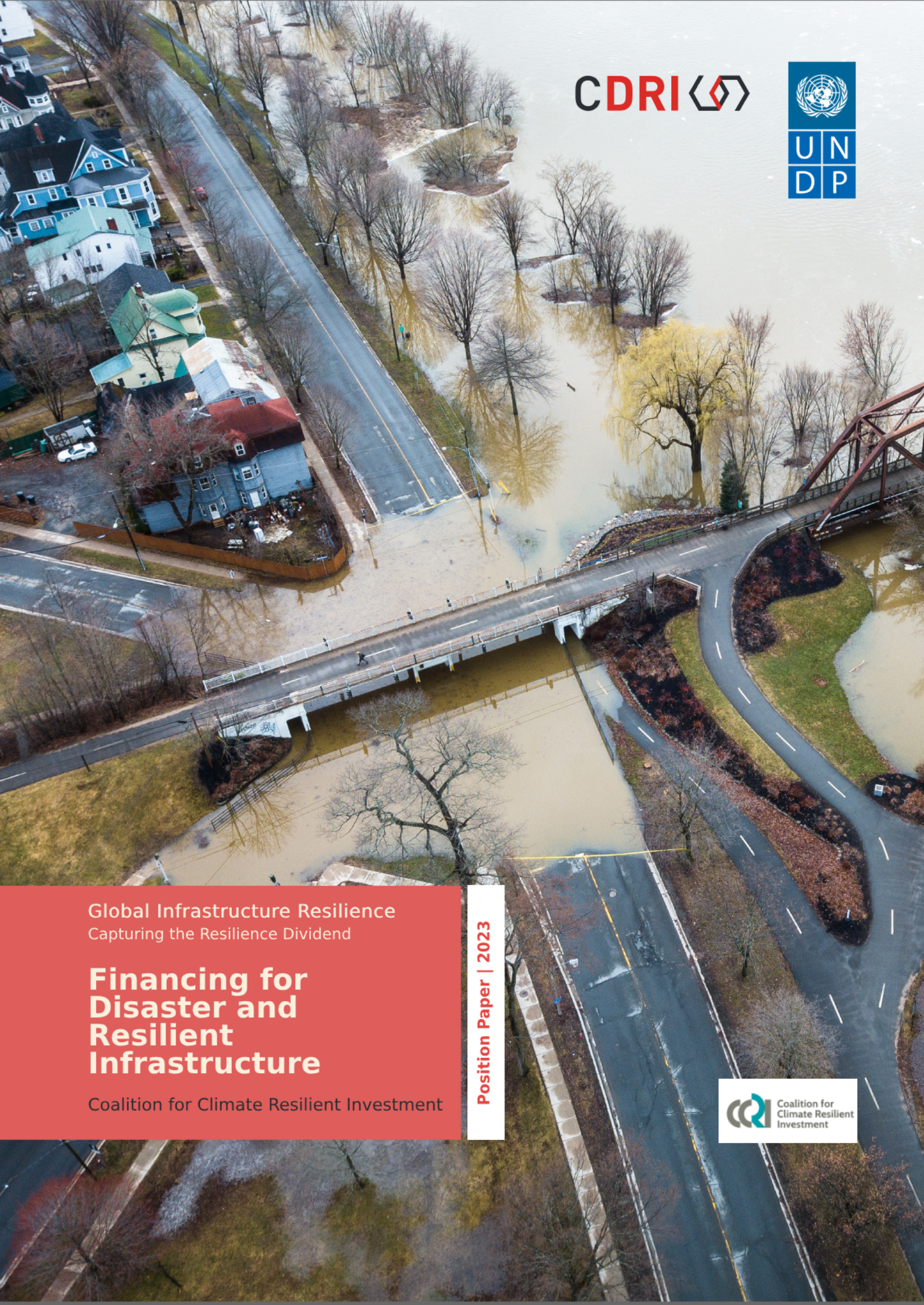


Global Infrastructure Resilience

Capturing the Resilience Dividend

Financing for Disaster and Resilient Infrastructure

Coalition for Climate Resilient Investment

Position Paper | 2023

Chapter 4: Financing for Disaster and Climate-Resilient Infrastructure

Introduction

Resilient infrastructure currently faces two concatenated global challenges. First, many high-income countries, particularly those that industrialised in the 19th and early-to-mid 20th century, need to replace large quantities of obsolete infrastructure assets that have outlived their design life, while strengthening resilience to new and existing hazards. Second, social, and economic development in many LMICs is constrained by a large infrastructure deficit, aggravated by weak infrastructure governance and growing contingent liabilities due to disaster risk. At the same time, international agreement on the need to reduce emissions and mitigate climate change is mandating a rapid transition from carbon-locked-in infrastructure to low, zero or negative emission infrastructure in both high-income countries, as well as in LMIC (Seto et al., 2016).

High-income countries have large capacities for public investment and remain attractive markets for private capital. However, the bulk of new infrastructure investment over the next 30 years is expected to take place in LMICs. Whether or not these new infrastructure assets are resilient to disaster and climate risk and contribute to reduced systemic risk, will largely determine the future of infrastructure risk. Whether that future is characterised by increasing contingent liability or by resilience or sustainability will be influenced by policy and planning decisions taken now and in the coming years (Indian Institute of Human Settlements, 2022).

Mobilising the volume of finance required for resilient infrastructure in LMIC is the key challenge. In many LMIC, weak infrastructure governance contributes to a low rate of return on investment, project delays, complex approval mechanisms, and political uncertainty, all of which discourage private investment. This is further exacerbated by the inability of domestic financial markets to channel capital towards investing in resilience. How to mobilise finance for a new "resilient infrastructure asset class", therefore, becomes all the more imperative (Indian Institute of Human Settlements, 2022).

At present, most infrastructure investment in LMIC is public investment, often with the participation of multilateral development banks (MDBs). However, given the magnitude of the infrastructure deficit, drastically increased private investment is essential. The case for infrastructure resilience, however, is still not firmly embedded in either public or private investment. In the public sector, investing in resilience is constrained by the political, governance and other challenges outlined in Chapter 3.

At present, private investors are also not convinced of the relevance or commercial benefits of investing in resilience. As highlighted in the previous chapter on NbSI, traditional cost-benefit analysis does little to build a strong business case for resilience because it doesn't capture the wider environmental, societal, or economic co-benefits.

It is critical, therefore, to identify mechanisms that can provide greater incentives for both public and private investment in strengthening resilience, reconfiguring infrastructure development in a way that begins to close the existing infrastructure deficit, reduces systemic risk over time and strengthens resilience to ongoing hazard shocks.

4.1: Setting the scene: Identifying the LMIC infrastructure resilience funding gap

The LMIC infrastructure resilience funding gap can be defined as the sum of the investment needed to strengthen the resilience of existing infrastructure and the capital required to build future resilient infrastructure. The funding requirements should be compared to existing and projected finance, including private capital, flowing into new infrastructure development, maintenance and resilience. This will highlight a different order of magnitude between the two and suggest that resilience cannot be achieved through existing finance mechanisms alone.

4.1.1: Determining the infrastructure resilience funding gap

The infrastructure resilience funding gap can be derived from various studies that quantified investment requirements to 2030 to achieve the SDGs and the objectives of the Paris Agreement on climate. These studies show a current annual shortfall of USD 2.5 to 3 trillion (Organisation for Economic Co-operation and Development. et al., 2018).

Many of the assumptions that underpinned such estimates need to be reappraised as countries begin to realign their economies and infrastructure investment towards net-zero emissions. While investments in climate mitigation reduce systemic risk, they also increase the overall funding requirements of LMICs for infrastructure assets. A recent assessment undertaken by McKinsey Sustainability division highlights that capital spending in physical assets, energy and land use amounting to USD 275 trillion or USD 9.2 trillion per year are required globally between 2021 and 2050 to achieve net zero (Krishnan et al., 2022) - equivalent to approximately USD 2 trillion more per annum than previously considered . THIS DOES NOT ADD UP. ALSO LETS MOVE THE MCKINSEY FIGURE FROM CH.1 TO HERE.

LMICs, particularly those with lower GDP per capita and higher dependency on fossil fuel resources, require more investments relative to GDP for supporting the transition to net-zero and at the same time are more vulnerable towards negative consequences of the transition, such as stranded assets and employment shocks. It is estimated that LMICs will have to spend approximately 30% of the global investment in physical assets and land use towards achieving net zero, amounting to USD 85 trillion cumulatively or USD 2.76 trillion annually between 2021 and 2050 (South Pole Carbon, 2022a).

Current investment levels for most LMIC are of at least an order of magnitude lower. Furthermore, much current investment is dedicated to the repair and rehabilitation of existing damaged infrastructure rather than new infrastructure and does not necessarily consider features that strengthen resilience (International Coalition for Sustainable Infrastructure (ICSI), 2022).

