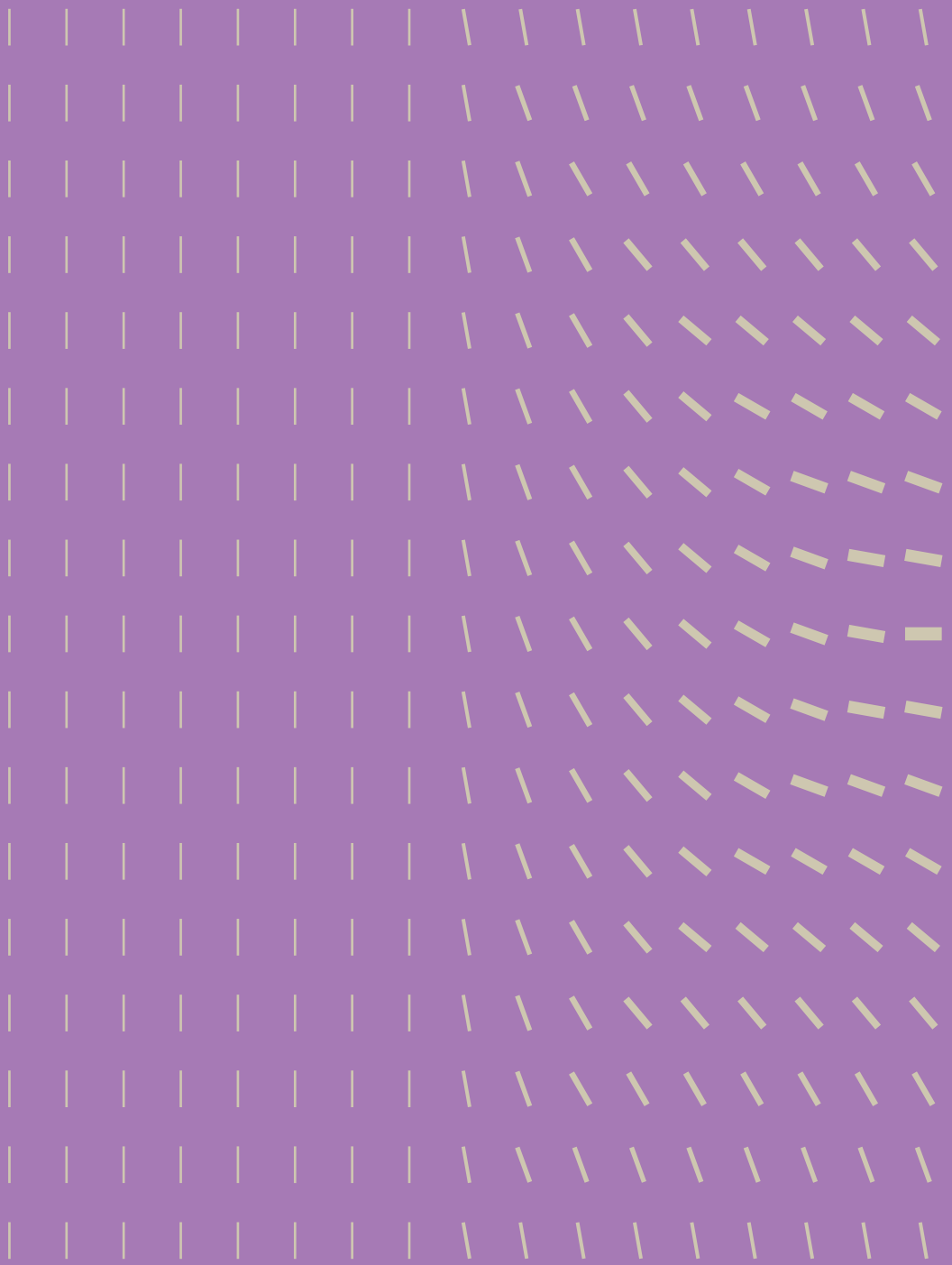
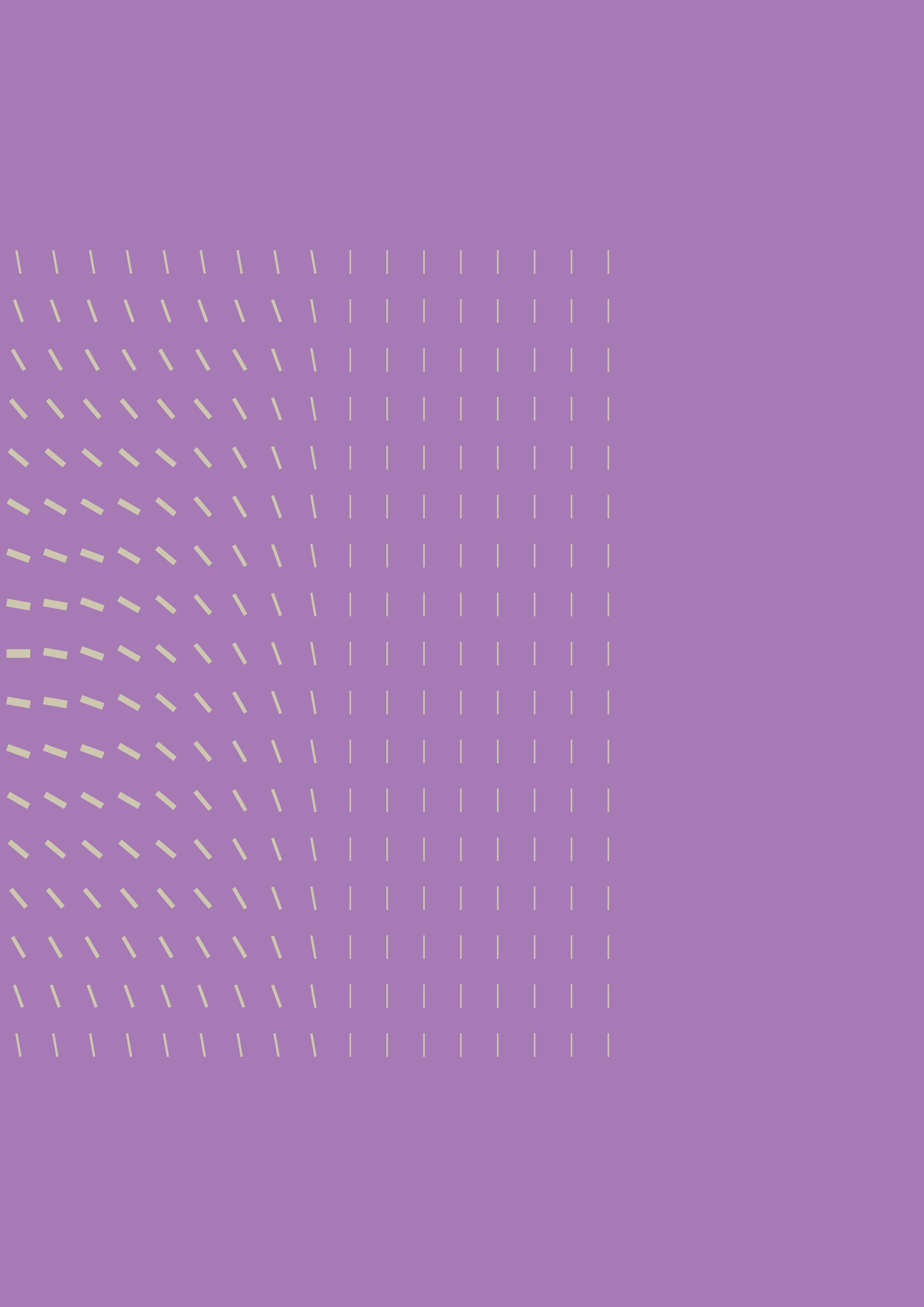
Chapter 4

Financing for Disaster- and Climate-Resilient Infrastructure





4.

Financing for Disaster- and Climate-Resilient Infrastructure

4.1. Introduction

The bulk of new infrastructure investment over the next 30 years needs to take place in LMICs

Financing infrastructure resilience requires mobilizing investment from geographies and sectors with surplus capital to those where major new funding is required.

Mobilizing new investment at large scale can only be facilitated by significant changes in the financial system and by building on the capacities of existing institutions (G20, 2018). Underinvestment in infrastructure is fundamentally one of the fault lines of the world economy and a key risk driver of stagnation in global economic growth (Blanchard, 2019; Krugman, 2014; Rachel and Summers, 2019).

As announcements of major new infrastructure investments by the USA and EU have shown, high-income countries have sufficient capacity for public investment to scale up their infrastructure investments (Chapter 1). They are also attractive markets for private capital. High-income countries are upgrading and replacing obsolete infrastructure that has outlived its design life and making major investments in renewable energy to accelerate the transition to net-zero emission. However, even these countries struggle with the increasing cost of capital, governance issues, and inadequate return on investments in infrastructure assets.

