMIC countries also outlining the instruments which can be used for resilient infrastructure development vis a vis which can be used for only post disaster risk financing.

Table 2: Innovative financing instruments, suitability from LMIC perspective

Type of Models	Definition	Potential to raise finance	Political will	Ease of access	Local Market Impact	Usage	
						Resilient Financing	Post-Disaster Financing
Green Climate Funds	The Green Climate Fund was created by the UNFCCC as part of the Financial Mechanism to help developing nations adapt to and mitigate climate change. The access to these funds requires dedicated resources in proposal development as well as a proof of driving significant leverage.	Medium	High	Low	High		
Green/Climate Bonds	Green/climate bonds have the potential to provide substantial revenue and the issuance of these bonds is relatively straightforward.	Medium	High	Medium	Medium		
Blue Bond[12]	A sustainability bond, which is a financing instrument issued to fund investments in thriving blue economies and healthy seas, has a relatively recent variant known as a blue bond.	High	Medium	Medium	Medium		
CAT Bond	CAT bonds are high-yield financial instruments designed to raise money for insurance companies in the event of a natural disaster. A CAT bond only pays out if certain events, such an earthquake or tornado, occur.	Medium	Medium	Medium	Medium		
Public Private Partnership (P3S)	A P3 is an agreement between a public and private entity in which the private entity agrees to renovate, construct, finance, operate, maintain, and/or manage a facility or system.	High	Medium	Medium	Medium		
Collaborative Revenue Bonds (CRB)	CRBs set up a cost-sharing agreement across multiple entities that benefit from a project It require economic, social, and environmental benefit valuation	High	Medium	High	High		

[12] Blue bonds: What they are, and how they can help the oceans. (n.d.). World Economic Forum. Retrieved September 21, 2022, from https://www.weforum.org/agenda/2019/06/world-oceans-day-blue-bonds-can-help-guarantee-the-oceans-wealth/

Type of Models	Definition	Potential to raise finance	Political will	Ease of access	Local Market Impact	Usage	
						Resilient Financing	Post-Disaster Financing
Event-based Insurance	Provides immediate and flexible recovery funds after a disruption event. Must prove economic stake in the assets.	Medium	Medium	Medium	Medium		
Regional Resilience Trust Fund	Provides self-sustaining source of capital for projects and Allows for a regional approach to resilience	High	Medium	Medium	Medium		

Type of Models	Definition	Potential to raise funds	Political will	Ease of access	Local Market Impact	Usage	
						Resilient Financing	Post-Disaster Financing
Tax Increment Financing (TIF)	TIF programs are relatively easy to implement, especially in already-existing business improvement districts.	Medium	Medium	Medium	Low		
Carbon Offset Markets	Revenue is likely insufficient to cover the cost of wetland restoration. Carbon Markets present an opportunity to monetize not only the carbon potential but also the related ecosystem benefits.	Medium	Medium	Medium	High		
Transfer of Development Rights (TDR)	TDR shifts development from one location to another. These programs can be difficult to design and do not always result in substantial land preservation.	Medium	Medium	Medium	Medium		

Source: South Pole Analysis, 2022- adapted from Harvard Paper on Resilience[13]

[13] *(https://ash.harvard.edu/files/ash/files/financing_climate_resilience_final_report.pdf)*

Best practices and innovative mechanisms

With an objective to overcome the key financing barriers, innovative policy, financing, and institutional mechanisms have been successfully introduced and implemented by some of the countries along the globe. The success of these mechanisms presents a case of wide scale replication of such solutions with support from policy makers, development finance institutions, climate funds and other key stakeholders. These case studies (Figure) not only focus on adaptation financing and funding of developing, low-middle income and developed countries but also recommend some nature-based solutions that must be implemented to the projects in future. This section of the position paper presents such case studies[14]:

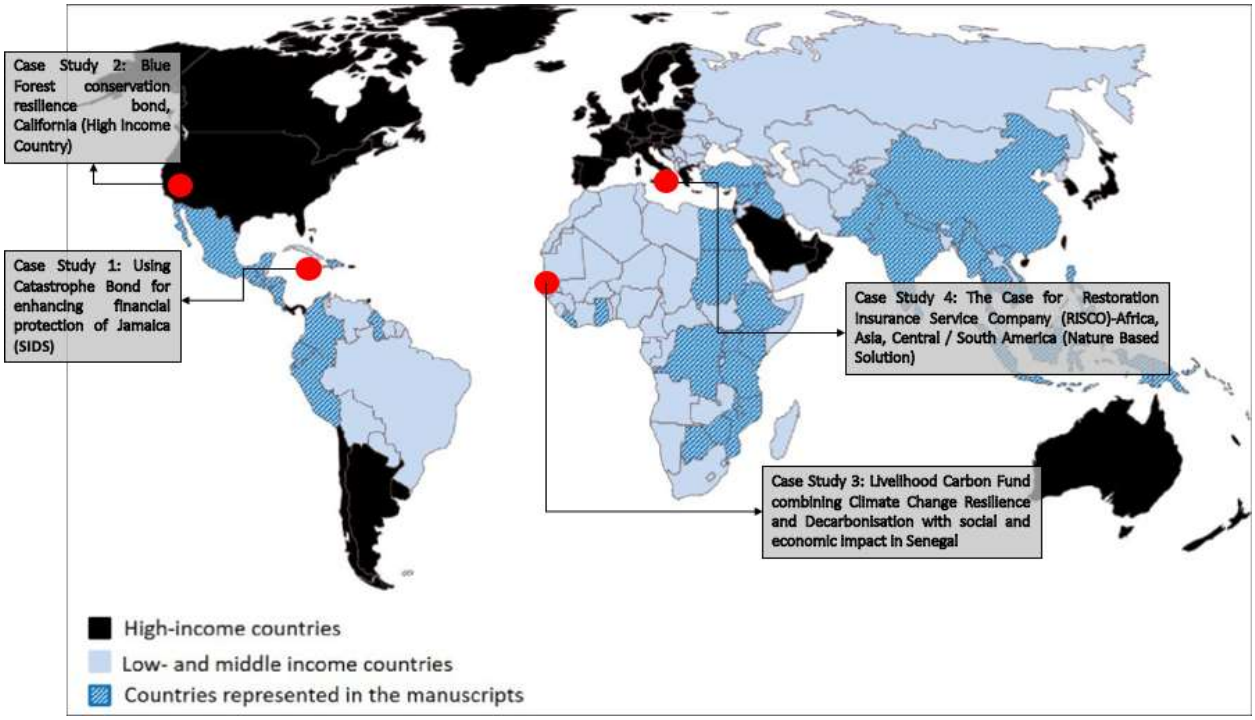

Figure 7: World Map showcasing case studies covered under the position paper

Case Study 1: Using Catastrophe Bond for enhancing financial protection of Jamaica[15]

Catastrophe Bond provides Jamaica with Financial Protection against Tropical Cyclones	
Instrument focus	Post disaster financing
Country/ Geographic Region	Jamaica, Caribbean (Local Project)
Country Income Level Classification	Small Island Developing State (SIDS)- UN- Upper Middle-Income Country- World Bank
Type of Project	Adaptation
Type of Hazards mitigated/Focus	Tropical Cyclone
Type of Financing	Using Catastrophe Bond