Investing in resilient infrastructure may provide economic benefits that far outweigh costs. According to some estimates, resilience measures for infrastructure projects produce an average of $4 in benefits for every $1 dollar spent (Hallegatte et al., 2019). However, such assumptions are questionable given that resilience is a relative rather than absolute variable. As a result, the costs and benefits can vary enormously, project by project, for different levels of resilience (see figure X). Investing in very high levels of resilience may not be economically viable, in some cases, which means that a certain level of risk must be retained. However, it can be assumed that for many projects the benefits considerably outweigh the costs, even when the calculation of benefits is limited to avoided loss and damage.

If is assumed that investing in resilience increases project costs by 3%, (approximately 0.1% of GDP for most LMICs) (International Coalition for Sustainable Infrastructure (ICSI), 2022) the LMIC infrastructure investment required to achieve net-zero by 2050 would increase to USD 2.84 trillion per annum[1].

The estimated USD106 trillion of untapped private institutional capital worldwide would be more than sufficient to close that gap. However, only 1.6 percent is currently invested in infrastructure (The World Bank, 2015), mainly in high-income countries and in renewables. How to reorient available capital to those geographies with the greatest need in resilient infrastructure, therefore, is the crux of the financing challenge.

4.1.2: Climate finance as a substitute?

Existing public and private investment is clearly insufficient to fill the big financing gap for resilient infrastructure. Climate finance is seen as an additional source, but as of today public adaptation finance, including through MDBs, reached just USD 15.1 bn in 2019, clearly nowhere near the requirements suggested by most global estimates (South Pole Carbon, 2022a; United Nations Environment Programme, 2022).

As discussed in Chapter 1, the challenge of strengthening resilience is different to that of adapting to climate change. A large part of the risk is associated with high-severity, long-return period events such as major earthquakes and tsunamis. At the same time, most of the risk is already built into existing infrastructure systems and would need to be priced into insurance or underwritten by existing development funds. Meanwhile, however, climate adaptation finance is one of the few new sources of funding that countries can access to strengthen resilience.

MDBs are the most important public sources of money for adaptation finance for LMICs and targeted a total of USD 14.9 bn mostly in the form of loan instruments– with South Asian and Sub Sahara African countries accounting for 50% of committed funds (African Development Bank (AfDB) et al., 2021). MDBs expect to increase this funding to USD 18 billion and assist in the mobilisation of additional private sector financing. Private sector climate finance has been relatively stable at an annual average of USD 14.4 billion until 2021, but it is important to note that most of it was for emissions reductions projects and only 10% of this has been targeted at adaptation (South Pole Carbon, 2022b).

Dedicated multilateral funds such as the Green Climate Fund (GCF) have also emerged as a key source of adaptation finance to LMIC countries. GCF has made overall commitments of USD 11.3 billion since its inception in 2010, with USD 8.8 billion currently under implementation allocated equally between mitigation and adaptation. Unlike MDBs, which still operate mostly through (concessional) loans, these funds mostly provide adaptation financing in the form of grants.

LMIC's domestic budgets are also, in principle, an important source of adaptation and resilience finance. In countries such as India, South Africa and China, domestic budget allocations to adaptation far exceed international climate finance. There is a growing recognition and acceptance that domestic budgeting should account for revenues and expenditure that enhance resilience to climate and disaster related risks. Taking on this responsibility is in line with article 2.1(c) of the Paris

[1] Another assessment by the IMF estimates that 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 in resilient infrastructure and ecosystems, the majority of which targeted towards coastal protection.

Agreement, which states that all countries need to make their finance flows consistent with low-carbon and climate-resilient development pathways.

Considering that only a portion of adaptation finance goes into retrofitting infrastructure, however, and that, while mitigation finance reduces long-term systemic risk, it does not directly support infrastructure resilience, climate finance, alone, is clearly not a viable route to achieve infrastructure resilience. A new approach to mobilizing capital is required, combining public sector support to monetise the resilience benefits in infrastructure systems and to de-risk investments with private sources of capital aggregated to fund pipelines of infrastructure projects. Resilience finance, in other words, should be seen as a new area of financing, complementary to and supplemented by but different from climate finance.

4.2: Challenges to mobilising finance for resilient infrastructure

The ability of LMICs to mobilise capital for resilient infrastructure is highly dependent on their capacity to develop and implement projects and on their overall quality of infrastructure governance (South Pole Carbon, 2022b). Challenges and barriers, summarised in Table X below include misperceptions of the costs and benefits of investing in resilience, governance issues and limited institutional capacities, and the limited buoyancy of public domestic capital markets.

Key Challenges	**Detailed Barriers**
Unquantified risk and misperception of investment in climate resilience	
Perception of 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, investment in resilience is often conceived as more expensive.
Externalities - the broader resilience dividends	Typical cost-benefit analysis underestimates the broader benefits of resilience, making such investments appear unattractive. Cost-benefit analysis may focus only on avoided physical asset damages, not on other benefits.
Information asymmetries	There is no effective or common way to measure resilience or its wide-reaching benefits. Infrastructure owners rarely share information on risk 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 clearly defined 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 adequate measures, which may be lacking in many LMICs, particularly at the local level. Many countries do not have a resilience policy framework for infrastructure.
Maintenance	To be sustainable, resilience requires ongoing maintenance, which can further misalign the incentives to invest.
Institutional capacity to develop “fundable” resilience proposals	LMICs often lack institutional capacity to develop such “*bankable*” proposals that clearly quantify the risks and the broader benefits of investing in resilience.

Public finance and capacity to innovate	
Limited public capital	Most of the LMICs have limited public capital to be invested, striking a balance between social and economic development requirements, climate mitigation ambitions as well as building resilience. Often due to limited upfront capital "additional" resilience financing is not available.
Public investment planning	Most LMICs lack capacities for risk estimation to inform public investment planning and evaluation, and don't have methodologies to incorporate resilience in public investment planning.
Credit rating of public agencies and vibrancy of local capital market	Low credit rating of public agencies, coupled with a limited revenue base which can be escrowed to mobilise financing from upfront investments, limits access to local and international debt capital markets. Additionally, in most LMICs, the local debt capital market is at the inception phase of development. LMIC financial markets often lack depth, access, efficiency, and stability[2] limiting the possibility to use capital markets (Beck et al., 2009)to access financing for resilient infrastructure (Donaubauer et al., 1929).
Knowledge and flexibility to access funding from innovative tools	Most LMICs 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.
High cost of capital	The current macroeconomic context of high inflation, increasing interest rates and supply chain constraints that exacerbate the difference between the costs of project capital in all countries, irrespective of income groups.

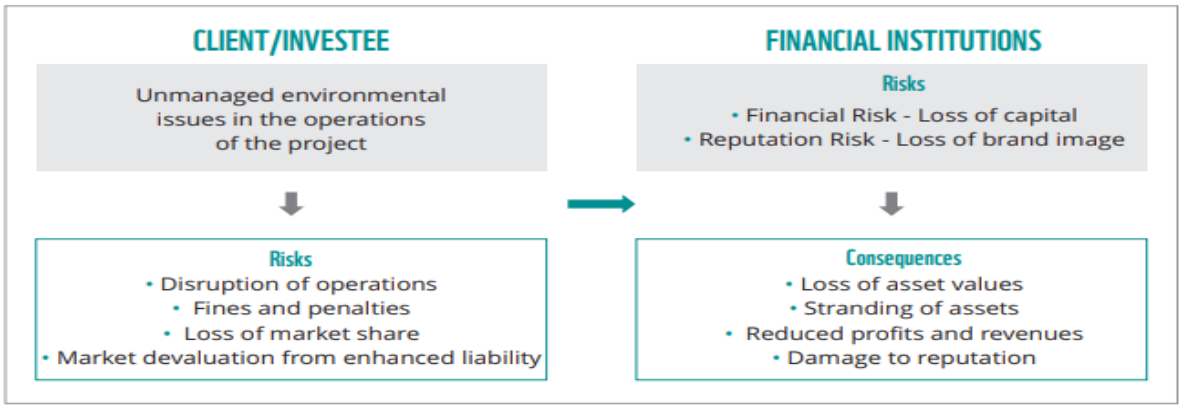
Some of these challenges and barriers are particularly critical to the mobilisation of resilience finance.

4.2.1: Unquantified climate risks and inadequate ESG metrics make it difficult to embed resilience in infrastructure systems

Private capital investment in infrastructure currently focuses on narrow risk assessment that do not sufficiently include sustainability related risks (Jain, 2014). In order for investors to fully understand their portfolio risks and shift investments towards more resilient infrastructure, more rigorous quantitative risk metrics need to be included in financial models and asset balance sheets (see Figure x).(WWF India, 2022)

Figure . How environmental risks translate to financial risks

[2] Market depth reflects the sufficient size of the financial institutions and financial markets. Market access represents the degree to which economic agents can use financial services. Market efficiency reflects the ability of financial institutions to successfully intermediate and facilitate financial resources and transactions. Market stability represents the low volatility and institutional fragility of the market.