The bulk of new infrastructure investment over the next 30 years needs to take place in LMICs. As previously argued, given the design lifecycles of new infrastructure, planning and investment decisions made today will determine whether countries follow one of the two alternative future trajectories: sustainable social and economic development or constrained development and increasing contingent liabilities and higher systemic risk (IIHS, 2023). It is not just new investment that is required; it is investment in infrastructure resilience.

Mobilizing the finance required to strengthen infrastructure resilience in LMICs is a huge challenge. Weak infrastructure governance is consistent with a low rate of return on investment, project delays, complex approval mechanisms, and political

uncertainty, all of which discourage private investment. At the same time, domestic financial markets generally lack capacities to channel capital towards infrastructure resilience. Therefore, identifying incentives and mobilizing finance for a new 'resilient infrastructure asset class' becomes imperative (IIHS, 2023).

Most infrastructure in LMICs is currently financed through public investment, with significant participation from MDBs. However, the infrastructure resilience deficit cannot be addressed without a drastic increase in private investment. Unfortunately, governments and private investors are yet to fully recognize the significance of investing in resilience.

In the public sector, only a weak political and economic imperative exists for investing in resilience. As discussed earlier, resilience benefits typically accrue over long periods, while electoral cycles demand short-term and visible results. Private investors are yet to be convinced of the relevance or commercial benefits of investing in resilience. As highlighted in Chapter 3, traditional cost-benefit analysis rarely captures the broader benefits of resilience, such as avoided loss, damage, and service disruption, or the environmental, societal, or economic co-benefits over the entire lifecycle of infrastructure assets. Furthermore, even if the resilience dividend is identified and measured, it is unclear how it can benefit investors. Identifying a compelling political and economic imperative for investment in resilience is, therefore, critical, along with mechanisms and incentives developed to integrate that imperative into investment decisions.

4.1.1. The Infrastructure Resilience Finance Gap

The infrastructure resilience finance gap can be defined as the difference between the sum of the investment needed to strengthen the resilience of existing infrastructure and build future resilient infrastructure and existing and projected public and private finance, including climate finance.

Estimates of the size of this gap vary widely and depend on the type of transformation envisaged,[21] the assumptions made, and the way income geographies are classified.[22] Most estimates include the requirements to achieve the SDGs or net-zero economies or both, but do not explicitly contemplate strengthening resilience. The World Bank estimated that developing countries need to invest around 4.5 percent of GDP to achieve infrastructure-related SDGs (Rozenberg and Fay, 2019). Other studies showed an annual shortfall of $2.5 to $3 trillion between required and available resources (OECD, UNEP et al., 2018).

The assumptions that underpinned these earlier estimates now need to be reappraised. Recent assessments have found that investment in physical assets, energy, and land use amounting to $9.2 trillion per year would be required between 2021 and 2050 to achieve net zero; this is an increase of $3.5 trillion or the equivalent to one-quarter of global total tax revenue in 2020 (McKinsey Sustainability, 2022).

LMICs, particularly those with low GDP per capita and a high dependency on fossil fuels, require more investments relative to GDP to undertake this transition (Averstad et al., 2023).

[21] For example: to achieve the SDG or to transit to net-zero economies.

[22] The definition of developing countries by the United Nations is different from that of LMICs by the World Bank or low-income developing countries and emerging economies by the IMF. However, there is a significant overlap between all three classifications.

They are also more vulnerable to the downsides, such as stranded infrastructure assets and employment shocks. **LMICs will thus have to spend approximately 30 percent of the global investment in infrastructure assets and land use to achieve net zero, which amounts to $2.76 trillion annually (South Pole Carbon, 2022). If it were assumed that the cost of strengthening infrastructure resilience represents an additional 3-5 percent, the total annual requirement would be in the range of $2.84-$2.90 trillion.**

The infrastructure investment of LMICs is far behind of what is actually required (African Development Bank et al., 2021). Private investment in LMICs was approximately $40 billion in 2021, with additional climate financing of around $50.7 billion channelled through MDBs (GIH, 2022). Estimates of public investment vary, but it seems likely that the sum of public and private investment and climate finance may be around one order of magnitude lower than the requirements in these countries.

Furthermore, even this estimate is probably overstated as much of the *new* investment is, in reality, used for repairing and rehabilitating damaged infrastructure. As highlighted in Chapter 2, **the proportion of GFCF at risk of disaster, climate loss, and damage in LMICs ranges from 4.7 percent in upper-middle income countries to 9.1 percent in low-income countries (GIRI, 2023). In 2021, total GFCF in low-income countries was $124 billion. This implies that around $11.3 billion would have to be set aside annually to cover the costs of repair and rehabilitation.** Owing to accumulated disaster and climate risk, less investment is available for new infrastructure in LMICs.

4.2. Climate Financing

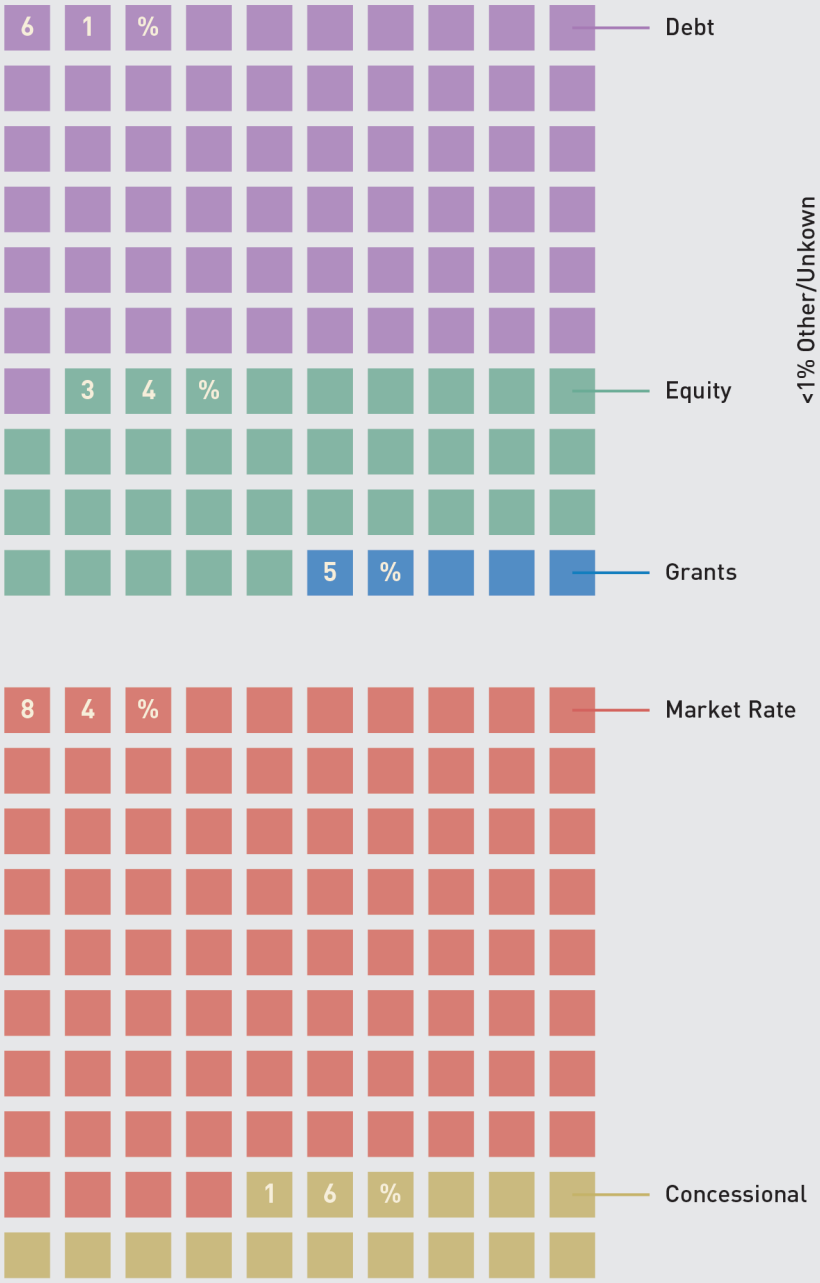
Climate adaptation finance is one of the few new sources of funding that LMICs can access to strengthen infrastructure resilience, primarily through MDBs. **In 2021, MDBs provided $19 billion in total adaptation financing, of which 92 percent went to LMICs, with South Asian and Sub-Saharan African countries accounting for 41 percent of committed funds** (African Development Bank et al., 2021). An additional $3 billion was mobilized from the private sector by MDBs. However, only a part of these funds has been dedicated to strengthening infrastructure resilience.

Dedicated multilateral funds, such as the Green Climate Fund (GCF), are also key sources of adaptation finance to LMICs, particularly in least-developed countries and SIDS. GCF has made an overall commitment of $11.3 billion since its inception in 2010, with $8.8 billion currently under implementation. The crucial feature of GCF is that it can tap into and catalyze both public and private finance flows, offering a range of financing instruments, from loans, equity, guarantees, and grants to specifically adapted solutions in investment-scarce environments. Its ability to partner with the private sector means it can help countries to de-risk large infrastructure investments and raise additional funding for climate action.