[14] Projects Archive - The Global Innovation Lab for Climate Finance. (n.d.). The Global Innovation Lab for Climate Finance. Retrieved September 21, 2022, from https://www.climatefinancelab.org/project/?_sf_s=adaptation%20projects&_sfm__focus=Blue%20carbon-%2C-Climate%20resilience-%2C-Nature-based%20solutions&_sfm_status=Endorsed-%2C-Fire%20Winner-%2C-In%20Development

[15] https://thedocs.worldbank.org/en/doc/43a111757d3b1ff1cabde80ee7eb0535-0340012021/original/Case-Study-Jamaica-Cat-Bond.pdf

Type of Governance	Public Utility
Lever of change	The country is working towards enhancing the resilience of the key infrastructure sectors, it is also looking for innovative instruments that can optimise the insurance cover of Jamaica with limited public funding.
Main Actors	Government of Jamaica UK and Germany funded Global Risk Financing Facility (GRiF) United States Agency for International Development (USAID)
Case- Study Summary	Jamaica is a Small Island Developing State and the largest island in the Caribbean. The country is highly vulnerable to natural disasters like hurricanes and earthquakes and the effect of climate change along the coastal sectors. These extreme events pose a significant challenge for the country's economic development activities. In the decade ending 2010 natural disasters have cost Jamaica ~USD 1.2 bn. Approximately 90 percent of Jamaica's $14 billion GDP is produced within its coastal zone, making its economically valuable tourism, industry, fisheries, and agriculture assets highly vulnerable to climate variability and change. Weather-related disasters over the past two decades, including those due to droughts, floods, tropical storms, and hurricanes, have severely impacted Jamaica's economic growth.
Key Takeaways	Unique trigger type: CAT-in-a grid structure localising the risk trigger to the area Pay-out Structure: enabling payments within a week of disaster through independent evaluation by a third party based on the central pressure and track of the cyclone.
Replicability Potential	**High**- can be used as an effective insurance tool to build financial resilience of Small Island States. The bond can also leverage grant funding from climate investment funds and philanthropies on other hand.

Project Rationale

[16]Hurricanes and earthquakes pose hazards to Jamaicans and their socioeconomic prospects due to the island nation's considerable exposure to natural catastrophes. Between 2001 and 2010, Jamaica suffered estimated losses of US$1.2 billion due to natural disasters. Hurricane Ivan alone caused more than US$350 million in losses and destruction in 2004. A plan being carried out by the Jamaican government (GoJ) intends to make Jamaica completely resilient to natural calamities. The World Bank (WB) supports these changes through a variety of finance instruments and technical assistance, and they cover reforms for financial, physical, and social resilience.

However, the GoJ's current disaster risk financing instruments (a contingency fund, contingent credit, and catastrophe insurance from the Caribbean Catastrophe Risk Insurance Facility (CCRIF)) are insufficient and leave Jamaica with significant funding gaps, especially for tropical cyclone events. This is despite the GoJ's efforts to increase its financial resilience through pre-arranged funding for post-disaster activities.

Project Objectives

- Boost the nation's ability to withstand tropical cyclones' financial impact without increasing to its financial distress.
- Give access to timely pay-out and affordable insurance through the capital markets.
- Create for the island of Jamaica a granular CAT-in-grid trigger structure.
- With limited resources, maximise Jamaica's insurance coverage.

Project Solution

The Government of Jamaica with support from the World Bank (WB) issued a Catastrophe bond providing the country an insurance cover of USD 185 Mio for tropical cyclone events between 2021-23. GoJ sponsored the bond with grant support from the Global Risk Financing Facility (GRiF) and the United States Agency for International

[16] https://thedocs.worldbank.org/en/doc/43a111757d3b1ff1cabde80ee7eb0535-0340012021/original/Case-Study-Jamaica-Cat-Bond.pdf

Development (USAID). The bond was subscribed by 21 investors globally. Jamaica became the first island state in the Caribbean region to independently sponsor a CAT bond.

The types of situations that will result in a compensation were specified during the transaction's structuring based on Jamaica's regulations. The independent calculating agency (AIR Worldwide) will calculate the compensation amount based on the central pressure and course of the cyclone after receiving a notice from Jamaica in the case of a qualifying event. Following a tropical cyclone event, the WB will send the reimbursements to the GoJ as soon as a computation report is provided, without first determining the country's actual losses.

Project Implementation

The GoJ is the first government to independently sponsor a cat bond in the Caribbean and the first small island state to do so. One of the sixteen nations in the CCRIF that benefited from the IBRD's first cat bond ever in 2014 was Jamaica.

This transaction incorporates an innovative reporting component that results in a speedy pay-out calculation within weeks following a tropical cyclone incident. Additionally, it is the first cat bond to incorporate a parametric trigger design for tropical cyclone risk using a cat-in-grid.

Figure 8: Instrument Structure CAT Bond

Transaction Summary

Peril	Tropical Cyclones
Principal (Coverage Amount)	US$185 million
Risk Period	2.4 years (24 July 2021 to 21 Dec 2023)
Trigger Type	Parametric CAT-in-a-grid
Payout Structure	Linear sliding scale based on severity of storm with a minimum payout of 30% of principal and maximum payout of 100% of principal
Risk Statistics (Annual)	Expected Loss: 1.52%, Attachment Probability 2.37%
Price/ Premium Multiple	Risk Margin: 4.4%

Source: World Bank, 2022

Lesson Learnt

A long-standing WB involvement on disaster risk management with Jamaica has included policy initiatives, investment lending, and technical assistance. The cat bond is the most recent activity in this context. Before entering this transaction, the WB assisted Jamaica in analysing the costs and benefits of financing disasters using the various disaster risk financing instruments that were available to and being considered by Jamaica, as well as the financial impact of tropical cyclone and earthquake events. Hence, technical assistance is a key towards success of such instruments.

The WB oversaw the planning, structure, and execution of the cat bond after Jamaica requested one and obtained the outside service providers needed for the transaction. Hence, to enable a LMIC to access financing through such innovative instruments a comprehensive approach is required to be followed by building prerequisite governance, policy, and institutional framework through focused technical assistance. Additionally, for the countries with limited access to local debt capital markets such co-hosted bonds provide an opportunity to access funding from global debt capital markets.