The risks associated with investments in infrastructure assets are associated with hazard events that impact the asset and with systemic risks, which the asset itself may generate. See for e.g. the case of Delhi Metro in Jain (2014) where the infrastructure asset itself was designed for earthquake risk, but the development this investment has promoted around it has increased overall systemic risk. The impacts of the latter may vary from local impacts on the surrounding environment and communities to global impacts, for example, through carbon emissions. Both kinds of risk impact an asset's financial performance via feedback loops, referred to as the 'double materiality', emphasising the need for a comprehensive approach to risk management by financial institutions.(WWF India, 2022)

Unfortunately, in most LMICs, robust, comparable, and credible disaster and climate risk metrics are not available in a form that can be used to establish financial risks for projects. The absence of these metrics, coupled with the escalating effects of climate change, means that the potential gains and co-benefits of building resilience into infrastructure projects cannot be properly quantified. This remains a key hurdle in attracting financing as it adds additional uncertainty to projects and implies hidden contingent liabilities for potential investors.

As such, planners and financiers are not well equipped to understand the disaster and climate risk internalised in a project. In the case of infrastructure assets, it is also challenging to determine who bears the contingent liability. For example, if a major transportation hub is damaged by a flood, there is no playbook for distributing losses amongst the different stakeholders. Furthermore, in LMICs, most of these losses are currently uninsured or reinsured by the public sector. This translates into contracting processes, which tend to leave the burden of risk uptake entirely by the public/public sector (Jain, 2014). As such it is difficult to estimate fiscal liability for the state and liability for investors, operators, and users.

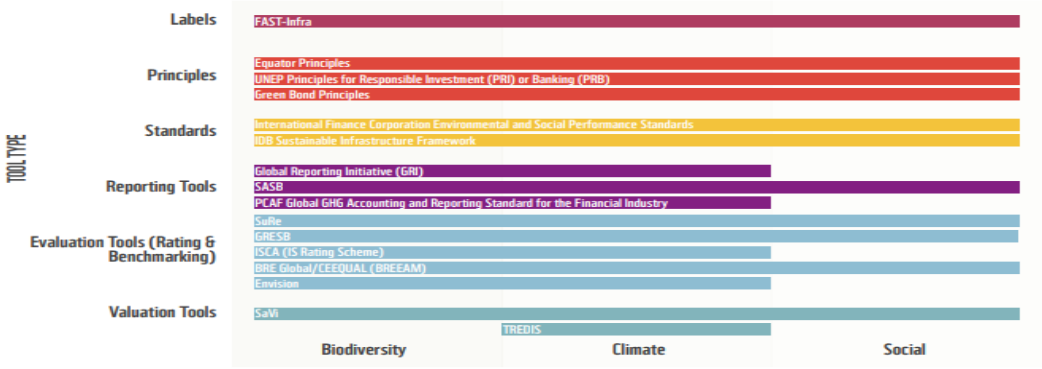
The availability of risk data is the single greatest test firms expect to face over the next five years in order to address climate risks (Willis Towers Watson, 2021). Fortunately, while access to risk data at the national and local level is often heavily constrained, due to institutional silos and national security issues, the growing availability of publicly accessible high-resolution global data, is enabling the development of new risk models that can go some way towards plugging the gap. These include the GIRI, presented in Chapter 2 and other new initiatives such as GRII[3].

Other tools and standards that can inform infrastructure investors are environmental, social and governance (ESG) performance indicators. Figure X provides an example of how to map the most

[3] A global coalition of ten organisations launched the Global Resilience Index Initiative (GRII) in November 2021 to assess resilience to climate risks. The initiative is expected to help countries focus on national adaptation investments. The OECD Centre on Green Finance and Investment (CGFI) stated that the initiative "will help global economic sectors understand, in concrete terms, the value of building climate resilience and the costs of doing nothing".

relevant ESG criteria for the selected asset, outlining which ESG criteria should be measured and reported, and quantifying and assigning monetary value to ESG metrics (WWF India, 2022).

Figure. Mapping exercise showing some of the principles, standards, frameworks, and tools most used by DFIs in the context of infrastructure investments (WWF 2021)



However, given the multitude of frameworks, principles, and standards that exist, no single, comprehensive set of criteria for ESG in infrastructure is universally recognized, meaning that current ESG frameworks are insufficient to assess infrastructure resilience. At the same time, it is unclear whether increasing investment flows into assets with positive ESG scores could have a real impact in scaling up finance for resilient infrastructure. In addition to the still-uncertain climate benefits of ESG investing, scores for companies in LMICs tend to be systematically lower than those in high-income countries. As a result, ESG-focused investment funds allocate only limited resources to projects in LMIC (Torsten Ehlers et al., 2022).

4.2.2: Risk financing mechanisms don't directly address infrastructure resilience

Financial risk metrics from probabilistic assessments are needed to price risks and underpin the proper functioning of insurance markets. With such metrics, risk transfer[4] can and should form part of a national or regional infrastructure resilience strategy. If a large number of uninsured infrastructure assets are damaged in a disaster, then governments without the necessary savings and reserves or without easy access to loans will have difficulties to cover the cost of rehabilitation and reconstruction. They may also face a fiscal shock, further reducing their capacity to recover and rebuild. In contrast, insurance payments can facilitate rapid recovery and reconstruction without the potential fiscal downsides.

Unfortunately, the roll out of disaster risk financing mechanisms remains incipient in many LMIC. Most public infrastructure is neither protected by asset insurance, nor by other instruments such as risk pools, reserve funds or insurance linked securities such as catastrophe bonds.[5] Existing regional sovereign catastrophe risk pools have required many years of sustained technical assistance from a partner organizations to facilitate the political and policy dialogue and coordination between participating governments (Miyamoto International, 2022). For example, the World Bank Group has assisted the development of the Caribbean Catastrophe Risk Insurance Facility (CCRIF), Pacific Catastrophe Risk Assessment Finance Initiative (PCRAFI) and Southeast Asia Disaster Risk Insurance Facility (SEADRIF), and the World Food Program has assisted African Risk Capacity (ARC).

[4] Risk transfer is defined as the formal or informal transfer of the financial consequences of specific risks from one party to another (a household, community, organization, or state authority), obtaining resources from a different party after a disaster happens in return for ongoing or compensation social or economic benefits given to that other party (source: Miyamoto International)

[5] A. Bazaz, IIHS, "Note on a Resilience Fund", CDRI contribution, 2022

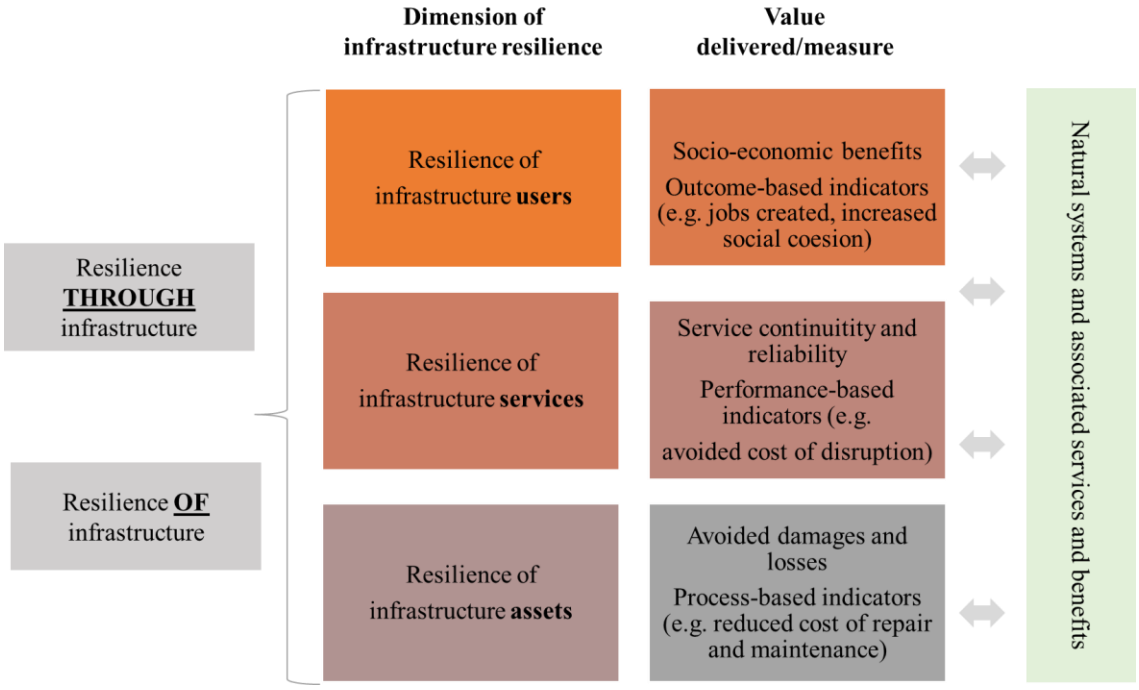
In particular, there is currently no evidence that insurance pricing is sensitive to improved resilience standards in infrastructure. In other words, countries and infrastructure developers that have made additional resilience investments are unlikely to see a corresponding reduction in their insurance premiums. As such the potential of risk financing to encourage investment in resilience is still not realised.