Over the past decade, only 16 percent of climate finance was concessional finance while 5 percent was grants (Figure 4.1). Concessions and grants are crucial in de-risking investment in the new technologies required to achieve net zero and in markets such as LMICs (Buchner et al., 2021). Instead, **debt remains the dominant instrument for climate finance**, increasing the risk for countries already struggling with high debt levels. As discussed, climate finance may not be appropriate for all resilience requirements. A significant proportion of infrastructure risk is associated with high-severity, long-return period events such as major earthquakes and tsunamis and is already internalized in existing infrastructure. Climate adaptation funding is not appropriate for addressing these risks.

In large emerging economies, such as India and South Africa, domestic budgets are an important source of adaptation finance, far exceeding international finance. In line with Article 2.1(c) of the Paris Agreement, there is a growing recognition that domestic budgeting should fully account for revenues and expenditures that enhance resilience in order to make finance flows consistent with low-carbon and climate-resilient development pathways.

Debt remains the dominant instrument for climate finance



If climate finance is insufficient to strengthen infrastructure resilience, a new approach to mobilizing capital is required. This would combine public sector support to de-risk investments and identify, estimate, and monetize the resilience dividend with private sources of capital to fund aggregated pipelines of infrastructure projects. In other words, resilience finance should become a mainstream channel for developing infrastructure, supplemented by climate finance.

↑ FIGURE 4.1

Climate Finance by Instrument, 2011-20 (in bn US$)

Source: Buchner et al. (2021)

4.3. Investing in Resilience

Investing in resilience can provide a dividend that outweighs the additional costs.

Some estimates claim that including resilience measures in infrastructure projects produces an average dividend of $4 for every $1 spent (Hallegatte et al., 2019). However, in reality, the costs and benefits vary enormously, asset by asset and sector by sector.

For example, the global power sector would require annual capital spending of around $2 trillion to decarbonize; it could create employment benefits of up to 43 million additional jobs by 2050. Meanwhile, the mobility sector would require annual spending of $3.5 trillion for road transportation transformation alone, but with net losses in employment of up to 3 million jobs lost by 2050 due to productivity gains in low-emission vehicle manufacturing (McKinsey Sustainability, 2022).

The Ministry of Economy and Finance in Peru was a pioneer in introducing resilience considerations into public investment planning and evaluation. Table 4.1 shows how the resilience dividend varies widely across public investment projects in Peru for hazard events of different return periods, considering only the value of avoided loss and damage. Achieving high levels of structural resilience of infrastructure may not always be economically viable, and normally some of the risks must be retained (ICSI, 2022). Strengthening resilience always involves trade-offs that must be identified and negotiated politically in each sector or territory. However, as the case studies summarized in Section 2.8 show, a resilience dividend exists even when considering only avoided loss and damage.

There is an estimated $106 trillion of untapped private institutional capital worldwide

↓ TABLE 4.1

Cost-benefit Relationship in Public Investment Projects in Peru

Source: UNISDR (2009)

Public Investment Project	Additional cost of disaster risk reduction(US$)	ESTIMATED VALUE OF AVOIDED LOSSES AND RECONSTRUCTION COSTS			
		25% probability of disaster in 10 years	50% probability of disaster in 10 years	75% probability of disaster in 10 years	100% probability of disaster in 10 years
Reconstruction of housing and water infrastructure following the 23 June, 2001 earthquake in Castilla Province	382,788	132,601	265,202	397,802	530,403
				Benefit / cost ratio = 1	
Prevention and preparedness for mudslides and floods in the upper Rimac Valley	95,616	330,986	661,971	992,957	1,323,942
				Benefit / cost ratio = 10	
Extension of the Pampacolca health centre (module to attend pregnant women)	15,570	6,789	13,579	20,368	27,158
				Benefit / cost ratio = 1.3	
Rehabilitation and construction of dykes in the Cansas Valley	95,616	330,986	661,971	992,957	1,323,942
				Benefit / cost ratio = 37.5	
Rehabilitation of the Machu Picchu hydroelectric plant	95,616	330,986	661,971	992,957	1,323,942
				Benefit / cost ratio = 19	

Note

Shaded cells indicate that value of avoided losses exceeds additional costs of disaster risk reduction investment

4.4. Challenges to Mobilizing Finance for Resilient Infrastructure

There is an estimated $106 trillion of untapped private institutional capital worldwide, which would be more than sufficient to close the current infrastructure resilience investment gap (World Bank Group, 2016). **However, only 1.6 percent of it is currently invested in infrastructure, mainly in high-income countries and renewables.[23] How to attract this capital to geographies with the greatest need, therefore, is the crux of the financing challenge.**

The ability of countries to mobilize private capital for infrastructure resilience is highly dependent on their capacity to develop and implement projects in the context of their overall quality of infrastructure governance (South Pole Carbon, 2022).

Challenges and barriers to accessing private capital include misperceptions of the costs and benefits of investing in resilience, governance issues, weak institutional capacities, and the limited buoyancy of public domestic capital markets (Table 4.2).

↓ TABLE 4.2

Challenges and Barriers to Investing in Resilience

Source: South Pole Carbon (2022)

Key Challenges	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 perceived to be 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 other benefits.
Information asymmetries	There is no common agreed way to measure resilience or its wide-reaching benefits. Infrastructure owners rarely share information on risk due to security concerns. Many infrastructure managers have little experience with disasters.

[23] Another assessment by the IMF estimates that low-income countries and small state countries would require additional investment to the tune of 1 to 2% of their GDP annually in resilient infrastructure and ecosystems, the majority of which are targeted towards coastal protection.

Key Challenges	Barriers
Infrastructure governance, policy, and institutional capacity	
Commitment and ownership of risk	Identifying key stakeholders in resilient infrastructure 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 ensure compliance. However, basic infrastructure management may be lacking in many LMICs, particularly at the local level. Many countries do not have a resilience policy or strategy for infrastructure.
Maintenance	To be sustainable, resilience requires ongoing operations and maintenance, which can further misalign the incentives to invest.
Institutional capacity to develop 'bankable' projects	LMICs often lack the institutional capacity to develop 'bankable' projects that clearly quantify the risks and the broader benefits of investing in resilience.
Public finance and capacity to innovate	
Limited public capital	Many LMICs, particularly small economies, have limited public capital to invest and to balance social and economic development requirements, climate mitigation ambitions, and strengthening 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 incorporate financial resilience metrics in project formulation.
Credit rating of public agencies and vibrancy of local capital market	Low credit rating of public agencies, coupled with a limited revenue base that can be escrowed to mobilize financing from upfront investments, limits access to local and international debt capital markets. Additionally, local debt capital markets may be at the inception phase of development. Financial markets in LMICs often lack depth, access, efficiency, and stability,[24] limiting the possibility of using capital markets to access financing for resilience.
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, catastrophe 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, a higher debt burden, and supply chain constraints exacerbate the costs of project capital.

[24] 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.