Case Study 2: Blue Forest conservation resilience bond[17]

Blue Forest Conservation Resilience Bond of California	
Country/ Geographic Region	California, United States
Country Income Level Classification	High Income Country- Advanced Economy
Type of Project	Adaptation
Type of Hazards mitigated/Focus	Wildfires
Type of Financing	Blue Forest Conservation Resilience Bond
Type of Governance	Public Utility
Lever of change	The Forest Resilience Bond (FRB) aims to address the need by utilising private finance to supplement existing funding and allow investment in the management of public lands rather than increasing public or charity funding using blending upfront funding from potential beneficiaries with government contracts.
Main Actors	Blue Forest Conservation (BFC) Encourage Capital The World Resources Institute The U.S. Forest Service The Sierra Nevada Conservancy The American Forest Foundation The U.S. Endowment for Forestry and Communities The Sierra Nevada Research Institute Natural Capital Project The National Forest Foundation. The Rockefeller Foundation
Case- Study Summary	Wildfires, a longstanding and frequent threat to California, are expected to increase in intensity and frequency due to climate change. While wildfires are obviously a significant threat to property and public safety, they can also significantly affect air quality by increasing the number of particulates in the air. Activities such as mechanical thinning, along with prescribed burns and meadow restoration can prevent some of the above risks and restore forests. It is these activities that Blue Forest Conservation's Forest Resilience Bond – a blended finance structure that provides funding to carry out risk mitigating activities – solves for. Blue Forest Conservation's Forest Resilience Bond is based on a premise that multiple beneficiaries would pay for forest restoration and prevention, such as utility companies, local government, and forestry organisations, which would therefore provide a repayment model that could attract private lenders or investors. Investors themselves could achieve a market rate return as well as benefit themselves from the reduced wildfire risk, such as insurance companies.
Key Takeaways	Through the following measures, the FRB specifically leverages the decreasingly available public funds used for forest restoration: ● Costs (and benefits) are shared, which lowers total costs for each stakeholder. ● Leveraging private financing increases the scope of repair without placing a strain on finances.

[17] Forest Resilience Bond & Blue Forest Conservation. (n.d.). Blue Forest Conservation. Retrieved September 19, 2022, from https://www.blueforest.org/forest-resilience-bond

	● Quickening restoration efforts reduces the risk of additional overgrowth and stakeholder expenses in the future. The FRB is actively increasing climate resilience as a new public-private partnership paradigm with the first pilot project launched in 2018 in Tahoe National Forest.
Replicability Potential	Medium- High: The replicability potential of this model for LMIC countries would medium to high given the nature of the model combining infrastructure and impact bonds- such an instruments can be used effectively for comprehensive resilience efforts focusing on activities like coastal projection and retrofitting wherein multiple beneficiaries are impacted but the majority of ownership remains with the public sector. But a flourishing debt capital market is also a prerequisite for success of such an instrument independently.

Objectives

The FRB is making the crucial moves necessary to close the gap between investors and environmental interventions by creating the measurement technology, reducing the contracting system, and financial structures that will enable private capital to finance land management while guaranteeing that public land remains public and reducing the risk of wildfires. A scalable investment mechanism that enables private investors to support forest and watershed health while earning competitive returns is being developed by the FRB to turn a funding crisis into a financing opportunity. Objectives of the FRB include:

- Encourage the development of additional financial and technical resources for forest collaboratives working on restoration initiatives.
- To increase the speed and scope of forest restoration across the nation, develop a highly repeatable finance mechanism.
- Restore the health of the forest and watershed.
- Reduce the risk of wildfires affecting nearby rural populations and forest ecosystems.

Solution

Blue forest develops a model by combining two types of financial structure, impact bonds and infrastructure financing. FRB is not a traditional bond, but a fixed income vehicle supported by contracted cash flows. The model is based on pay-for performance structure with private investors providing upfront capital for the project and the public beneficiaries reimbursed the investors along with modest return based on achievements of impact targets. The Forest Resilience Bond (FRB) aims to close the financial gap for forest restoration by allowing private capital to participate in supporting public land management rather than by increasing public or philanthropic sources. According to a survey by Forest Trends and JP Morgan, over $3.1 billion in sustainable investment money is still sitting on the side-lines since there aren't enough investment opportunities in the field of conservation financing. Because there aren't enough good deals available, conservation-minded investors haven't had a chance to fund these projects.

Capital Structure:

- investors: concessional investors like philanthropies entitled to interest rate of 1% PA and commercial investors entitled to interest of 4% PA.
- Source of cash flows: public agencies in form of grants as per pay for performance model.

Implementation Structure

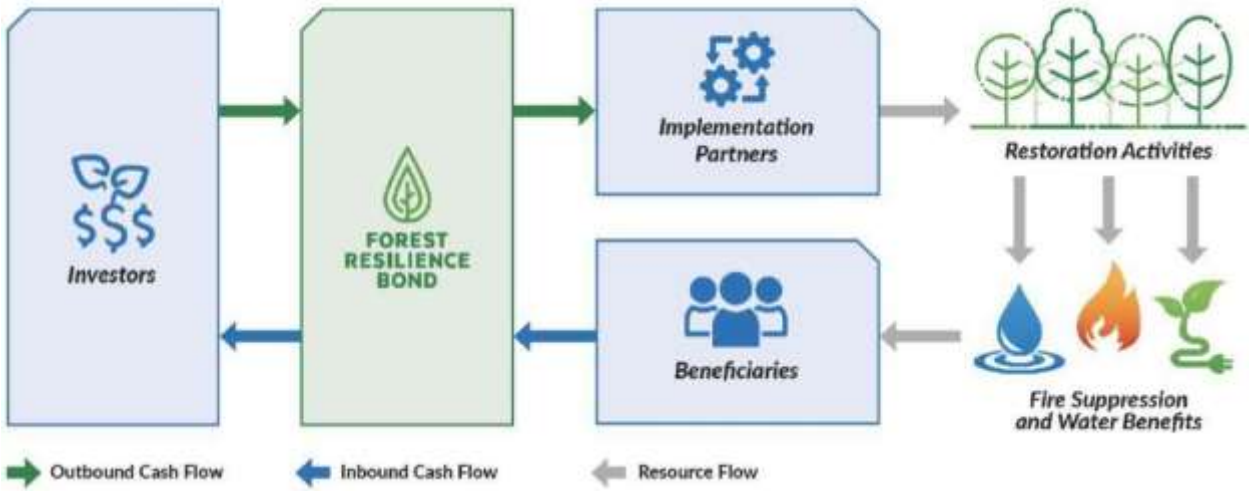

Figure 9:Blue forest bond structure

Lesson Learnt

The health of some of our most valuable natural resources and the public benefits they provide are at risk due to overgrowth, tree mortality, and water scarcity in many of the western U.S. forests. The length and severity of wildfire seasons are increasing, and there is no stop in sight. A total of 6 to 9 million acres of forest land needs to be restored in California alone. Scaling private funding for conservation also necessitates standardising environmental services measurement, developing clear and consistent contracting processes, and financial structuring to encourage investment. Flexible and diverse financial sources, as opposed to solely relying on market-rate finance, can aid in ensuring that a sustainable development process is centred on reproducible, scalable projects. Market rate financing can be crucial in replicating and increasing natural infrastructure investments like the Forest Resilience Bond as soon as the initial pilots are successful, and the model is established. It's critical to keep in mind that sometimes moving slowly can lead to rapid advancement when developing sustainable financial solutions to some of our most serious environmental problems.