4.2.3: Investment in resilience seen as a cost

A major barrier is that investments in resilience are often considered by developers and providers of capital as incremental costs with no immediate benefits, sometimes imposed by regulators to meet safety standards. Project developers aren't necessarily incentivized to optimize life cycle costs, partly due to the time value of money and the way discount rates tend to skew asset valuations towards the short and medium terms, with little consideration for an asset's residual value.

There is a need, therefore, to demonstrate that investment in resilience can lead to value creation, through a combination of reduced future damages and economic losses, optimized life cycle costs and improved certainty of operating cashflows, and positive development outcomes in the form of increased well-being and economic growth. Discount rates could also be adjusted to reflect the lower risk profile of assets that benefit from incremental investments in resilience.

To make investment in disaster and climate resilient infrastructure more attractive, it is necessary to also factor in the social rate of return on investment, considering avoided loss and damage and wider social, economic, and environmental benefits.[6] Thus, recognising the difference between the resilience of infrastructure, i.e. asset resilience, and the resilience of services and systems is required to articulate the broader benefits delivered by the infrastructure.



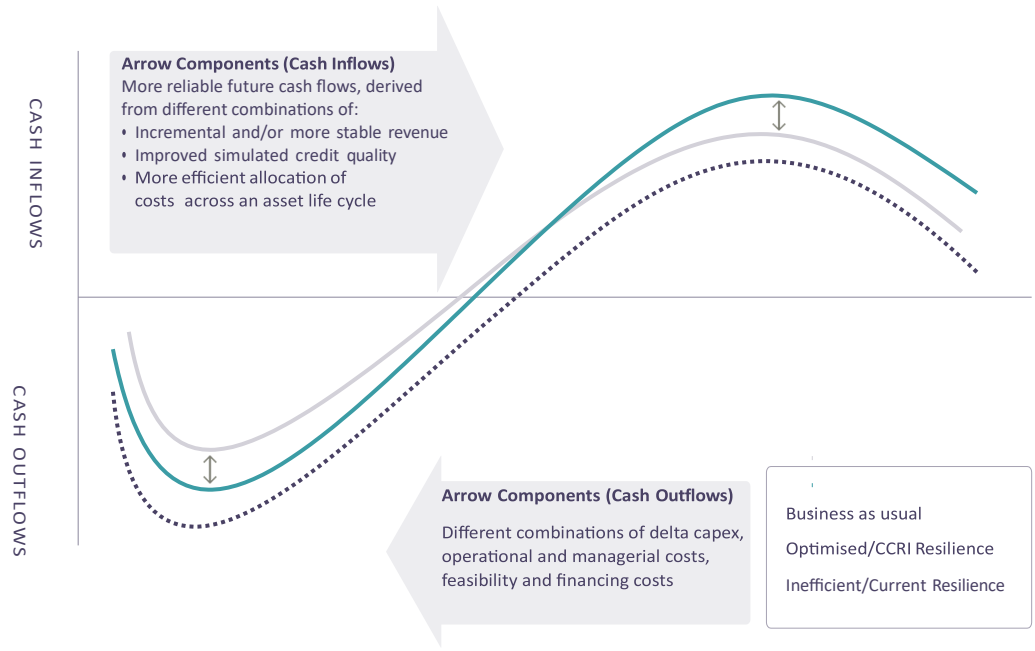
More resilient infrastructure assets would reduce loss and damage and generate significant (co)benefits in terms of lower repair costs and maintenance needs over the life cycle of the asset.

[6] See description of these concepts in the GCF and IIHS Position Papers, respectively

But to be resilient, assets not only need to be robust; they also need to be well maintained, with adequate O&M standards and targets, which requires a steady flow of resources, and hence well planned and soundly estimated targeted investments (European Commission, 2019)

If appropriate resilience standards are integrated into infrastructure projects at the planning and design stage, then it is possible to optimize both capital expenditure and operating expenditure over an assets lifecycle in a way that converts investment in resilience from a cost to a vehicle for generating additional or more stable revenue over the asset lifecycle (see figure X). The different benefits of integrating physical climate risks into asset design become clear, as in addition to more predictable cashflows it would also allow for improved credit quality simulations and a more efficient allocation of costs across an asset life cycle (Coalition for Climate Resilient Investment, n.d.)

Figure : The resilient investment perception problem (CCRI*)*



4.3: Pathways to up-scaling financing in resilient infrastructure

Given the above challenges, any viable pathway to scaling up both public and private investment in resilience will require a number of elements:

- National Resilience Strategies guiding public investment in resilience that addresses social development goals and local economic growth (e.g. employment, skill development, demand for infrastructure services).
- Financial risk metrics that clearly inform the economic case for resilience
- Strengthened infrastructure governance, including planning, implementation and maintenance, with a focus on resilience to ensure investments generate adequate returns and are secured
- Standards and certification of resilience to inform a resilient infrastructure asset class
- Revenue models that enable the co-benefits of investment in resilience to be monetized in a way that appropriately benefit investors and other stakeholders

- New international financing mechanisms such as “debt for climate swaps”, enabling domestic investments in resilience and net-zero transition

4.3.1: National resilience strategies

In many LMICs weak infrastructure governance contributes to a low rate of return on investment, project delays, complex approval mechanisms, and political uncertainty, all of which inhibit private investment in infrastructure. Infrastructure characteristics that require specific governance considerations include long-duration assets, natural monopoly, social returns that exceed private returns and the role of government as a shareholder. Thus, infrastructure governance should address not only asset resilience but also service and systemic resilience.

A first way to strengthen infrastructure governance could be for countries to develop national resilience strategies. National resilience strategies should identify which levers of change can facilitate the integration of resilience features as part of a systemic approach. They are defined as areas that have the potential to enhance systemic resilience, or tackle the drivers of low systemic resilience, while synergistically addressing other challenges or societal priorities that seek to solve or mitigate problems on a global scale (International Coalition for Sustainable Infrastructure (ICSI), 2022). The integration of levers of change supports the identification of the infrastructure projects with greatest potential for a net positive impact on the wider system. If systemic resilience is treated as a priority by all other decision-making processes, the cost of enhancing resilience can be shared across the cost of other societal objectives.

To enable this, a national register of all infrastructure asset classes and service nodes is required to be developed and maintained, complete with spatial information, authorities involved in building/maintenance/service delivery, and regular updates on physical and service quality. Such an inventory will be the first step to recognise per capita access to local and strategic infrastructure and ascertain the basic infrastructure gap. The service delivery levels and updates can give a greater insight on the level of resilience and a chance to reduce mounting risks pre-emptively.

Such a database will be crucial to building risk metrics. Risk metrics are essential (though not sufficient) to build the financial case for investing in disaster and resilience. By layering risk, national resilience strategies should identify the most cost-effective approaches to ensuring resilience, including prospective risk management (higher infrastructure standards, environmental protection etc.), corrective risk management (retrofitting, reinforcing and remedial measures), compensatory risk management (risk financing and transfer) and reactive risk management (early warning systems and effective response and recovery).

National resilience strategies are essential to determine country-specific resilience objectives and the policy mix that should be implemented to address the different levers of change that can be relied upon. Such strategies can ensure that national infrastructure procurement policies adhere to internationally agreed resilience standards, encourage the development of Model Concessional Agreements (MCAs) for Public Private Partnerships (PPP) aligned with disaster and climate resilience goals as in the case in Japan (Indian Institute of Human Settlements, 2022).

The development of a national resilience strategy may already send positive signals to capital markets that a government is serious about, reducing loss and damage in infrastructure, addressing systemic risk, and therefore improving potential returns and reducing risks for investors. If reflected

in analyst rating and in global indexes,[7] it may have the potential to reduce the cost of capital and encourage investors to view the country concerned more favorably.

4.3.2. Public investment planning and evaluation

Within the policy framework provided by national resilience strategies, governments can then use financial risk metrics to integrate resilience into their public investment planning and evaluation systems.

In most LMIC, local infrastructure systems, such as health and educational facilities, local water and power systems and rural roads are financed almost exclusively through public investment. Given that most contingent liability in local infrastructure systems is associated with extensive risk (very frequent low-severity events), disaster loss and damage data may provide the most appropriate way of calculating risk[8]. However, at present, disaster loss and damage data is sparse and inconsistently documented across different hazards and regions (see box below for an illustration).

Box: Status and opportunity for a Disaster loss and damage Atlas for India

While it is critical to have historical and on-going database of loss and damage owing to disasters to analyze the long-term impacts of past environmental shocks and stresses in India, a comprehensive source of information on historical climatic and non-climatic events does not exist. A global database, EM-DAT (EM-DAT, n.d.) documents some past events, however its reliance on existing public and media sources has meant extensive events such as urban droughts, heat or local flood events are not captured. Additionally, geographical information is very coarse (some with barely the name of the states affected), and many extensive events are not documented at all (such as urban droughts). This limits the assessment of losses specific to infrastructure classes at the local level. Another global database of loss and damage, DesInventar (UNDRR, n.d.), too, only has information for three states in India – Tamil Nadu, Odisha, and Uttarakhand Some of these databases are discontinued. Specific hazard-wise also data is limited. Cyclone eAtlas (Ministry of Earth Sciences et al., n.d.) has historical tracks, but not geographical extents of affected areas, people and infrastructure.