4.5. Pathways to Upscaling Financing for Infrastructure Resilience

4.5.1. Strengthening Infrastructure Governance: National Resilience Policies, Strategies and Plans

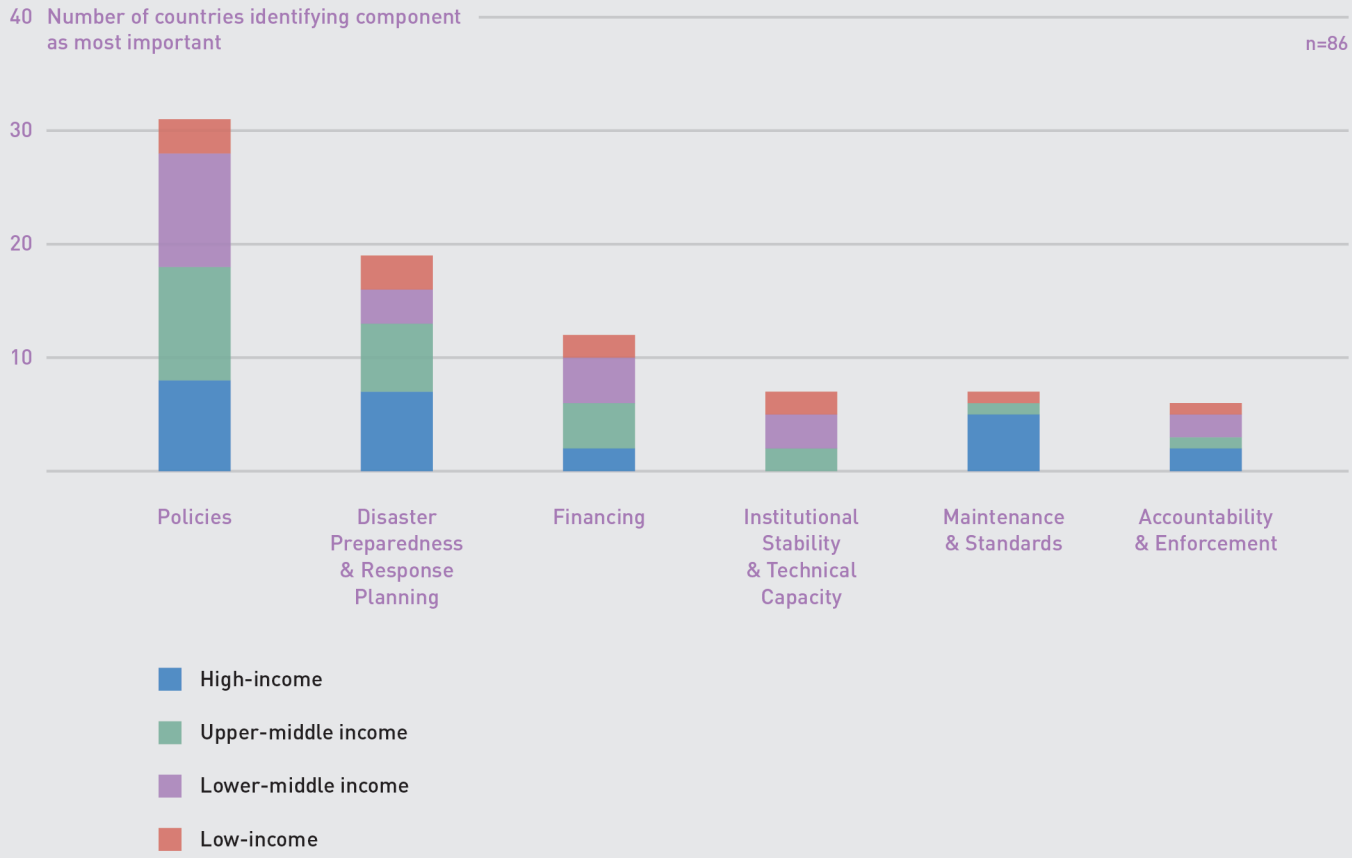
Infrastructure governance should encompass not only asset resilience but also service and systemic resilience. Infrastructure characteristics that require specific attention include long-duration assets, natural monopoly, social returns that exceed private returns, and the role of government as a shareholder.

Infrastructure governance may be strengthened by developing national resilience policies, strategies, and plans that identify which levers of change can facilitate the integration of resilience into infrastructure as part of a systemic approach (ICSI, 2022) with inclusiveness practised throughout the design cycle of procurement, delivery, management, and risk assessment. The integration of levers of change can enable identifying infrastructure projects with the greatest potential for a net positive impact in terms of reduced risk and strengthened resilience.

An essential first step in most countries is to ensure the development and maintenance of a national audit of all infrastructure asset classes and service nodes, including spatial information, data on the authorities involved in building, the quality of O&M and services, and asset loss and service interruption. Such audits can identify per capita access to local and strategic infrastructure and ascertain the basic infrastructure deficit. The service delivery levels and updates can give greater insight into the level of resilience and the establishment of priorities for investment.

The application of financial risk metrics, such as those produced by the GIRI, can then allow risk and resilience to be layered in each sector and territory. The layering of risk is critical as some assets may be resilient to high-frequency, low-severity events such as floods or storms but not to low-frequency, high-severity events such as high-magnitude earthquakes or tsunamis. By layering risk, national resilience strategies can then identify the most cost-effective approach 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 policies are essential for determining country-specific resilience objectives and the different levers of change that can be



↑ FIGURE 4.2

The Importance of Policy Frameworks for Infrastructure Resilience (GIRS)

Source: Chow and Hall (2023)

used in the policy mix; for example, to ensure that procurement policies adhere to internationally agreed resilience standards and encourage the development of Model Concession Agreements (MCAs) forPPPs aligned with resilience targets (IIHS, 2023). Japan, for example, introduced the PPP model on a large scale by enacting and promoting the Private Finance Initiative (PFI) Act. The Cabinet Office has established a PPP/PFI Promotion Office, which plays an advisory role to the Prime Minister and other relevant public agencies and has developed several guidelines that help local governments understand the process of PPP projects and contracting. The same office coordinates PPP promotion with the public and across central government agencies (Chavarot, 2023).

As Figure 4.2 shows, the GIRS confirmed the importance of national policies: 'In most nations, having stronger policies are seen as the most important infrastructure management development to ensure long term resilience'.

The development of national resilience policies, strategies, and plans can already send positive signals to capital markets that a country is serious about strengthening resilience, improving potential returns, and reducing risks for investors. If reflected in the reports of rating agencies and risk indexes,[25] risk perceptions may then be improved and the cost of capital reduced. Box 4.1, in the case of Dominica, shows how aspirational national policies can create a centre of gravity to attract a range of resilience actions.

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

4.5.2. Financial Risk Metrics and the Economic Case for Resilience

Private capital investment in infrastructure does not adequately account for sustainability-related risks, but the sector is changing rapidly. For investors to fully understand their portfolio risks and shift investments towards more strengthened resilience, metrics that account for disaster and climate risks need to be included in financial models and asset balance sheets.

Disaster and climate risk translate into financial risk (Figure 4.3) (WWF India, 2023). This includes risk associated with hazards that impact the asset and systemic risk that the asset itself may generate (Maskrey et al., 2023). For example, the Delhi Metro was designed considering earthquake risk. Still the surrounding development facilitated by the Metro increased the overall systemic risk, including local impacts on the surrounding environment and communities and global impacts, such as carbon emissions (Jain, 2015). Both kinds of risk affect an asset's financial performance via feedback loops, referred to as 'double materiality' (WWF India, 2023).

Unfortunately, in most LMICs, robust, comparable, and credible disaster and climate risk metrics are not available in a form that can be easily used to measure the financial risk in projects. Consequently, the resilience dividend cannot be properly quantified. This remains a key hurdle in attracting private capital as it adds additional uncertainty to projects and implies hidden contingent liabilities for potential investors.

The lack of accessible risk data is now recognized as a critical barrier by financial institutions (Willis Towers Watson, 2021). In many LMICs, the required input data on hazard, exposure or vulnerability, disaster loss and damage, or ecosystem services may not exist or be heavily constrained due to institutional silos and national security issues. However, the growing availability of high-resolution, publicly accessible global data enables the development of global risk models such as GIRI that begin to close the gap, even in countries where official data is difficult to access. As explained in Section 2.8, downscaling these models to the national or sub-national level can make a clear

↓ BOX 4.1

Dominica's Vision to be the World's First Climate-resilient Country

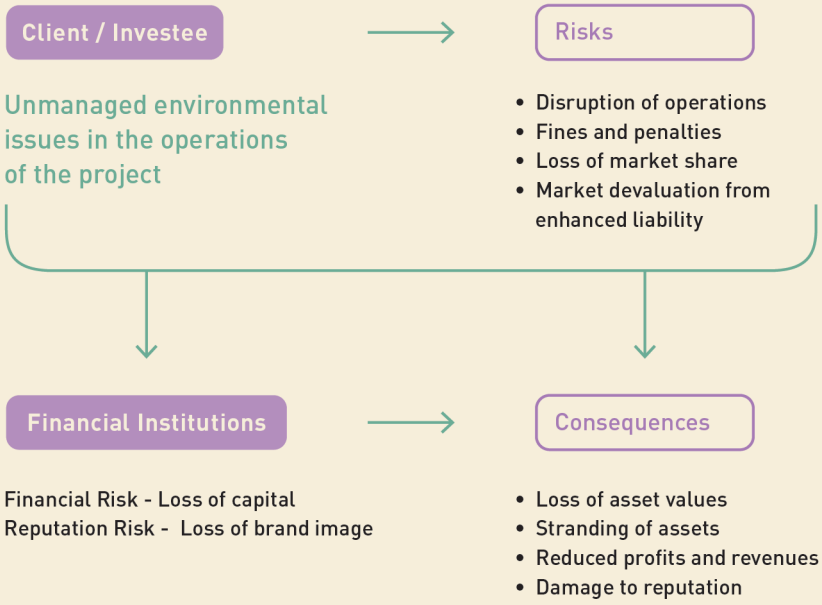
Source: Maskrey et al. (2023)

Before Hurricane Erika and Hurricane Maria devastated this Small Island Developing State in 2015 and 2017, respectively, Dominica pursued a more traditional approach of corrective risk management with a dominant focus on preparedness and response. The increasing concern for climate change opened a window of opportunity to drive a significant shift in the national policy towards prospective action and a commitment to transforming the island into the first climate-resilient country in the world.

The Prime Minister, in his address at the CARICOM (Caribbean Community)-UNDP Conference in New York in November 2017, soon after Hurricane Maria, stated, 'The unprecedented challenge we face has led us to take the unprecedented decision to build an executive agency outside of our standard public service systems. We are calling it CREAD – Climate Resilient Execution Agency of Dominica. The mission of the agency will be to coordinate all reconstruction work to avoid duplication, maximize economies of scale, spot and fill critical gaps, avoid bureaucratic infighting, and ensure all reconstruction activities are focused on a single climate-resilient recovery plan developed by Dominica and its partners.'