Case Study 3: Livelihood Carbon fund combining climate change resilience and decarbonisation with social & economic impact in Senegal[18]

Livelihood Carbon fund combining climate change resilience and decarbonisation with social & economic impact in Senegal	
Country/ Geographic Region	Senegal, Western Africa
Country Income Level Classification	Low-and middle-Income Countries
Type of Project	Adaptation and Mitigation
Type of Hazards mitigated/Focus	Climate Resilience
Type of Financing	Hybrid Impact fund with carbon revenues
Type of Governance	Private Impact Fund
Lever of change	The fund provides an innovative funding mechanism for ecosystem-based resilience activities such as conserving, managing, and restoring ecosystems such as mangroves, seagrass, coral reefs, forests, grasslands, rivers, lakes, and soil using sustainable resource management activities through private sector financing. These activities often result in multitude benefits in terms of disaster protection and at the same time act as a natural storage for carbon for 1000 years.
Main Actors	Host: Livelihood Carbon Fund Local NGO: NGO OCEANIUM Private Companies: DANONE, SAP, MARS, Schneider
Case- Study Summary	Senegal has 185,000 hectares of mangrove estuaries in the regions of Casamance and Sine Saloum, but they are disappearing at an alarming pace. A quarter of the total surface area, 45,000 hectares of mangroves, has already been lost since the 70's due to droughts and freshwater reduction caused by upstream agricultural practices. The mangrove restoration project in Senegal, coordinated by the Livelihoods Carbon Fund (LCF) since 2011, aims at restoring an ecosystem that protects arable land from salinization and produces fish resources (fish, shellfish, crustaceans) and wood. The project has been implemented by the Senegalese NGO OCEANIUM that has been working for environment preservation and the restoration of Mangroves since 1984. The project is financed through the provision of upfront financing to project developers for large-scale project implementation and maintenance over periods of 10 to 20 years. The funds receive result-based payments for the risks they bear in the form of carbon credits. The upfront financing is pooled and received from the key investors of the fund.
Key Takeaways	The project is amongst the most successful mangrove restoration projects in the world and has been operational for the last 10 years as a unique blended instrument leveraging voluntary carbon markets. Some of the key takeaways from the project are: ● **Pre- financing i**s necessary: To enable local organisations to implement such large-scale projects it is necessary to provide pre-financing. Livelihood Carbon Fund provided this pre-financing/ risk capital which was recovered through funds received from carbon credits. ● **Carbon finance:** In cases wherein environment and social objectives are truly integrated into carbon projects carbon finance can be a powerful lever.

[18] https://livelihoods.eu/

	Companies which have invested in the fund have dual ambition, one to offset their unavoidable emission and create a positive impact to society at the same time. The companies are willing to take upfront risk in such cases. ● **Measurement and Evaluation:** The stringent monitoring and evaluation conditions said aside by international carbon standards have become a boon for the project rather than a constraint enabling pre-emptive and quick corrective actions ensuring operations and maintenance of natural assets.
Replicability Potential	High: Particularly for the SIDS and LMICs with high investment needs for coastal protection

Objectives

Livelihoods Carbon Funds (LCF) leverage the carbon economy to finance ecosystem restoration, agroforestry, and rural energy projects to improve food security for rural communities and increase farmers' revenues. It has emerged as an efficient way of financing ecosystem services which enhance economic, physical, and social resilience of the communities.

Solution

The fund has been created as an instrument through which private sector companies (impact investors) are able to invest into ecosystem-based services and NBS which in turn result in carbon sequestration, improving livelihoods, and improving biodiversity. These benefits can be quantified in form carbon credits at the same time ensure a resilient supply chain for these investors.

Figure 10: Livelihood Carbon Fund Structure; *Source: Livelihood Fund, EU, 2022*

Implementation updates

As of 2021, two rounds of the Livelihood Carbon Fund have been closed and the third round is operational:

- The Livelihoods Carbon Fund #1 was launched in 2011 by 10 investors: Danone, Schneider Electric, Crédit Agricole S.A., Michelin, Hermès, SAP, Groupe Caisse des Dépôts, La Poste, Firmenich, Voyageurs du Monde. The fund invested around EUR 40 million in the natural ecosystem resulting in improving the resilience of 1 million beneficiaries and 10 million tons of carbon sequestration.
- Livelihoods Carbon Fund #2 was created in 2017 by Crédit Agricole, Danone, Firmenich, Hermès, Michelin, SAP, Schneider Electric & Voyageurs du Monde to enable them to accelerate their actions for climate and the most vulnerable populations. It was joined by Eurofins in 2019. The fund invested around EUR 100 million in the natural ecosystem resulting in improving resilience for 2 million beneficiaries and 12 million tons of carbon sequestration.
- In 2021, Livelihoods Carbon Fund #3 was launched with 14 investors: Bel Group, Chanel, Danone, DEG Invest, Eurofins, Hermès, L'Occitane, Mars, Mauritius Commercial Bank, McCain Foods, Orange, SAP, Schneider Electric, and Voyageurs du Monde this fund blends capital from financial institutions and private

sector and is expected to invest EUR 200 million in natural ecosystem with an anticipated objective of impacting 2 million beneficiaries.

Lesson Learnt

Voluntary carbon markets can also be an effective source of mobilising financing for nature-based ecosystem resilience activities which also have carbon sequestration as one of the outputs of the activity. Demand for credits for carbon sequestration has shown a steep increase in the last 2 years and with more and more companies committing to initiatives like Net Zero/ UN Race to Zero the demand is expected to grow. The premium pricing for community impact projects coupled with demand can be an interesting opportunity for LMIC countries to explore this non- conventional source of financing nature-based resilience activities. Additionally, the monitoring and verification framework ensures the long-term operational effectiveness of the project.

Case Study 4: The Case for Restoration Insurance Service Company (RISCO)-Africa, Asia, Central / South America (Nature Based Solution)[19]

Nature Based Solutions for Mangrove Protection in LMIC (Pilot stage)	
Country/ Geographic Region	Africa, Asia, Central/South America (LMIC)
Country Income Level Classification	Low-and middle-Income Countries
Type of Project	Adaptation as well as Mitigation
Type of Hazards mitigated/Focus	Flooding
Type of Financing	Insurance Service Company
Type of Governance	Public Utility
Lever of change	Mangroves are key to improving coastal protection, globally, mangroves protect more than 18 million people and lessen the flood damage to coastal properties and assets by more than US$ 82 billion a year. At the same time, mangroves provide enormous mitigation benefits, storing up to 10 times more carbon on a per area basis than terrestrial forests. However, mangroves are in decline; approximately half of the world's mangroves have been lost in the last 50 years. The coastal protection and carbon storage benefits provided by mangroves are still underrecognized and often considered 'free' ecosystem services. Restoration Insurance Service Company -RISCO seeks to create new revenue streams for mangrove conservation and restoration by incorporating mangroves' risk reduction value into insurance products and monetizing the climate mitigation value of mangroves through blue carbon credits.
Main Actors	**Investors:** Carbon Credit Buyers- Corporates, private sector Impact Investors Commercial Investors **Partners:** Insurance Companies Service Providers- NGOs Coastal asset owners
Case- Study Summary	Mangrove forests are woody vegetation that can be found in about 120 different nations and territories along tropical and subtropical coastlines. These forests offer significant advantages for climate adaptation, acting as a strong natural barrier against storms (such as typhoons and cyclones) by lowering flood depths and wave heights. Over 18 million people are protected by mangroves worldwide, and they prevent over 82 billion dollars in flood damage to surrounding homes and other coastal assets each year (Beck et al, 2018). In addition, mangroves offer significant benefits for climate change mitigation, storing up to 10 times as much carbon per unit of area as terrestrial forests (Kauffman, 2017). RISCO overcomes existing barriers to mangrove protection by connecting the adaptation and mitigation values of mangroves to the beneficiaries of these values, most of whom currently do not have the knowledge or resources needed to protect mangroves—including insurance companies.