IMD recently launched the Climate Hazard and Vulnerability Atlas (Indian Meteorological Department & Ministry of Earth Sciences, n.d.), but it has many limitations for practical or research purposes. The data is aggregated for the current year and does not give much information about the past. Besides, it is presented as an exposure and vulnerability map rather than downloadable geographic data that can be used for analysis. By recording this information monthly, CSE's Down To Earth (Centre for Science and Environment, 2022) came up with a striking finding that there was an extreme event experienced across India almost on all days in 2022. This suggests that while some this information exists, and is insightful, it is locked away with different actors.

Meanwhile, many new remote sensing methods are being used now to document historical information on the extent and people affected by disasters, such as the Global Flood Database (DFO Flood Observatory, n.d.) for floods and storm surges. These already include what is widely used as the basis of analysis, such as the Dartmouth Flood Observatory data (Brakenridge et al., n.d.). Besides, all states and many districts have Disaster Management and Climate Change

[7] For example, the WEF Global Competitiveness Index or the EIU Country Risk Profiles.

[8] Probabilistic risk estimation rarely accounts adequately for the extensive risk layer of highly idiosyncratic, localized, frequent events, in which case a retrospective approach, using disaster loss and damage data may be the most appropriate.

Action Plans that document much of these losses and expenditures made by the state and non-state actors. UNDP's PDNAs (United Nations Development Programme, 2018) are a recent but great resource too, but all too recent and split into multiple documents. Building Material and Technology Promotion Council (BMTPC) has a Vulnerability Atlas of India (Building Material and Technology Promotion Council, n.d.) as a tool for formulating proactive policies, strategies, and programmes to face the threat caused due to natural hazards, however, this has not been updated for many years.

Combined with EM-DAT, IMD's more than 100-year records of temperature, rainfall, (India Water Portal, n.d.) and cyclone tracks, state and district plans and national atlases, and satellite image processing, a useful Atlas of Disasters could be established as an open access portal that documents and freely disseminates information on the spatial extents, losses, and resources spent by the state and other non-state actors. A better knowledge of recovery costs and be another incentive for investing in pre-emptive investments for resilient infrastructure.

4.3.3 Financial risk metrics to make the economic case for resilience

Globally comparable, multi-hazard, probabilistic, climate conditioned risk metrics, such as those provided by the GIRI provide estimates of the contingent liabilities internalised in infrastructure, in each sector, for each country of territory and for different hazards, including geological and climate related hazards.

Financial risk metrics enable governments to understand the contingent liabilities they face and to identify particular sectors or territories of concern. They make the economic case for resilience because they enable governments to estimate the average annual levels of loss and damage due to lack of resilience and how this erodes their capacity for future social and economic development.

Understanding contingent liability is an essential first step towards, measuring the sovereign, and mainly fiscal risk, internalised in infrastructure systems and generating a political and economic imperative for strengthening resilience.

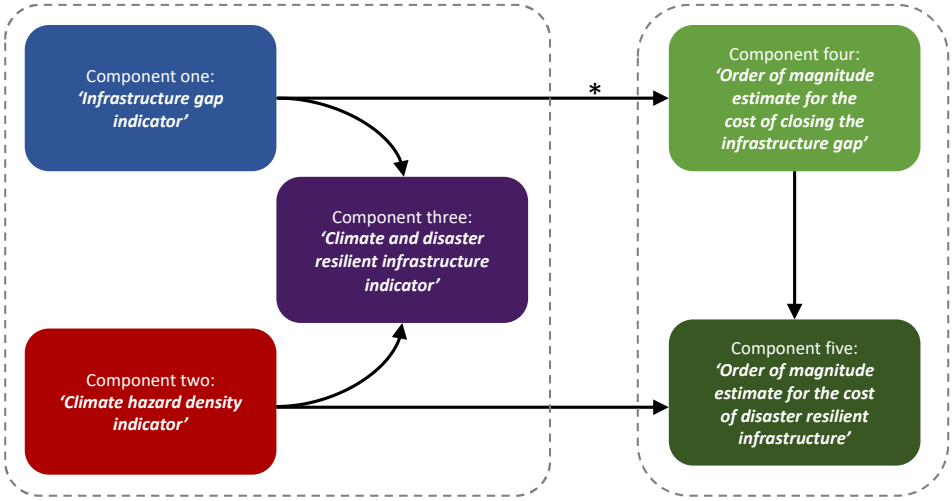
Financial risk metrics can reduce uncertainty for potential investors and governments by enabling risk to be appropriately factored into investment decisions and credible estimates of ensuring disaster and climate resilience. This is relevant to areas such as capital investment, social spending, economic growth and savings and reserves, all of which can provide an important political and economic imperative to invest in resilience. Understanding risk to existing infrastructure assets at the national level is fundamental first step towards identifying appropriate resilience standards and policy and strategy frameworks provide incentives for investment in resilience

A number of governments in Latin America as well as in Asia have adopted methodologies for incorporating risk and resilience into their prioritization of capital investment[9]. One such methodology is highlighted in Box X below. These efforts have produced mixed results to date, mainly due to limited local capacities to formulate infrastructure projects on the basis of financial risk metrics and resilience standards.

Box : Using estimates of extensive risk to calculate the cost of closing the resilience gap (UNDP, 2022)

[9] See for example the INCENTIVA project of the Central American Institute for Public Administration (ICAP). https://icapincentiva.org/web2/incentiva/

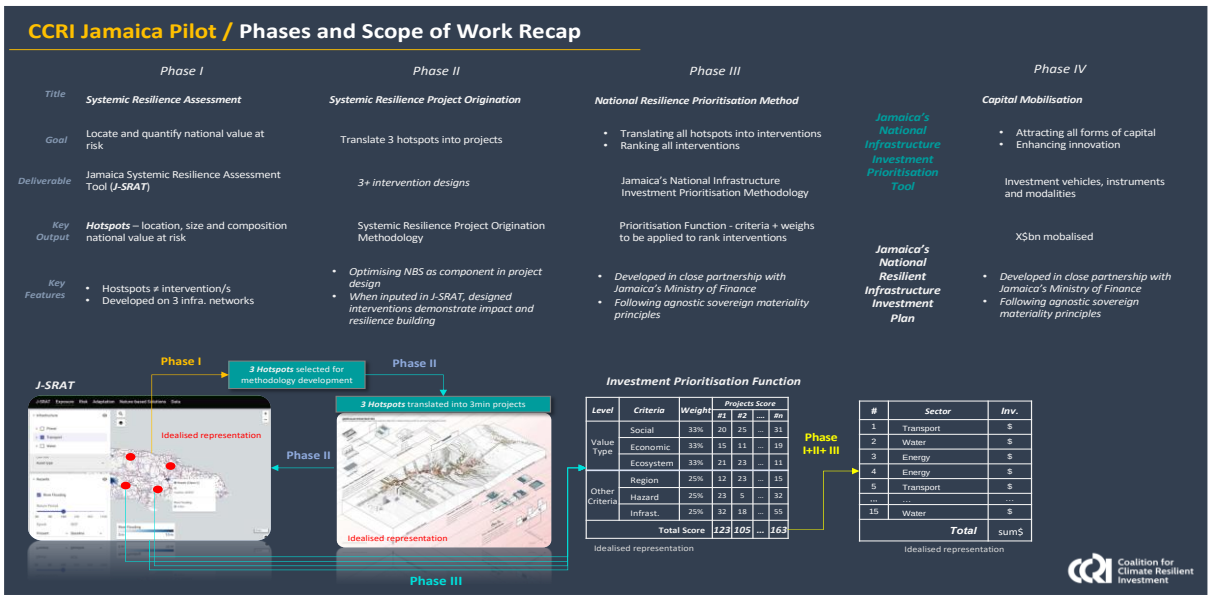
The DX4 Resilience initiative of UNDP and the Government of Japan developed a composite methodology to providing analysis and findings that are actionable by local governments to make their urban infrastructure disaster and climate resilient and achieve relevant SDGs. The composite methodology is made up of five components that work together to support local governments in developing countries to assess the local infrastructure gaps and estimate the extensive risks on existing and future local infrastructure, and then generate order of magnitude estimates for the costs of closing the existing infrastructure gaps as well as the additional costs of ensuring that the new infrastructure can be climate and disaster resilient. The composite methodology's five components are as follows:



4.3.4. National Infrastructure plans and project pipelines.

Financial risk metrics can also inform the development of national infrastructure plans with updated sector and territorial investment estimates. In the case of Jamaica, such metrics facilitated the formulation of a national plan to strengthen resilience for the country (see figure X).