CREAD was accompanied by the 2018 National Resilient Development Strategy (NRDS), Dominica Climate Resilience and Recovery Plan 2020-30, and a new environmental law. These plans and strategies are built on its existing 2012 National Climate Change Adaptation Policy and the Low Carbon Climate Resilience Development Strategy. Collectively, these integrated climate resilience and disaster risk management into the national growth and development planning framework.

Systemic risk being socially constructed was also well articulated within the NRDS, which states that 'government is aware that climate change will affect many different economic sectors both directly and indirectly, and the characteristics of our social and economic systems will play an important role in determining their resilience amidst other development challenges. Therefore, addressing climate impacts in isolation is unlikely to achieve the desired equitable, efficient or effective outcomes of small island developing states such as Dominica.'



← FIGURE 4.3

How Environmental Risks Translate to Financial Risks

Source: WWF India (2023)

economic case for investing in resilience and estimating the resilience dividend, including through NbIS.

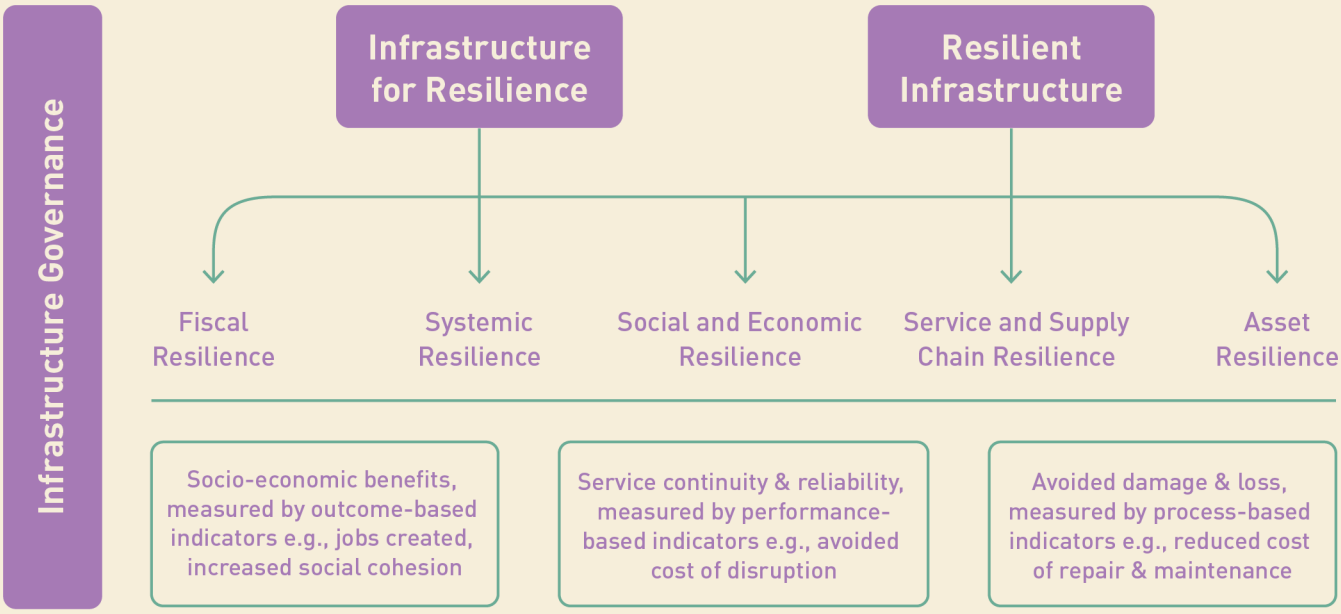
Financial risk metrics are also used to price risks and underpin insurance markets. Risk transfer mechanisms such as insurance (Miyamoto International, 2022)[26] can and should form an integral part of a national infrastructure resilience policy, strategy, and infrastructure financing. With a major loss of infrastructure assets in a large disaster, governments without an adequate level of savings and reserves cannot access contingency loans. They will have difficulties paying for the rehabilitation and reconstruction of uninsured assets (Mechler et al., 2016). Due to interrupted economic activity, fiscal shocks further reduce the capacity to finance recovery. If infrastructure assets are insured, recovery and reconstruction can be accelerated, avoiding fiscal downsides.

Unfortunately, in most LMICs, public infrastructure is protected neither by asset insurance nor by other instruments such as risk pools or insurance-linked securities (IIHS, 2022). The sovereign catastrophe risk pools that do exist in the Caribbean, Pacific, and Africa have required many years of sustained technical assistance from partner organizations[27] to facilitate the political and policy dialogue and coordination between participating governments (Miyamoto International, 2022).

While it is desirable that all infrastructure assets are insured, the pricing of premiums is generally insensitive to investments in resilience. Insurance premiums are usually calibrated with respect to the AAL of large pools of assets with differing levels of resilience (OECD, 2015). Thus, the cost of risk financing is rarely an effective incentive to encourage investments in resilience.

[26] 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 compensatory social or economic benefits given to that other party.

[27] 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), Southeast Asia Disaster Risk Insurance Facility (SEADRIF), and the World Food Programme has assisted African Risk Capacity (ARC).



↑ FIGURE 4.4

Framework for Infrastructure Resilience: Dimensions, Enabling Conditions, and Outcome Monitoring

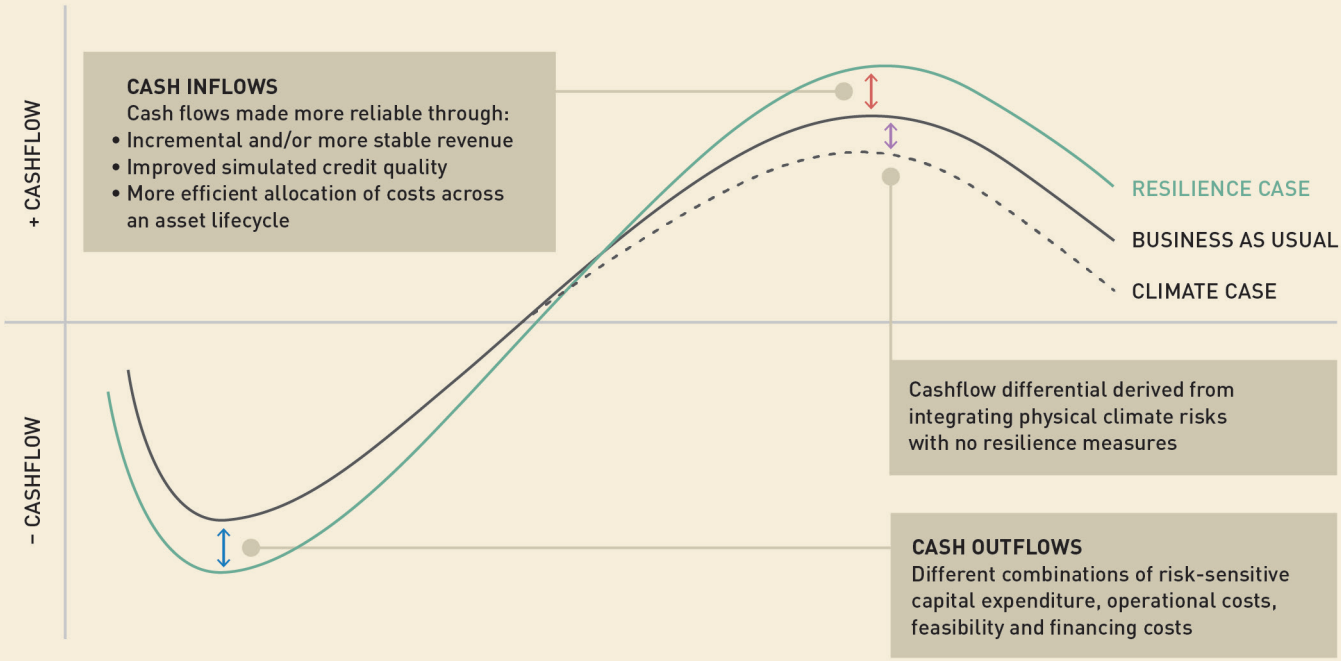
4.5.3. Identifying the Resilience Dividend

Investments in resilience are still considered by many infrastructure developers and financiers as incremental costs with no immediate benefits and sometimes imposed by regulators to meet safety standards.

Similarly, there is little incentive to optimize lifecycle costs, given 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 still insufficient awareness that investment in resilience can lead to value creation through a combination of reduced future loss and damage, optimized lifecycle costs, and improved certainty of operating cash-flows, combined with positive development outcomes, such as increased well-being and economic growth (Figure 4.4).

As already highlighted in Section 3.3.7, if investment in resilience is to become more attractive, the social rate of return on investment, including avoided loss and damage and service disruption; broader social, economic, and environmental co-benefits; and reduced systemic risk, needs to be considered (GCF, 2022; IIHS, 2023). Identifying and estimating the *resilience dividend* clearly is essential to change the perception of investments in resilience from a cost to an opportunity.