[19] Restoration Insurance Service Company (RISCO) - The Global Innovation Lab for Climate Finance. (2022, February 4). The Global Innovation Lab for Climate Finance. https://www.climatefinancelab.org/project/coastal-risk-reduction/

Key Takeaways	● Innovative: To expand the insurance industry's ability to incorporate mangroves into their natural catastrophe and flood risk models coupled with monetisation of carbon benefits, RISCO will be the first company to commercialise the risk reduction and blue carbon advantages of mangroves at the same time blend this with blue carbon. ● Financial Sustainability: RISCO is anticipated to be economically viable in areas vulnerable to cyclones and flooding, provided that these areas have sufficiently extensive, robust mangrove forests and insured high-value coastal properties. Increased threat levels should increase sales of blue carbon.
Replicability Potential	After being demonstrated through the project in the Philippines (pilot), RISCO can be repeated in many other nations, attracting millions of dollars in private funding, and preventing huge amounts of CO2 from being emitted and sequestered.

Objectives

By tackling the adaptation and mitigation values of mangroves to the beneficiaries of these values, the majority of whom currently lack the knowledge or resources needed to protect mangroves, including insurance companies, RISCO overcomes the most difficult barriers to mangrove conservation and restoration. RISCO will specifically address several obstacles that currently limit mangrove protection:

- Barrier: Mangroves' contribution to lowering the risk of coastal flooding has not been sufficiently appreciated or monetized. Insurers alone paid out more than US$ 300 billion for storm-related coastal losses between 2000 and 2010. (UNISDR, 2011). If the importance of mangroves' role in coastal protection is not properly recognised, this ecosystem will keep disappearing, increasing the risk of flooding for up to 18 million more people and the cost of coastal property damage by up to 16%, or US$ 82 billion yearly (Beck et al, 2018).
    - In response, RISCO will estimate the costs and benefits of mangrove protection and restoration in potential areas and make this information available to the public, creating a global database of data on the decrease of floods caused by mangroves. To hasten replication, RISCO will also make the modelling approach available.
- Barrier: Insurance companies do not yet factor the ability of mangrove ecosystems to protect into models of flood risk. Wetland management scenarios are not yet frequently included in flood risk models, despite the fact that wetlands may be included in insurance models as estimates of land-cover (Narayan et al, 2016).
    - In response, RISCO will identify the site-specific benefits of flood reduction and collaborate with insurance firms to integrate the risk reduction values into flood risk models. There will be agreements in place where the insurance companies will pay a yearly charge, most likely determined on a per-hectare basis, and RISCO will conserve and/or restore mangroves.
- Barrier: Although mangroves store up to ten times as much carbon per area as the typical terrestrial forest5, there aren't many projects that produce blue carbon credits to take use of this value. However, very few blue carbon initiatives have been created, possibly as a result of the significant expenses involved in creating and implementing these programmes as well as the relatively recent understanding of the ability of these ecosystems to mitigate climate change.
    - In response, RISCO will pick a site (or sites) that cover a sufficient area to support the development of a blue carbon project. In some nations, this can necessitate grouping together of multiple smaller locations. This strategy should be possible with the upcoming Verra methods for Wetlands Restoration and Conservation.

Solution

RISCO is a social enterprise with the objective of safeguarding and restoring mangrove ecosystems in developing nations with high levels of blue carbon potential, high risk of floods and storms, and assets and people residing close to the coast. The mechanism is currently at pilot stage. To pilot the strategy and fine-tune the business model, it will initially rely on a blended mix of grants, equity, and loans. However, the intention is for RISCO to become self-financing within 3-5 years via two revenue streams: one related to the insurance sector, and one related to blue carbon credits.

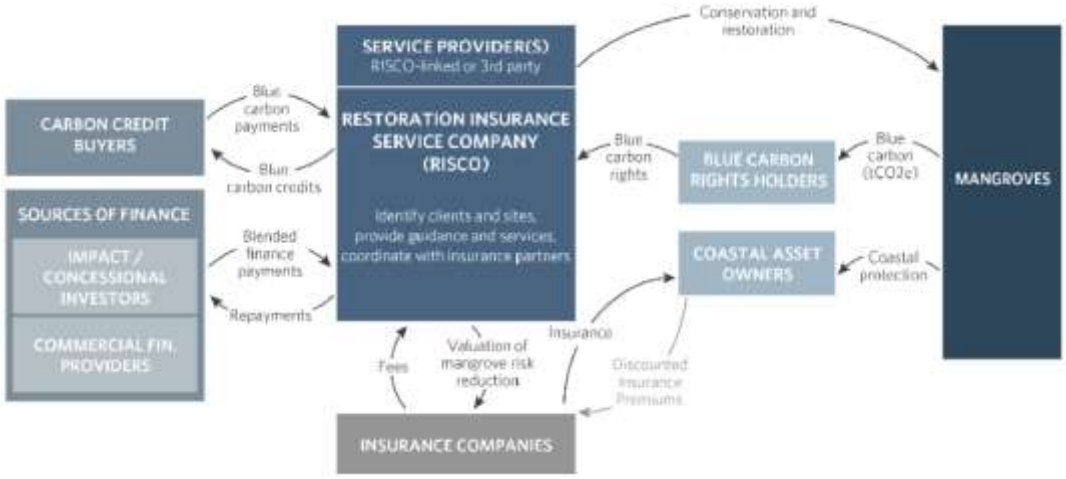

Figure 11: RISCO Project Structure

Source: CPI, 2022

Implementation Updates

RISCO will be put into action in three stages: Pre-Pilot, Pilot Implementation, and Replication. Each was modelled to establish its overall viability and finance requirements. A grant worth roughly $1.21 million will be used to fund Phase 1. RISCO will then be able to negotiate contracts with insurance companies, conduct additional scoping and analysis, secure the necessary partnerships (such as those with insurance companies, risk modelling experts or companies, and other local partners), and create a project design document for the creation of blue carbon credits. The expected cost of the Phase 2 project is $5.69 million, of which $2.35 million will go into restoration efforts and $3.34 million will go toward operational expenses (OPEX), which include ongoing conservation costs, over a ten-year period.

Figure 12: RISCO, Implementation Pathway

Lessons Learnt

The instrument is under pre-pilot phase now, but this can also be an effective source of building resilience in the coastal cities across LMIC countries where significant private investment is at risk. This can be an effective instrument financed through the private sector addressing the challenge of resilience and transition to net zero at the same time. Acceptance by the insurance industry and local insurance coverage, policy support and right pricing of blue carbon would be a key challenge which can be foreseen from the instrument. The result of the ongoing pilot would be a key to understanding the operational challenges for the instrument and scalability potential.

RECOMMENDED INNOVATIVE FINANCING SOLUTIONS FOR DEVELOPMENT OF NATURE BASED INFRASTRUCTURE TO ENHANCE DISASTER AND CLIMATE RESILENCE

Nature Based Solution (NBS) use a set of structural and non-structural interventions that protect, manage, restore, or create natural or nature- based features. Alongside other benefits, NBS can reduce the impact of natural hazards in cities, such as flooding, erosion, landslides, drought, and extreme heat (World Bank, 2019[20]). They can also complement grey infrastructure such as storm drains, embankments, and retaining walls. NBS can be a cost-effective solution for building resilience to extreme climate events if planned holistically for example an estimate drawn by an engineering firm CH2M outlines that conserving mangroves and coral reefs can be 50x more cost effective than building a sea wall (a grey infrastructure solution) for coastal protection[21]. At the same time NBS align to the global ambition towards net zero as most of the solutions are proven to enhance carbon sequestration.