Figure : Jamaica Systemic Risk Assessment Tool (CCRI)



A project pipeline development approach helps structure national infrastructure plans and enables the development of a series of projects in connection with each other. By integrating resilience measures into a project pipeline at the outset, disaster and climate risk considerations become part of the early stage of design and cost-benefit analyses can take account of potential social, economic, and environmental benefits (Green Climate Fund, 2022). The combination of avoided asset loss and damage and broader benefits that the approach would capture is a significant departure from the traditional way of planning developmental assessment of infrastructure investments in LMIC[10].

Pipelines are important because they enable government, industry, and communities to better plan and fundraise for investment in resilience (Global Infrastructure Hub, n.d.):

- For governments, pipeline development is an essential step in planning infrastructure, which complements the government's infrastructure plans and project preparation practices.
- Industry needs pipelines to plan and prepare its resources both on a micro level (in pursuit of specific programs and projects) and a macro level (by using pipelines to identify market trends).
- Pipelines are an important signal for attracting new entrants to infrastructure markets and for industry and academia to prioritise workforce education and upskilling programs.
- Communities want pipelines so that they can see what is being built and when. Pipelines can be an effective tool to demonstrate transparency and build trust with communities.

Project pipelines also facilitate projects bundling and aggregation that optimises the allocation of funding sources across projects . Multiple small projects do not have the scale to attract private investment and increase risk for investors. If these small projects are aggregated and bundled together in the context of project pipelines, then they become more attractive for investors, while the risk is distributed across the range of projects.

A well-bundled project pipeline presented in an investment roadmap for climate resilient investment can then attract private sector institutional investors alongside public sector funding (see Box X) (Green Climate Fund, 2022).

Box . Ghana Case Study

The Ministry of Environment, Science, Technology and Innovation of Ghana (MESTI) and the Global Center on Adaptation (GCA) developed Ghana's first investment roadmap for climate resilient infrastructure, in collaboration with UNOPS, University of Oxford and UNEP. The roadmap quantified the direct and indirect impacts of exposure of infrastructure to climate risks, and prioritized an evidence-based pipeline of 35 adaptation investment options. GCA is working with the Government of Ghana and other partners to finance these projects, which requires the support of public and private partners.
Key recommendations to implement national infrastructure roadmaps are:

- **Resilient assets must translate into resilient services:** Besides quantifying the impacts of climate risks to infrastructure, it is key to assess the impacts and consequences of climate risks to the provision of infrastructure services to vulnerable groups and achievements of SDGs. For example, in Ghana damages to roads and highways can reach US$3.9 billion under a high-flood risk scenario by 2050, which means 13-14 million people (particularly women) would lose access to healthcare facilities.
- **Enhancing data and capacity to quantify climate risks:** The availability of high-resolution climate hazard, infrastructure and natural assets data, and the use of innovative methodologies to quantify

[10] The GCF position paper presents the main project risks in detail, proposes a way to streamline climate and natural risks into the main risk list and presents methodological steps that allow to substantially diminish these risks.

climate risk, allow to provide insights on infrastructure exposure and impacts of climate risks at a granular scale (e.g., households or people). This requires agencies and institutions across sectors to share existing data, keeping the information up to date, and also have the capacity to perform this analysis.

- **Prioritizing resilient infrastructure investments based on adaptation needs:** The development of the roadmap was led by the Government of Ghana and mobilized the engagement with over 20 government agencies, institutions, and investment partners. Engaging with stakeholders from the start of the project allows the prioritization of projects that are aligned with ongoing and planned investments in the country and priority development objectives in the country.

4.3.5: Defining a set of commonly accepted infrastructure resilience standards and certifications

Standards and certifications provide a common language to understand and compare different infrastructure projects, which could aid in scaling projects and prioritizing project benefits. In particular, standards and certifications can help lower perceived risks for private investors by providing additional clarity, therefore unlocking additional financing and funding streams (International Coalition for Sustainable Infrastructure (ICSI), 2022).

Initiatives that promote a common approach to identify sustainable, quality, and/or green infrastructure projects include the 'meta-standards'- FASTInfra (Finance to Accelerate the Sustainable Transition-Infrastructure) label and the Blue Dot Network (BDN). FAST-Infra (presented in Figure X below), led primarily by finance-sector institutions, launched the Sustainable Infrastructure Label to identify sustainable infrastructure projects. The Blue Dot Network, led by the Governments of the United States, Australia, and Japan, introduced the Blue Dot Network framework for certifying quality infrastructure projects. Both FAST-Infra and Blue Dot Network propose hosting digital data platforms that will serve as a repository of all projects.

Source: Building a Common Approach: Global Infrastructure Standards (Duke University 2022)

CASE STUDY: FAST – INFRA SUSTAINABLE INFRASTRUCTURE LABEL: FRAMEWORK

FAST-Infra was a product of French President Emmanuel Macron's One Planet Lab think tank, with an aim to promote innovative solutions to the global challenges related to climate change, biodiversity loss, and the well-being of societies (One Planet Summit 2022). A globally recognized and trusted label which harmonized existing standards could build the confidence that financiers was identified to increase private investments to sustainable infrastructure, especially within emerging and developing markets.

The FAST-Infra Initiative has two major components: the SI Label and the FAST-Infra Tech Platform.

The SI Label aims to be a widely recognized and transparent label that reliably communicates that an infrastructure asset meets international sustainability standards in terms of four dimensions: (1) Environmental, (2) Social, (3) Governance, and (4) Adaptation & Resilience. The Label rests on the IFC Performance Standards, as well as filling gaps in the current standards, together with making a positive contribution towards a set of criteria drawn from good market practice. The 14 sustainability criteria that underpin the SI label were developed by extensive mapping of leading standards, taxonomies, and principles in the market. Under each criterion, baseline requirements would be the minimum standards that all SI Label infrastructure projects/assets are required to adhere to. Beyond the baseline requirements, there must be a quantifiable positive contribution to a sustainability objective. The strength of the SI Label framework is that stakeholders have the flexibility to use the best available techniques and metrics to demonstrate compliance with the 14 sustainability criteria.

Use of the SI Framework and application of the associated SI Label are voluntary. The SI Label can be applied at all lifecycle stages including planning, designing, sponsoring, developing, constructing, operating, financing, and decommissioning. The SI framework has five key requirements-

- Indicative & Non-Exhaustive Sustainable Infrastructure Types
- Sustainability Dimensions, Criteria, Methodology, & Measurement
- Minimum Safeguards & Risk Management
- Declaration, Disclosure, & Reporting
- Independent External Review

FAST-Infra is currently in the pilot testing phase, as moving towards full release post which the focus will be on continuing to applying the SI Label, raising its visibility and encouraging the adoption of the label.

Going forward, it is essential that these 'meta-standards' are fully aligned and address the user-needs across all infrastructure sub-sectors, especially for emerging geographies where the majority of new infrastructure is expected to be built.[11]

A combination of resilience standards and credible *third party* certification processes could then pave the way for the creation of a resilient infrastructure asset class, providing investors with a transparent identification of opportunities for investment in resilience.

4.3.6: Pricing resilience

If resilience is to be fully factored into the planning, design, financing, operations, and maintenance costs of infrastructure projects, the benefits and costs of resilience need to be correctly priced. As highlighted in 4.2.3 above, conventional cost benefit analysis for infrastructure projects often fail to identify the full range of benefits and co-benefits of investing in resilience over the life cycle of a project. These include not only avoided loss and damage to infrastructure assets, but also the benefits accrued through more reliable and dependable services and co-benefits in terms of enhanced ecosystem services, social welfare, employment etc.

A traditional economic and financial approach to evaluating costs and benefits should be broadened to include: avoided asset loss and damage and service disruption; the value of ecosystem services

protected; increased social and economic resilience of households, communities and businesses; avoided systemic risk, including climate change and loss in biodiversity.

These broader benefits should be identified as early as possible in a project's development. Some of these benefits are more easily quantifiable and measurable, such as the creation of new jobs. Others, such as loss avoidance associated with low-return period hazards, can be quantified but may seem less tangible to owners and users of the infrastructure.

Good examples of co-benefits assessments exist but and they are usually *ad hoc,* and they are heavily impacted by gaps in data and technical capacity. As Box X shows, investing in the planning process as such, for example through pre-development technical assistance, plays a key role in allowing for the quantification of such benefits. Box X provides an example in the case of the City Climate Finance Gap Fund.