To be resilient, infrastructure assets need to be robust and well-maintained, with adequate O&M standards and targets (European Commission, 2019). As mentioned earlier, the capital cost of an infrastructure asset often only accounts for 15–30 percent of the overall expenditure over the design lifecycle, while 70–85 percent represent O&M expenses (UN, 2021). This requires a steady flow of resources, and hence, well-planned and soundly estimated



↑ FIGURE 4.5

Changes in Cashflow under Business-as-usual and Resilience Scenarios

Source: Chavarot et al. (2021)

investments. For example, in countries such as Austria, Denmark, Italy, Moldova, New Zealand, and Slovenia, over 50 percent of the total budget for road transport is spent on maintenance (OECD International Transport Forum, 2022).

If appropriate resilience standards are integrated at the project planning and design stage, then both capital expenditure (CAPEX) and operating expenditure (OPEX) can be optimized to convert resilience from a cost to a vehicle to generate additional, stable revenue over the asset lifecycle. Integrating financial risk metrics into asset design enables more predictable cash flows, improved credit quality simulations, and a more efficient allocation of costs across the whole asset lifecycle (Figure 4.5).

A critical challenge is determining who bears the contingent liability. For example, if a flood damages a major transportation hub, there is often no procedure for distributing losses amongst different stakeholders. The actual fiscal liability for investors, operators and users, as well as the public sector, is unclear. Furthermore, in most low-income countries, most of these losses are currently uninsured. Consequently, the burden of risk may lie entirely with the public sector (Jain, 2015), though this challenge can be addressed by explicitly defining shares in contingent liability.

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 discussed in Section 3.3.9, conventional cost-benefit analysis for infrastructure projects often fails to identify the total resilience dividend that can accrue over the lifecycle of a project. To identify the resilience dividend, this approach should be broadened to include avoided asset loss and damage and service disruption; the value of protected ecosystem services; co-benefits for households, communities, and businesses; and avoided systemic risk, including climate change and loss in biodiversity.

These broader benefits should be identified early in a project's development. Some are more easily quantifiable and measurable, such as the creation of new jobs. While 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. As Box 4.2 shows, investing in the planning of infrastructure development, for example, through pre-development technical assistance, plays a crucial role in allowing quantification of such benefits.

Realizing these benefits requires a shift in terms of how projects are planned, executed, and monitored. For instance, transport infrastructure would have to be planned from a broader perspective that includes the benefits of asset resilience, as well as reduced emissions and protected biodiversity, rather than only considering time and distance optimization (WWF India, 2023).

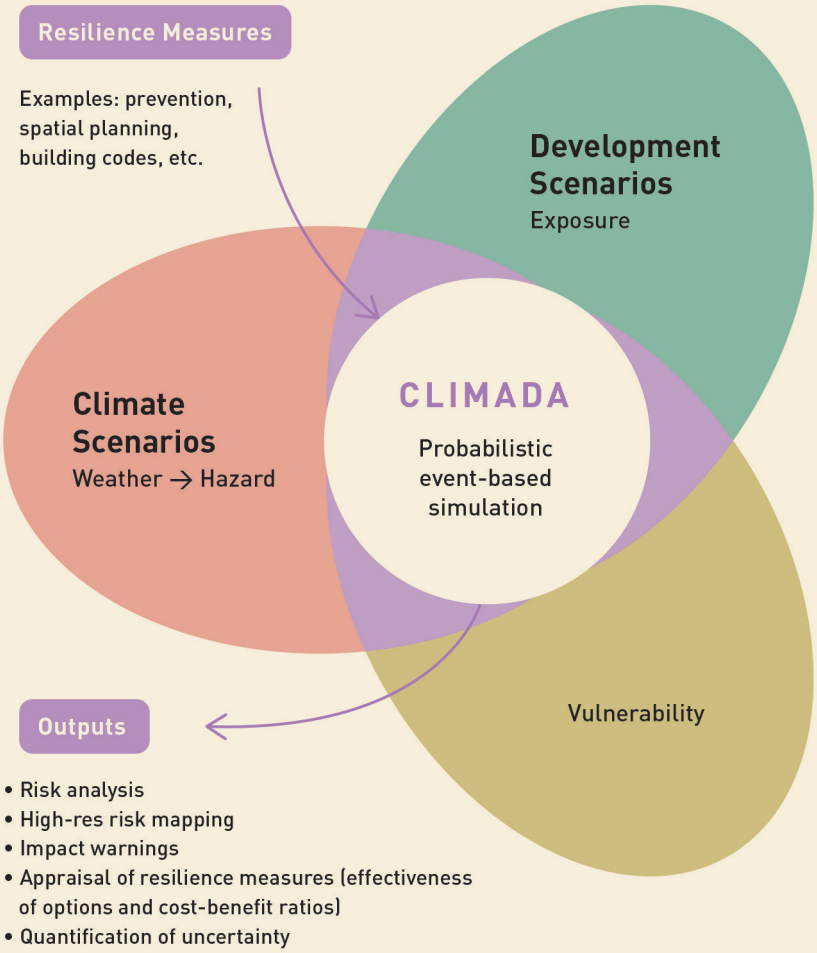
↓ BOX 4.2

The City Climate Finance Gap Fund
Source: ICSI (2022))

Investing in planning and risk-informed policymaking 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 (Global Covenant of Mayors for Climate and Energy (GcOM), C40, International Council for Local Environmental Initiatives (ICLEI), and Cities Climate Finance Leadership Alliance (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 encourage resilient infrastructure, which will have an impact on all projects in the future.

Identifying the resilience dividend can increase the economic and financial value of projects, thus demonstrating that the risk-adjusted returns of resilient investments can be attractive. There are a number of tools that facilitate the identification of the resilience dividend. For example, the CCRI Physical Climate Risks Assessment Methodology (PCRAM) determines the baseline climate resilience level of an asset and undertakes a cost-benefit analysis of potential resilience options (Chavarot et al., 2021). The Economics of Climate Adaptation studies present another useful framework and a modelling platform, CLIMADA, to assess not just the risks related to climate change but also the costs and benefits of different adaptation options (Figure 4.6).

The integration of resilience features in project design and operations should address bankability issues, improve the ability to raise project debt, and lower the cost of capital. Therefore, methodologies and frameworks, such as PCRAM or CLIMADA, should form part of standard lender due diligence processes. Discount rates can then be adjusted to reflect the Net Present Value of an asset once resilience features are factored into cash-flow projections. For example, in a renewable energy power plant in Asia, resilience was embedded into the design of the project from the outset. Implementing this resilience option increased the initial CAPEX by approximately 2 percent and decreased the internal rate of return by 0.1 percent. However, accounting for avoided future potential losses increased the internal rate of return by 2 percent, which highlighted an important resilience dividend (Chavarot et al., 2021).



↑ FIGURE 4.6

The CLIMADA Platform for Assessing Climate Change Impacts and Cost-benefit Ratios of Adaptation Options

Source: Adapted from ETH Zürich (2023)

4.5.4. Public Investment Planning and Evaluation

Within the context of a national resilience policy or strategy, governments can use financial risk metrics to integrate resilience into their public investment planning and evaluation systems.

In most LMICs, local infrastructure systems, such as health and educational facilities, water and power systems, and rural roads, are financed almost exclusively through public investment. Local infrastructure investments yield significant social and economic returns. While local governments play a key role (McIntosh et al., 2018), it is difficult to mobilize finance for local infrastructure systems in smaller cities with limited governance capacities (UNDESA, 2012).

The capacity of local government varies across the globe: in Europe, municipalities account for around 45 percent of all public investment in infrastructure, but in LMIC, it is often just a fraction of this (EIB, 2021). The contingent liabilities of local governments in lower-income countries are often associated with extensive risk (frequent low-severity events). A retrospective analysis of disaster loss and damage data[28] can often be an important first step in identifying and estimating risks to local infrastructure.[29] However, as Box 4.3 highlights, data availability is still a challenge.

[28] Despite several decades of efforts to strengthen data collection and reporting, disaster loss and damage data continues to be inconsistently documented in many countries.

[29] 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.

Several governments in Latin America and Asia have adopted methodologies for incorporating risk and resilience into their prioritization of capital investment (ICAP & GIZ, n.d.). These efforts have produced mixed results to date, mainly due to limited local capacities to formulate infrastructure projects based on financial risk metrics and resilience standards. The DX4 Resilience initiative of UNDP and the Government of Japan developed a composite methodology to provide 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 comprises five components that together enable local governments to assess the local infrastructure deficit, estimate the risk to existing and future local infrastructure, and generate the order of magnitude estimates for the costs of reducing the deficit and strengthening resilience.

↓ **BOX 4.3**

Disaster Databases in India

In India, the National Remote Sensing Centre has established a National Database for Emergency Management (NDEM) that brings together geo-referenced data on historical climatic and non-climatic disasters at multiple scales with the participation of multiple institutions.