As outlined in the section 1 of the position paper LMIC countries require unprecedented amounts of investments in building resilient infrastructure, retrofitting existing infrastructure and coastal protection. NBS can be a cost-effective solution for these countries towards building resilience towards multiple climate and human induced disaster such as cyclones, inland flooding among others. This section of the position paper would discuss potential solution packages and funding structures for enhancing resilience of LMIC countries through Nature Based Solution discussing a case on inland flooding.

Nature Based Solution for Inland Flooding

The impact of climate change and global warming are now very much visible, the rising temperatures have led to events of absolutely no rain for long periods of time and then a sudden event of excessive rainfall creating extreme weather events, particularly floods that have taken a toll on human livelihood. This has further resulted in huge losses of income, private properties, and public infrastructure assets. Conventional infrastructure systems are in many instances no longer able to cope with the new patterns of changing climate and are often permanently damaged or temporarily out of order because of unexpected events. The current approach that emphasises 'grey infrastructure' has significant limitations, high costs and provides limited co-benefits when compared with nature-based alternatives such as Nature-Based Infrastructure (NBI). India, a low- and middle-income country has experienced multiple episodes of inland urban flooding resulting in huge human and economic losses. According to a United Nations report, India's average annual economic losses due to disasters are estimated at US$9.8 billion of which over US$7 billion can be attributed to floods. While grey infrastructure in most cases exacerbates flooding and is costly to update to handle increased water flow, nature-based solutions can help mitigate flooding from overflowing rivers and storm drainage systems in cost-effective ways. But nature-based solutions are required to be adopted holistically, piecemeal adoption of such solutions would often not result in the desired result. These solutions can be used for improving resilience of new as well as retrofitting existing infrastructure. The nature and use of NBS solution would be dependent on the type of the city- coastal, delta, river, mountain-combination of different solutions can work based on the needs of the city the table below provides an overview of NBS solutions which can be used to build resilience of a city against inland flooding:

Table below identifies the potential NBS solutions for inland flooding and potential funding models.

Table 3: NBS Catalogue, Urban Flooding

#	Name and description of solution	Actors Responsible	Potential funding/ implementation model
1	Green Roofs – Roofs covered in plants to make a living landscape can collect 40 to 80 percent of precipitation which falls on the roof and release it slowly to reduce flooding.	Building owners (private and public)	The building byelaws can be changed to make it mandatory for provision of green roofs in new developments. Funding: Private sector (By real estate developers and included in building costs)

[20] https://documents1.worldbank.org/curated/en/253401551126252092/pdf/Booklet.pdf

[21] https://dev.jacobs.com/newsroom/news/demonstrating-value-natural-and-nature-based-defenses-5-steps-assessing-coastal

#	Name and description of solution	Actors Responsible	Potential funding/ implementation model
			For brownfield real estate developments, a separate provision needs to be inserted by the local authority and timeframe be included for implementation. Funding: Mix of government and private sector funding (depending upon the propensity to pay of the residents)
2	Rain Gardens: Gardens planted in shallow basins in yards and along streets or sidewalks to absorb street, sidewalk, and rooftop runoff. They are typically 30 percent more absorbent than a traditional lawn.	City/local administration Building Management	To be funded by resources mobilised by administration- private sector may provide grant support or take ownership of few trees
3	**Bioswales** – Long, deep channels of plants and grasses along roads and parking lots that absorb runoff and release water slowly. Can be developed in place of grey storm water drains	City/ local administration	To be funded by resources mobilised by administration
4	**Urban Tree Canopies** – The intentional planting of trees throughout cities. Trees collect raindrops before they hit the ground, giving rain more time to evaporate instead of turning to runoff. Deciduous trees can collect up to 700 gallons/year and evergreens up to 4,000 gallons/year.	City/ local administration	To be funded by resources mobilised by administration- private sector may provide grant support or take ownership of few trees
5	**Permeable Pavements** – Pavements made of materials such as porous concrete that allow water to filter through and into the soil instead of turning into runoff. They can be up to 50 percent less expensive to install than traditional pavement and are generally cheaper to maintain.	City/local Administration Private building owners	Public infrastructure to be funded or local administration.
6	**Urban Forests:** Urban forests are parcels of land developed within the city into dense forest or conservation of existing dense forest in city limits. They act as a great resource to retain stormwater. They protect rivers by intercepting rainfall, increasing infiltration, and reducing flooding along with other eco system benefits.	City/ local administration	To be funded by resources mobilised by administration- private sector may provide grant support or take ownership of few trees

#	Name and description of solution	Actors Responsible	Potential funding/ implementation model
6	**Protecting and/or restoring wetlands and marshes** – They can help absorb precipitation and reduce runoff. One acre of wetlands can store and filter up to 330,000 gallons of water.	City Administration Coastal protection authority	Financing through grants and carbon funds may be explored
7	**Protecting and/or restoring riparian buffers** – Vegetated or forested buffers along rivers or streams reduce the amount of water entering waterways. Natural systems can absorb up to 90 percent of the precipitation they receive.	City Administration Coastal protection authority	Grants as well as schemes to generate urban livelihood
8	**River and Stream Renaturation -** Stream restoration or river restoration, also termed river renaturation, improves a river's environmental health for biodiversity, recreation, flood management, and/or landscape development.	City Administration Coastal Protection Authority (if existent)	Several organisations may provide financing for river renaturation. Renaturation projects are frequently funded by a combination of donations from local, national, and international public sector organisations, the corporate sector, and civil society actors, reflecting the possibility that benefits may accrue to numerous stakeholders.
9	**Urban Farming-** Urban farming is food production in cities or other densely inhabited places. It's about urban and peri-urban agriculture. It promotes food availability for needy people by encouraging gardens on underused land**.**	Households, city administration	Urban farming as an activity can be encouraged through incentives and providing seeds and organic compost for free.
10	**Bioretention areas-** Bioretention areas are shallow landscaped depressions that rely on engineered soils, improved vegetation, and filtration to prevent downstream runoff. They manage and treat rainwater runoff.	City/ local administration/local community	Grants as well as schemes to generate urban livelihood
11	**Natural and Constructed Wetlands**- A natural wetland is an area that is permanently or intermittently wet, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions, whereas a constructed wetland is an organic wastewater treatment system that resembles and improves the effectiveness of the processes that help to purify water that occur naturally.	City Administration Coastal Protection Authority	Financing through grants and carbon funds may be explored