Box : The City Climate Finance Gap Fund (International Coalition for Sustainable Infrastructure (ICSI), 2022)[12]

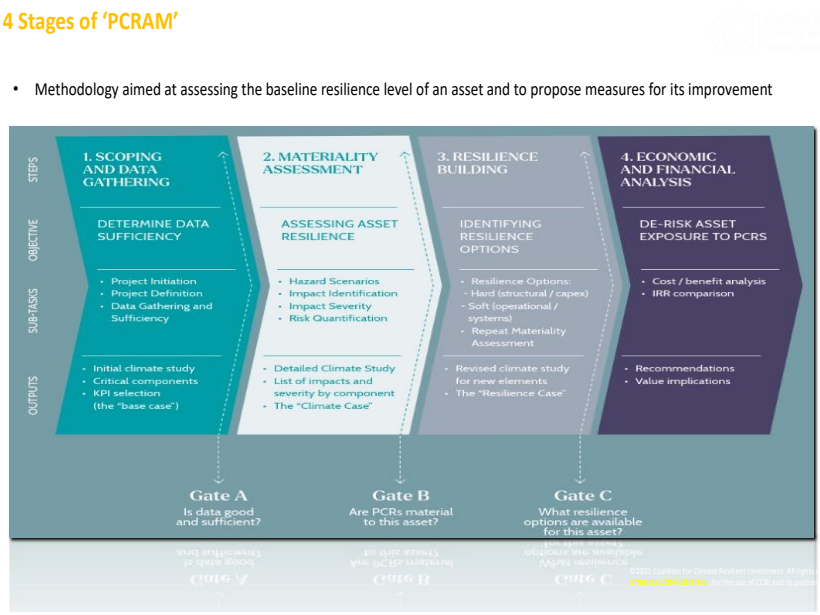
Investing in planning and risk-informed policy making is key to resilient infrastructure development and yet is often overlooked and underfunded. The Gap Fund seeks to address this. It is a unique collaboration between implementing agencies (the World Bank and the European Investment Bank), donors, and city networks (GCoM, C40, ICLEI, and CCFLA) that supports planning for resilient infrastructure assets and urban systems. Since its inception, the Gap Fund has supported 80+ cities worldwide by mobilizing more than Euro 7 million in early-stage project preparation. The Gap fund's work in Pristina enabled the city to develop policies that would encourage resilient infrastructure, which will have an impact on all projects into the future.

Realising these benefits requires a shift in terms of how projects are planned, executed and monitored. For instance, transport infrastructure would have to be thought of from the broader perspective of reducing emission and protecting biodiversity rather than through only optimising for time and distance considerations. In such a case, resilience would have to be built in at all stages of the lifecycle: at the planning stage, to avoid fragmentation of intact ecosystems; in design, by including wildlife corridors in sensitive areas; and in the construction stage to ensure these considerations are implemented and disclosed to stakeholders periodically (WWF India, 2022).

An adequate pricing of resilience should increase the economic and financial value of projects and demonstrate that the risk-adjusted returns of resilient investments can be attractive to capital providers. As Figure illustrates how the CCRI Physical Climate Risks Assessment Methodology (PCRAM) has been used to determine the baseline climate resilience level of an asset and undertake a cost benefit analysis of potential resilience options.

[12] ICSI Position Paper, 2022

Figure : The Physical Climate Risks Assessment Methodology (CCRI)



The integration of resilience features in project design and operations should address bankability issues and improve the ability of resilient assets to both raise project debt and lower their cost of capital. Methodologies such as PCRAM could therefore form part of standard lender due diligence processes. Discount rates could then be adjusted to reflect the Net Present Value of an asset once resilience features are factored into cashflow projections.

In a CCRI 'real world' case study relating to a renewable energy power plant in Asia, resilience was embedded into the design of the project. Implementing this resilience option increased initial CAPEX by approximately 2% and decreased the project IRR by 0.1%. The project avoided future potential losses, which using PCRAM were projected to decrease the Project IRR by 2% (Coalition for Climate Resilient Investment, 2022).

4.3.7 Allocating resilience costs and benefits among different stakeholders

Allocating the costs and benefits of risk and resilience is key to ensuring the proper integration of resilience in infrastructure systems. Resilience is important to everyone involved in the value chain of infrastructure but is valued differently by different stakeholders, including national governments, sub-national governments, private assets owners, landowners and users (see Box X) (International Coalition for Sustainable Infrastructure (ICSI), 2022).

Box: Stakeholder incentives and influence dynamics
One of the major barriers to increased private investment in resilient infrastructure is that the resilience benefits over the asset life cycle may benefit a broader set of stakeholders. Governments may benefit from reduced asset loss and damage and a reduction in the costs of rehabilitation and reconstruction. Households, communities, and businesses may benefit from reduced service disruption and thus enhanced social and economic development. Other benefits, such as protected biodiversity of reduced carbon emissions may be shared more broadly, including with other countries or the global commons.

Multiple stakeholders have varying stakes in the project. their influences also vary during the process of the project. one way of incentivising the inclusion of safety and DRR measures in the planning processes of the project can be done by increasing stakes and improving relative power dynamics (Fig. 9). For instance

i. By improving public participation processes, and improving awareness amongst the masses regarding their Right to Information and large scale planning projects, influences of users and people may be improved.
ii. By improving capacities of the implementation agencies and regulatory bodies, their influence over the lifecycle of the project may be increased.
iii. By enforcing an Engineer's Act and a Planners Act, and making the professionals more liable for their practice, their stakes may be increased in every project, and thereby the incentive to include disaster risk reduction strategies during the technical planning processes can be further improved.

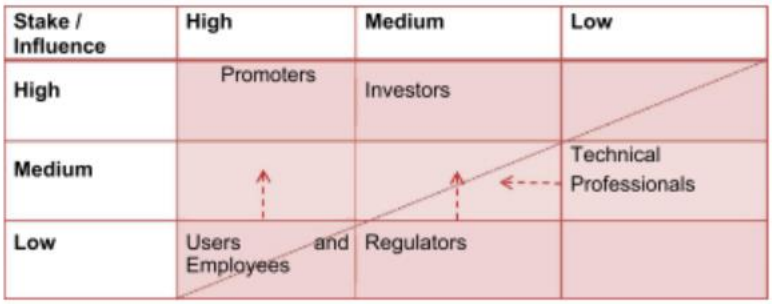


Fig. 9. Stake vs. influence matrix.

Source : Jain 2014

Quantifying and allocating the benefits and costs of resilience will help determine the most appropriate economic and funding mechanisms to adequately implement an investment in resilience. Some of the considerations that should be included in project appraisal include:

- **Identification of key beneficiaries:** If parties, such as property owners or private infrastructure providers, stand to benefit from public investment in resilience, it may be appropriate for them to contribute financially (through development contributions, land value capture instruments, taxation, etc.)
- **Share of cross-subsidization:** National governments need to establish the extent to which they want to subsidize sub-national governments. Some parties simply will not be able to fund their share of investment in resilience, so some cross-subsidization will be inevitable.
- **Equity**: Some stakeholders will be better placed to finance resilient infrastructure than others. Vulnerable communities may need additional financial support from central governments or third parties to meet an acceptable level of resilient infrastructure.
- **Incentives and disincentives:** Disincentivize asset owners and landowners from building infrastructure in high-risk places in the future. One effective way to do this is to transfer a reasonable and proportionate share of financial risk upon them. It is also reasonable that private asset owners and property owners pay for some of the resilience costs, given they are the direct beneficiaries of the investment.
- **Compensation and liability:** Understanding who is financially liable if land, for example, is deemed no longer habitable is an important step in determining who the financial contributors ought to be. Insurance can provide a buffer in case of a disaster, although the limitations of this approach should be acknowledged (International Coalition for Sustainable Infrastructure (ICSI), 2022).

Once the benefits of resilience as well as the beneficiaries have been identified it is necessary to develop policies that monetise the socio-economic benefits of investing in resilience and that enable investors to capture part of the "resilience dividend". Again, for this to work, the value of the resilience dividend would have to be estimated, combining project and economic evaluation, such as

done through the Resilience Dividend Valuation Model developed by the Rand Corporation with support from the Rockefeller Foundation (Bond et al., 2017). In this approach, the resilience dividend is calculated as the sum of benefits, over time, from a project investment based on resilience principles compared to one that is not. In other words, it is the additional value that is generated by investing in resilience over following a "business as usual" design. [13]

The creation of country-specific resilience funds could help monetise the resilience dividends that should accrue from investing in resilience and translate into lower future damages, reduced insurance premia, less interruption of public services, and potentially lower maintenance costs.

National resilience funds if organically linked to national resilience policies, infrastructure plans, project pipelines and mechanisms to monetise the resilience benefits could provide a vehicle through which private and institutional investors could participate in national infrastructure projects.

National resilience funds would include blends of public capital, private investment, and where appropriate climate finance in a way that de-risks projects for investors, maximises rates-of-return and distributes appropriately the resulting resilience benefits. They can also potentially provide a vehicle for integrating insurance and other risk financing mechanisms such as catastrophe bonds, as an integral part of infrastructure financing.

Although at present there is little empirical evidence to demonstrate its feasibility, in principle insurance pricing should be sensitive to investments in resilience. Infrastructure projects that integrate resilience features and standards should be able to command lower premiums in markets for insurance, re-insurance and insurance linked securities.

4.3.8: Encouraging the development of innovative financing instruments and structures

LOOK AT WHETHER WE SHOULD INCLUDE NATIONAL RESILIENCE FUNDS HERE OR NOT

Financing resilient infrastructure implies the mobilization of capital sources from geographies and sectors with surplus capital to where more funding is required, in particular to LMIC.

This can only be facilitated by large scale changes in the financial system, building on the capacities of existing institutions (G20, Making the Global Financial System Work, 2018). Under-investment in infrastructure sectors is fundamentally one of the fault lines of the world economy and a key risk driver of stagnation in global economic growth (Krugman, 2014; Blanchard, 2019; Summers and Rachel, 2019).