A global database, EM-DAT (International Disaster Database of the Centre for Research on the Epidemiology of Disasters, i.e. CRED), documents major disasters; however, it neither captures extensive events, such as urban droughts, heat or local floods, or storm events, nor data on infrastructure damage [EM-DAT, 2009]. At the same time, it is not geo-referenced to the local level, which is necessary to identify infrastructure-relate risk. Initiatives, such as NDEM have the potential to close this gap.

NDEM attempts to bring together hazard-specific data that is spread over multiple sources. For example, the Cyclone eAtlas has historical tracks [Ministry of Earth Science et al.' 1891]. The India Meteorological Department [IMD] recently launched a Climate Hazard and Vulnerability Atlas. All states and most districts have Disaster Management and Climate Change Action Plans that document much of the disaster losses and expenditure made by the state and non-state actors. Post-Disaster Needs Assessments [PDNAs] are a potentially useful resource too but split into multiple documents [ECHO et al., 2018]. NDEM can integrate historical data from multiple sources on all hazards and their impacts.

On the basis of IMD's more than 100-year records of temperature, rainfall, and cyclone tracks, state and district plans and national atlases, and satellite image processing, a useful Atlas of Disaster Loss and Damage could be established as an open access portal that documents and freely disseminates information on the spatial extents and attributes of infrastructure loss and damage and recovery costs (India Water Portal & Tyndall Centre for Climate Change Research, 2005). Such an atlas could be invaluable for estimating risk and calculating the investment required to strengthen resilience.

↓ FIGURE 4.7

Steps towards Developing Integrated Projects Pipelines to Mitigate Risk

Source: GCF (2022)

4.5.5. Pipelines of Bankable Resilience Projects

National resilience plans can include developing project pipelines consisting of a series of projects developed in connection with each other.

Project pipelines can enable government, industry, and communities to plan better and finance investment in resilience (GIH, 2022). For governments, pipeline development is an essential step in planning infrastructure. The industry needs pipelines to plan and prepare its resources both on a micro level (in pursuit of specific programmes and projects) and on 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 prioritize workforce education and upskilling programmes. Moreover, pipelines can be an effective tool to demonstrate transparency so that communities can see what is being built and when.

Project pipelines also allow the bundling and aggregation of smaller projects in a way that optimizes the allocation of funding sources across projects. Small projects do not have the scale to attract private investment and increase risk for investors. But if they are aggregated and bundled together in a project pipeline, they become more attractive to investors as the risk is distributed across the range of projects.

Project and portfolio risk valuation needs to cover a range of risks, from construction to market risks and O&M to regulatory and political risks (GCF, 2022). By accounting for the full range of risks, project pipelines can help to *de-risk* private infrastructure investment. This allows governments to then select the most appropriate mix of financial instruments for the pipeline rather than

bundling projects to match specific financing mechanisms, which can increase the portfolio risk (Figure 4.7).

A well-bundled project pipeline presented in an investment road map for climate-resilient investment can attract private-sector institutional investors alongside public-sector funding (Box 4.4) (GCF, 2022).

4.5.6. Towards a Resilient Infrastructure Asset Class

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 (ICSI, 2022). Environmental, social and governance (ESG) performance indicators can also potentially inform infrastructure investors. Figure 4.8 provides an example of how to map the most 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, 2023).

However, no single comprehensive set of criteria for ESG in infrastructure is universally recognized, limiting the usefulness of current multiple ESG frameworks for infrastructure resilience. At the same time, there is insufficient evidence that confirms how positive ESG scores increase investment in resilience. ESG scores for LMICs companies tend to be systematically lower than those in high-income countries, meaning ESG-focused funds allocate only limited resources to LMICs (Ehlers et al., 2022).

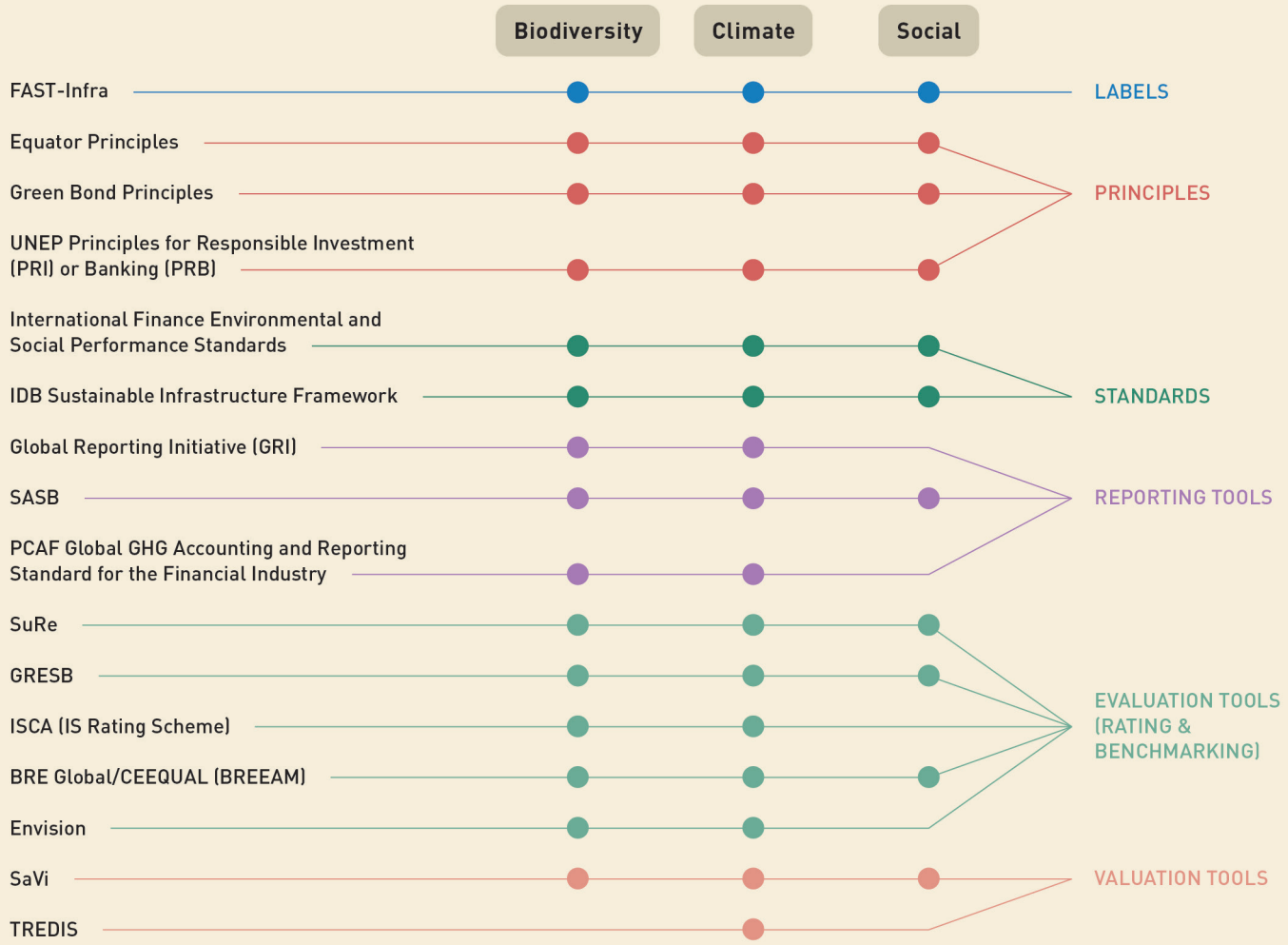
Initiatives that promote a common approach to identifying sustainable, quality, and/or green infrastructure projects include several 'meta-standards', such as FAST-Infra (Finance to Accelerate the Sustainable Transition-Infrastructure) label, the SuRe (Standard for Sustainable and Resilient Infrastructure) standard, and the Blue Dot Network (BDN). FAST-Infra (presented in Box 4.5), led primarily by finance-sector institutions, launched the Sustainable Infrastructure Label to identify sustainable infrastructure projects. SuRe is a third-party verified global voluntary standard developed by Global Infrastructure Basel (GIB). It provides certificates in line with insurance standards (Global Infrastructure Basel Foundation, n.d.). The American, Australian and Japanese governments introduced the Blue Dot Network framework to certify quality infrastructure projects (US Department of State, 2019).

↓ BOX 4.4

Ghana's Investment Roadmap for Climate-resilient Infrastructure

Source: GCF (2022)

The Ministry of Environment, Science, Technology and Innovation of Ghana (MESTI) and GCF developed Ghana's first investment roadmap for climate-resilient infrastructure in collaboration with UNOPS (United Nations Office for Project Services), 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. GCF is working with the Government of Ghana and other partners to finance these projects, which requires the support of public and private partners.



↑ FIGURE 4.8

Principles, Standards, Frameworks and Tools in the Context of Infrastructure Investments

Source: WWF India (2023)

Going forward, it is essential that these meta-standards are fully aligned and address the user needs across all infrastructure sub-sectors, especially in emerging geographies where the majority of new infrastructure is expected to be built (WWF India, 2023). A combination of resilience standards and credible *third-party* certification processes can pave the way for creating an infrastructure resilience asset class, providing investors with a transparent identification of opportunities for investment in resilience.