#	Name and description of solution	Actors Responsible	Potential funding/ implementation model
12	**Mangrove Forests-** Mangroves are good at capturing and storing carbon. Mangroves live in carbon-rich mud, which they add to by trapping material and holding it in place.	City/ regional administration, Disaster Management Agency	To be funded by resources mobilised by administration- private sector may provide grant support or take ownership of few trees- carbon funds can be explored
13	**Salt Marshes-** Salt marshes lessen the severity of approaching waves, and grazing herbivores prevent erosion by boosting soil-binding vegetation.	City/ local administration	Financing through grants and carbon funds may be explored
14	**River Flood Plain-** Floodplains delay runoff and store flood water, reducing flood risk. They give economic, social, and environmental benefits that local land-use decisions often overlooked. Floodplains includes wetlands and other natural zones that affect local environment.	City Administration Coastal Protection Authority	Grants as well as schemes to generate urban livelihood
15	**Sandy Shores-** They serve as a natural coastal defence, offer fresh water, and support fisheries and recreation.	City Administration Coastal Protection Authority	To be funded by resources mobilised by administration

Source: South Pole Analysis, adapted from WB booklet on Urban NBS, 2022

Implementation of Nature Based Solution as a solution to Urban Flooding in Bangalore, India (Conceptual)	
Country/ Geographic Region	Bangalore Karnataka, India
Type of Project	Nature Based Solution
Type of Hazards mitigated/Focus	Flooding
Type of Financing	Innovative structure recommended
Type of Governance	Public Utility
Main Actors	**Bruhat Bengaluru Mahanagara Palike** National Disaster Management Authority Central Ground Water Board Private sector companies Insurance, reinsurance companies

Bangalore lies at 12.591/4 north latitude and 77.571/4 east longitude, equidistant from the east and west coasts of the South Indian peninsula. It is 920 metres above mean sea level. The last ten years have averaged 880 mm of rain and 60 rainy days. Recently, Bangalore came at halt for the third time in last 5 years due to heavy rainfall in August i.e., 370mm only few mm less than the all-time high of 387mm in August 1998. The flood resulted in huge economic and livelihood losses a one-day economic loss was anticipated ~26.5 mil USD[22] not considering loss to infrastructure and public costs. Bangalore has seen a massive increase in population and urbanisation in last 2 decades, while the increase in precipitation is an underlying cause of the flood but the massive urbanisation has led to aggravation of losses due to unplanned structural development resulting in substantially altered drainage characteristics of natural catchments by increasing the volume and rate of surface runoff, poorly managed and inadequate drainage system, poor solid waste management system often resulting in blocking storm drains among others. The figure 11 shows that from 1973 to 2017, the city's green cover decreased alarmingly. 78.65% of the city is built-up, 6.45% is vegetation, 1.033% is water, etc. Urbanization caused a dramatic drop in the groundwater table, causing urban flooding. Since 2000, high-density urban growth and the loss of wetlands and forests have caused recurrent flooding in Bangalore. This is coupled with narrowing and concretizing storm water drains, lack of drainage maintenance with changes in enhanced run-offs, encroachment and filling in the floodplain on the waterways, obstruction by sewer pipes, manholes, and relevant structures, deposits of building materials and solid wastes, and flow restrictions from under capacity road crossings (bridge and culverts). Due to lack of planning and enforcement, illegal development has restricted streams and filled floodplains.

[22] https://www.thehindu.com/data/data-deluge-in-bengaluru-flood-woes-are-a-recent-phenomenon-in-karnataka/article65919247.ece

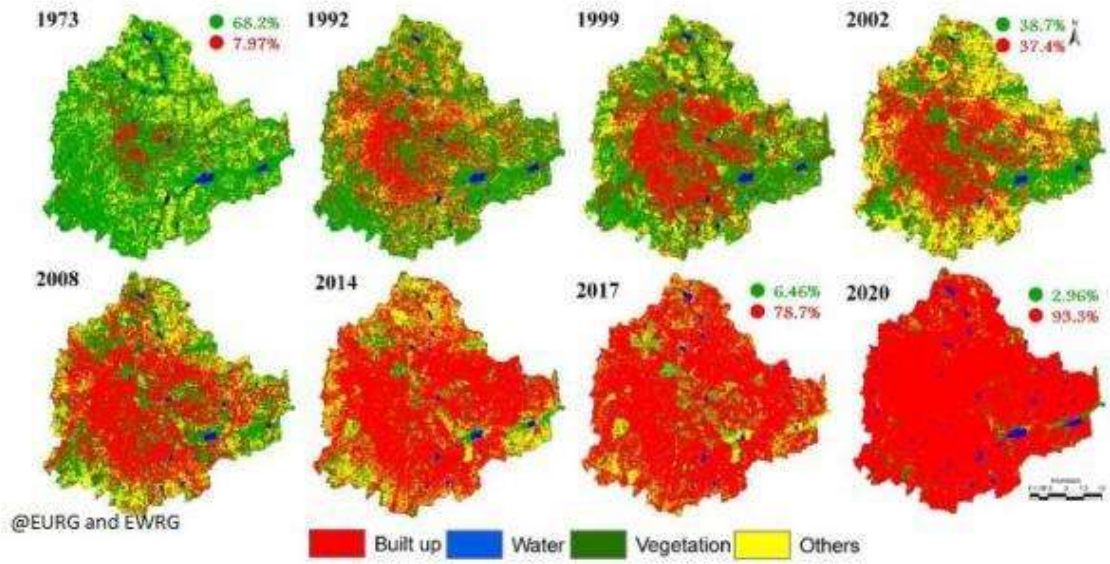

Figure 13: Land use dynamics of Bengaluru, WRI, 2022

Nature-based Solutions (NBS) that strategically conserve or restore nature to support conventionally built infrastructure systems (also referred to as grey infrastructure) can reduce disaster risk and produce more resilient and lower-cost services in developing countries. In the disaster risk management (DRM) and water security sectors, NBS can be applied as green infrastructure strategies that work in harmony with grey infrastructure systems. NBS can also support community well-being, generate benefits for the environment, and make progress on the Sustainable Development Goals (SDGs) in ways that grey infrastructure systems alone cannot.

Implementation of Nature-Based Solution for Re-naturalisation of Bangalore

Nature-based solutions (NBS) that focuses on conserving or restoring nature blended with grey infrastructure can be a potential low-cost solution that can reduce the disaster risk of urban flooding. NBS are holistic green infra strategies that work in harmony with grey infrastructure and can have significant eco-system benefits supporting community well-being and helping meet SDGs. A holistic NBS solution for urban flooding in case of Bangalore could include:

- Building solutions: green roofs, open green spaces as part of building compound, urban farming, roof farming
- Large scale NBS: urban forests, lake and stream denaturalisation, open green spaces, green corridors, bio retention areas, natural and constructed inland wetlands among others

Financing NBS

- **Changing the flow of public finance to enable Nature-Based Infrastructure implementation:** As a result of flooding, the local and state Government are paying recurrent damage costs and compensation annually due to the impact of flooding on lives, properties, infrastructure, and the economy. These outlays constitute, in many instances, a significant percentage of the state and city l budget. If NBS could deliver flooding protection, a fraction of these annual costs usually spent as compensation damages, could be used as the revenue source to fund the NBS assets and maintain them over time. A portion of public finance expenditure can be used to upfront finance NBS at the same time enhance natural capital and biodiversity.
- **An Innovative Financing Model for Nature Based-Solution:** *The core concept of the financing model is based on the use of avoided damage costs to finance the implementation of NBS delivering flood risk reduction services that are insured.* The example of latest floods in Bangalore in terms of business continuity losses ~ USD 26.5 mil for one day were claimed in addition significant amount of private home and car insurance was claimed coupled with huge public sector expenditure in form of compensation and rehabilitation, which could be significantly avoided by deployment of holistic NBS. Under these circumstances, a proportion of the avoided annual damage costs could be disbursed from the private sector companies, re-insurance companies and public sector to an "NBS facility: which manages design construct and maintain NBS in a holistic manner that reduces flood risk. The next section of the paper provides a conceptual structure of such a financing mechanism.