New financial instruments are required to bridge this gap and inject liquidity, not only into the energy, infrastructure, and urban transitions, but also into resilience, thus unlocking new economic opportunities (GCEC, 2014; NCE, 2016; Indian Institute of Human Settlements, 2022).

Firstly, there is a need for financial structures that adequately blend public and private sources of capital through de-risking mechanisms (see Box X). Through such mechanisms, public funds, mostly in the form of grants, can provide the basis for and stimulate private investment in resilient infrastructure while simultaneously accelerating development goals.

[13] Post from S. Bridgett-Jones, former Chief Partnerships and Advocacy Officer, The Rockefeller Foundation, 2017

Box: Blending public and private capital to de-risk investments: Climate Investor Two (CI2)
Climate Investor Two (CI2) is an infrastructure fund established in 2019 by Climate Fund Managers (CFM). It uses a blended finance approach that invests in private equity water, water-based energy, and ocean infrastructure projects in emerging markets. CI2 has developed an innovative project finance structure that works across three stages: 1) a development fund (DF), 2) a construction equity fund (CEF), and 3) a climate credit fund. The DF is a wholly concessional capital pool funded by donor contributions that aims for capital preservation and mobilizes private capital into the CEF. The DF offers up to 50% of the planning and development costs of the projects along with technical assistance. Equity financing of up to 75% of construction costs is available under the CEF.

Blended finance was an enabler to accelerate the development of, and subsequent investment in, resilient infrastructure projects like solar-powered desalination units in Kenya and two waste-to-energy facilities in Thailand. CI2 closed its first round at $675 million in November 2021. CI2's success is owed to its flexible and modular governance structure that attracts institutional investors at scale while delivering projects locally. Aligning investment instruments to focus on distinct risk periods in the project lifecycle lowers the cost of capital and accelerates timelines. Flexibility and adaptability in transaction design can also prove critical to a successful fundraise.

Source:

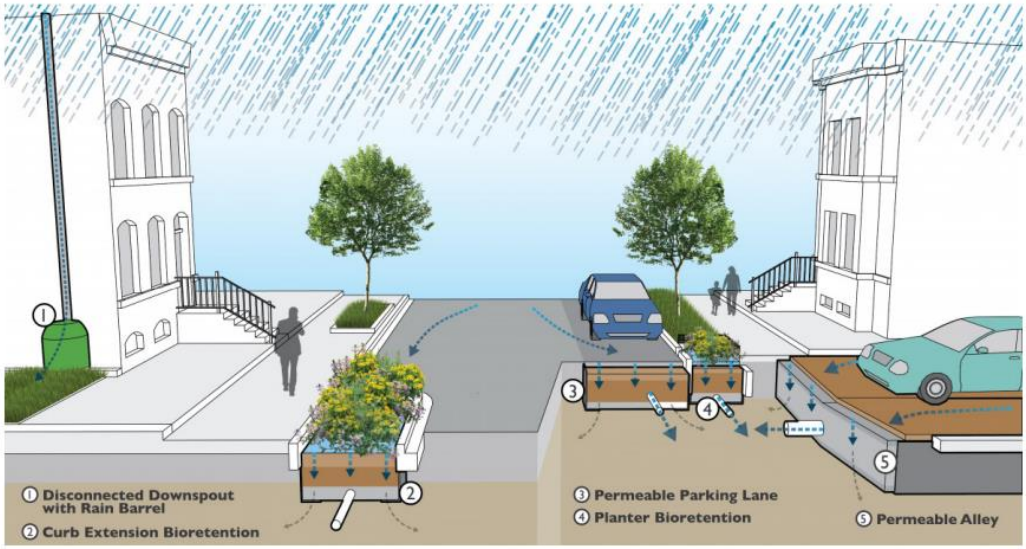
Secondly the development of financial instruments that allow the mobilization of untapped financial resources are required (see Box).

Box: Financial instruments to mobilise untapped financial resources: Philippines Energy Development Corporation (EDC)
Following a series of severe weather events in 2017, the renewable energy company Philippines EDC and its partners developed an approach to prioritize the implementation of risk reduction measures to protect key assets. In June 2018, IFC issued the first AAA peso-denominated green bond for approximately $90 million with a fifteen-year maturity. The bond was intended to support EDC with restoration and resilience efforts at the Malitbog plant. The bond quickly attracted investment from several major players within the Philippines. These efforts reduced risk to EDC Philippines's assets, allowing EDC to expand its generation capacity and its offerings to other clients. In addition to increasing resilience to physical assets, IFC's green bond also paved the way for EDC Philippines to issue its own green bonds. EDC established a similar procedural model for green bond issuance as the IFC, with clearly defined guidelines for projects and a second reviewer. EDC issued its first bonds in 2021 for several small projects across its portfolio.

IFC's peso-backed green bond was innovative not necessarily due to the financial mechanism used, but for a vision of what it could bring for local investment. IFC and other investors anticipated that the first green bond issued for the Philippines could create a market for local green bond investments in the country. EDC Philippines benefitted from a regulatory environment that was amenable to green finance and resilient projects. Pre-established governance structures related to risk and capacity in disaster risk reduction allowed EDC to engage with different departments and incorporate new assessment tools.

Thirdly, as Box shows, green financial instruments linked to NbSI can be integrated into the funding of infrastructure assets (International Coalition for Sustainable Infrastructure (ICSI), 2022).

Integration of green financial instruments linked to Nature-based Solutions into the funding of infrastructure assets: District of Columbia Water and Sewer Authority (DC Water)
The combined stormwater/ sewer system in the District of Columbia (DC) could no longer handle capacity, especially during flooding events, increasing sewage levels in the District's rivers, and exceeding existing water quality standards. DC Water and its partners financed an integrated green-gray infrastructure solution with the first-ever Environmental Impact Bond (EIB) to remediate stormwater and sewer pollution. Alongside retrofitting sewage tunnels, the project integrated green infrastructure measures (e.g. rain gardens, rain barrels, green roofs, street side bio-retention planters, tree cover, permeable pavement, and green verges) to reduce stormwater runoff, and volumes and frequencies of overflows into the rivers.



Credit: DC Water

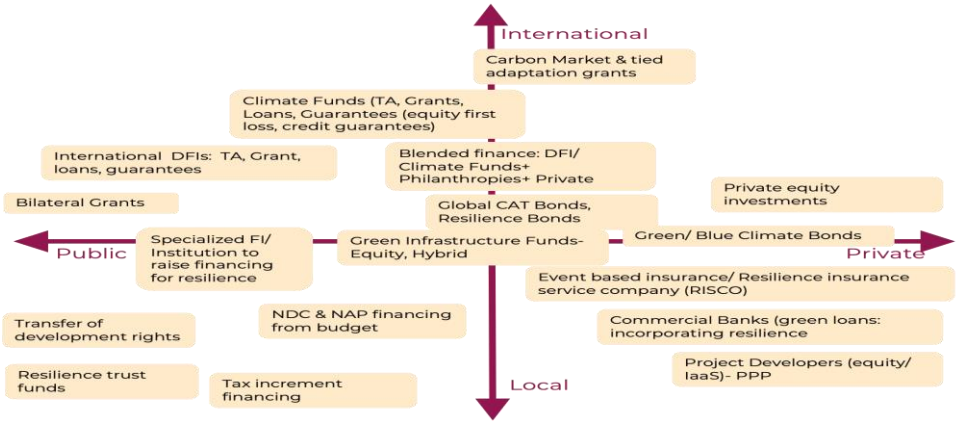
Traditional financial products could not adequately incorporate project uncertainty or capture longer term benefits of DC Water's green-gray solution. The EIB adapted performance mechanisms from a social impact bond to better meet these needs. The bond used performance-based metrics to hedge project performance uncertainties for DC Water yet remained attractive to investors. The $25 million EIB was structured as a tax-exempt municipal bond with a 30-year maturity. The bond functioned much like a standard bond except for a one-time mandatory tender date at the bond's five-year mark. The DC Water case study demonstrates that innovative financing often does not necessitate the creation of completely new instruments, but rather the creative application of existing ones.

Fourth, the unsustainable levels of debt that many LMIC currently face can be reduced by new debt swap mechanisms, increasing their fiscal space and generating new resources for resilience building and the energy transition (see Box X) (Elston, 2021).

Box : Debt for climate swaps as new ways to align increased fiscal spaces with globally shared climate and development goals

Figure below summarises some of the sources and innovative instruments which may be used by LMICs for mobilising resilience financing (South Pole Carbon, 2022). Sources of financing range from local to international and public to private and include instruments which can be used for resilient infrastructure development and those which are linked to post disaster risk financing.

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



NDC: Nationally Determined Contributions; NAP: National Adaptation Plans; FI: Financial Institutions: DFI: Development Finance Institutions; TA: Technical assistance;: ITMO: Internationally traded mitigation outcomes: PPP: Public Private Partnership