Conceptual financing and funding model for NBS

As shown in the table a city/ region based on the requirements can incorporate a package of above activities to enhance resilience to the inland flooding. Impact of the above activities can be modelled into the flood risk assessment of the city. To mobilise financing for funding these activities a city may design the comprehensive project as flood resilience improvement projects with benefits to all communities clearly identified and quantified in the form of ecosystem services. A city may use the following conceptual level financing model tailored to its requirements for financing such infrastructure:

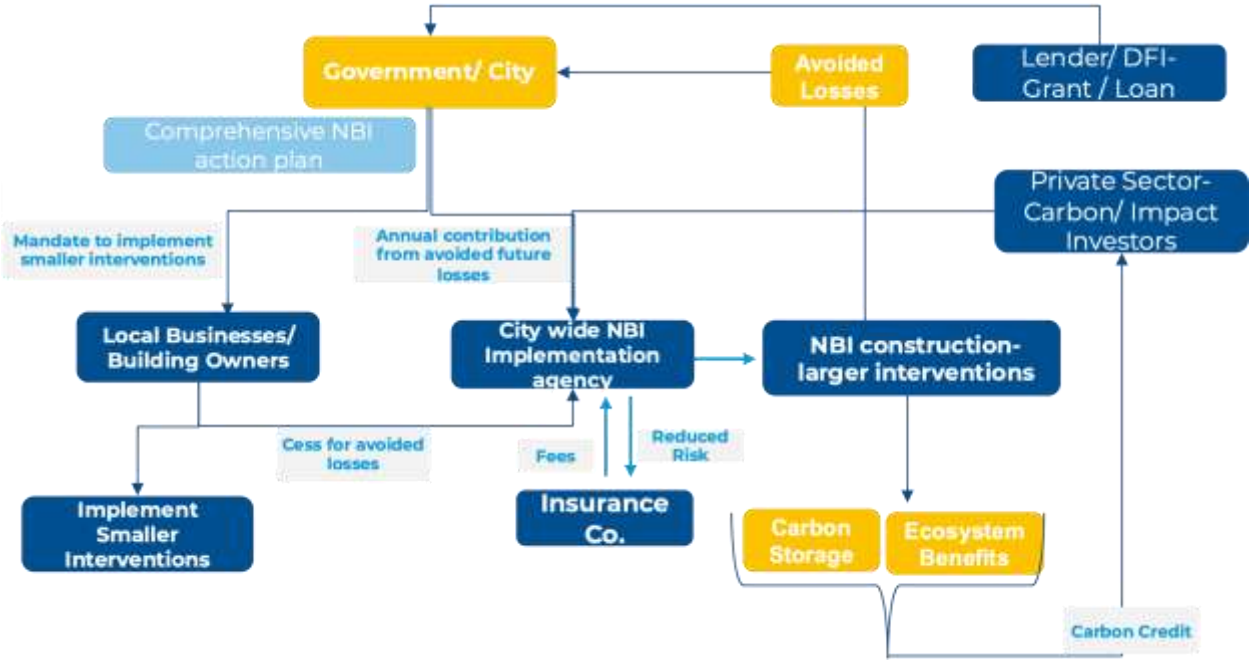

Figure 14: Thematic Structure on proposed innovative financing mechanism ; *Source: South Pole Recommendation, 2022*

Under the above conceptual financing model, the financing for NBI construction to improve inland flooding resilience can be funded by the following beneficiaries against the impact of the implementation of the NBI.

Implementation

1. **City Administration:** City Government makes a comprehensive plan for NBI development as part of making its infrastructure more resilient. The implementation of NBI would result in significant reduction in cost for the city/ government incurred in responding to the physical and social infrastructure losses which happen during such an event. The reduction of the future cost or a part of resources that the city allocates to disaster responsiveness can be used for funding the facility.
2. **Implementation:** For the smaller interventions which can be integrated with building bye laws city administration mandates private sector/ businesses to undertake them at their own cost. For the larger intervention city administration provides annual grant to NBI implementation agency.

Funding

1. **Lenders/ Development Finance Institutions/ Grant providers:** The funding for resilience activities can also be mobilised in form of concessional loans and grants provided by multilateral development banks and funds. To access the funding the project/facility should be developed to meet the minimum requirements. Additionally, in cases of loans from DFIs, approvals from upper tier governments may be required.
2. **Local Businesses- Cess on property tax:** Part of avoided losses is monetised to pay for NBI infrastructure (A city appoints third party to compute losses to city business on account of natural calamities like flooding, cyclones etc, predevelopment of NBI. Post implementation of NBI, the third-party company computes the losses to city on account of natural calamities and compares pre and post NBI losses. If post NBI losses are reduced substantially a NBI infrastructure cess is integrated with property tax and levied on local business post a certain turnover criterion.

3. **Private Sector:** in the form of international corporations looking for high quality carbon credits to achieve their climate ambition and local businesses could also be important sources to mobilise finance for the facility. The funding may be provided upfront by the private sector against future supply of carbon credits and impacts from the projects. The local businesses would be amongst the direct beneficiaries of such intervention and thus may pay an additional cess which can be used for servicing the funding raised for the facility.
4. **Insurance companies:** Development of NBI would significantly result in lowering the risk for insurance companies, the facility would share the risk assessment with and without NBI which can be incorporated in their natural catastrophe and flood risk models against fixed fees.

Governance, policy, and institutional prerequisites

The following governance, policy and institutional framework would be a prerequisite towards implementation of NBI inland flood management facility.

1. **Local building bye laws incorporating the solution:** As outlined in the table above some of the solutions for managing urban flooding must be directly integrated into building bye laws, the city/local administration based on the flood risk assessment should incorporate these solutions in the building bye laws, this would ensure these solutions are implemented and financed.
2. **Capacity building of public officials to assess inland flood risk and develop comprehensive nature-based flood management plan and capture financial losses:** Implementation of an integrated flood management solution would require city to enhance capacity of its city officials on flood risk modelling, economic losses quantification, mapping and engaging with risk owners, knowledge of NBI solution and ability to develop NBI based flood management action plan.
3. **Regulatory framework for payment of ecosystem services:** A framework for payment to be collected from local businesses in form of cess against the benefits in terms of avoiding losses and ecosystem benefits of NBI would be required to ensure not only efficient development but also operational and maintenance of NBI infrastructure.
4. **Recognised methodology to quantify ecosystem services in carbon credits:** Given the limited size of NBS in urban context the carbon sequestration in terms of volume would be mostly limited. But a NBI solution does have wider ecosystem benefits in form of asset protection, land value enhancement, community and social livelihood development, air quality improvement, cooling surface temperature among others. A methodology capturing and quantifying the other benefits over, and above carbon benefits should be developed, so that premium value can be claimed for such credits.