↓ BOX 4.5

FAST-Infra
Source: Losos and Fetter (2022)

FAST-Infra (Finance to Accelerate Sustainable Transition-Infrastructure) is a PPP aimed at closing the current investment gap in sustainable infrastructure. Initially launched as a collaboration between Hongkong and Shanghai Banking Corporation Limited, the Organization for Economic Co-operation and Development, the International Finance Corporation, the Global Infrastructure Facility, and the Climate Policy Initiative under the auspices of the One Planet Summit, it has become a broad partnership supported by more than 80 public and private institutions.

The main objective of FAST-Infra is to accelerate the deployment of sustainable infrastructure globally by promoting the development and improvement of sustainable, affordable, and inclusive infrastructure services. To achieve this, FAST-Infra has developed a three-pronged strategy consisting of:

1. Sustainable Infrastructure Label: Certifying the sustainability of infrastructure projects
2. FAST-Infra Platform: Increasing the volume of bankable/financeable projects
3. FAST-Infra Beyond: Accelerating innovation in the field of sustainable infrastructure

The Sustainable Infrastructure Label is based on five dimensions (Figure 4.9) of sustainability: environmental, social, governance, adaptation, and resilience, and is intended to define and measure sustainability contribution and credentials, increase market trust and confidence around the sustainability of infrastructure assets, inform investment decision-making and attract private investment into infrastructure, and encourage new financial product development. The FAST-Infra platform supports stakeholders in preparing, developing, financing, and deploying large-scale sustainable infrastructure programmes, particularly in developing countries. The platform is designed to enhance cooperation around project data and mobilize third-party technologies, as well as lower transaction costs, accelerate lead time, and enhance project quality and bankability. FAST-Infra Beyond is a sustainable infrastructure innovation hub that incubates and accelerates digital, tech, financial, legal, regulatory, and governance innovations. The hub aims to help institutions de-risk, aggregate, and automate projects across the sustainable infrastructure value chain.

↓ FIGURE 4.9

FAST Mechanism
Source: Losos and Fetter (2022)

4.5.7. Allocating the Resilience Dividend

One of the major barriers to increasing private investment in resilient infrastructure is that the resilience dividend over the design lifecycle usually benefits a broad set of stakeholders. Allocating the costs and benefits of risk and resilience amongst these stakeholders is the key to providing incentives for 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 and local governments, private asset owners, landowners, and users (ICSI, 2022). 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.

Once the resilience dividend and stakeholders have been clearly identified, it is necessary to develop policies that monetize the socio-economic benefits of investing in resilience and enable investors to capture a part. The value of the resilience dividend needs to be estimated first, combining project and economic evaluation (e.g., through the Resilience Dividend Valuation Model).[30] In this approach, the resilience dividend is calculated as the sum of benefits, over time, from a project investment integrating resilience, compared to one that does not.

↓ BOX 4.6

Implementing NbIS at Scale
Source: USFS (2023)

Blue Forest (BF) is a mission-driven non-profit organization dedicated to leveraging financial innovation to develop sustainable solutions to pressing environmental challenges. In 2017, the United States Forest Service and Blue Forest signed a memorandum of understanding (MOU) to develop and implement the Forest Resilience Bond (FRB)[31], and in 2018, launched Yuba I, the first FRB pilot project to fund forest restoration across 15,000 acres of the Tahoe National Forest in California.

The FRB is based on the idea that the value of the ecosystem services that restored healthy forests provide, such as decreasing the severity of wildfires, exceeds the restoration cost. The FRB allowed public agencies to increase the pace and scale of forest landscape restoration with a cost-benefit analysis that showed the programme to be more effective than current models of forest landscape restoration.

Yuba I provided $4 million in upfront private capital from four investors to fund ecological restoration treatments to reduce wildfire risk. Three beneficiaries-the US Forest Service, Yuba Water Agency, and the State of California-provided in-kind support and funding at contracted rates to reimburse investors for restoration work. Restoration activities were carried out by the National Forest Foundation, the project's primary implementation partner and its contractors (Figure 4.10).

[30] Developed by the Rand Corporation with support from the Rockefeller Foundation (Bond et al., 2017).

[31] https://www.blueforest.org/forest-resilience-bond

The $4 million pilot project attracted $25 million in private investment, paving the way for larger projects. There was a net gain in biodiversity from maintaining existing wildlife habitats and increasing habitats for species that require less dense forest structures. Restoring aspen and meadow ecosystems and removing invasive weeds also enhanced plant and animal biodiversity in these habitats.

The economic feasibility was ensured by grants from private foundations that agreed to a 1 percent return on investment. Other private investors agreed to a 4 percent return on investment. Infrastructure entities paid for the investments with proceeds generated from monetized benefits, including avoided wildfire costs and improved water quality and quantity. The funds generated from thinning activities were used to pay contracts and for additional ecosystem restoration work. Ecosystem valuation cost-benefit accounting convinced the beneficiaries and investors that the value of benefits outweighed their contribution to the project.

The pilot project laid the foundation for the future use of this instrument for NbIS to restore landscapes. Private finance capital and blended finance mechanisms can influence the public sector to participate in new forms of financing to benefit its goals and objectives.

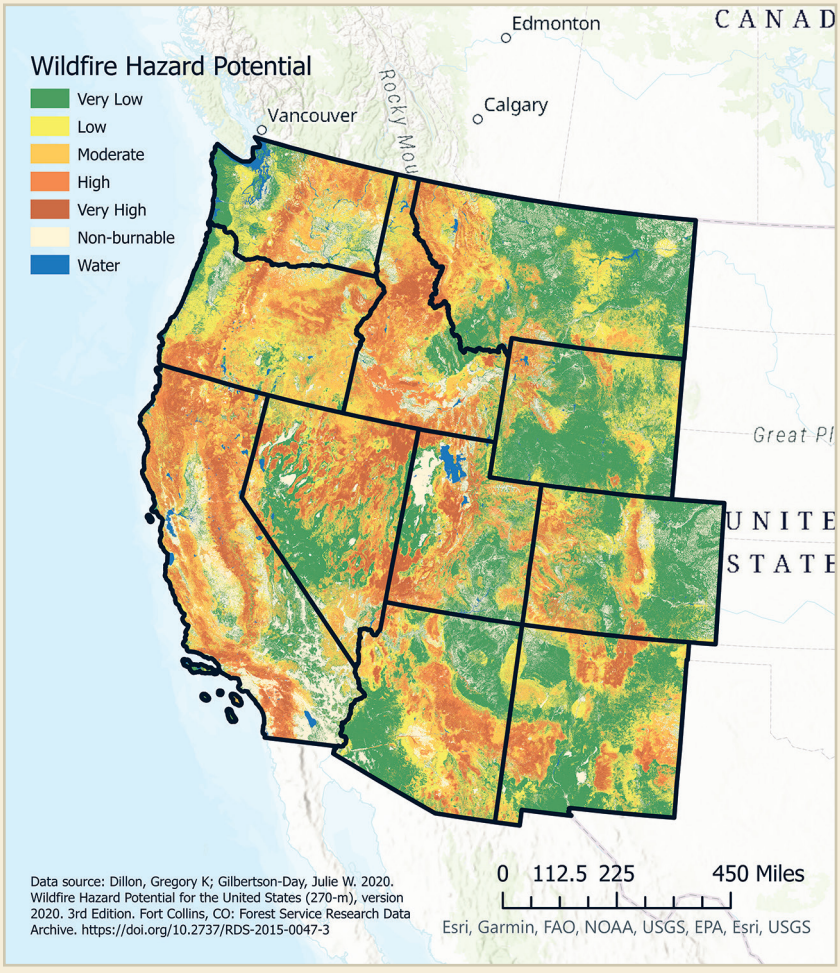
Initiative 20x20 is a regional fiscal intermediary group launched in 2014 to change the dynamics of land degradation in Latin America and the Caribbean. Currently, 18 countries and 3 regional programmes have committed to improving more than 52 million hectares of land by protecting and restoring forests, farms, pastures, and other landscapes by 2030. Over 85 technical organizations, institutions, impact investors, and funds have contributed $3.09 billion in private investment to Initiative 20X20 (Initiative 20x20, 2014).

Both Blue Forest Conservation and Initiative 20x20 have now developed long term PPPs, built a collective of investors, and supplied a robust pipeline of NbIS projects ready for funding (Gartner et al., 2022). Private funds supplement government funding for NbIS projects and greatly increase the pace and scale of strengthening infrastructure resilience (Blue Forest Conservation, n.d.).

↓ FIGURE 4.10

Yuba Project Completed Treatments (2019)

Source: Tahoe National Forest & Blue Forest Conservation (2018)



↓ BOX 4.7

Blending Public and Private Capital to de-risk Investments: Climate Investor Two

Source: ICSI (2022)

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: (i) a development fund (DF), (ii) a construction equity fund (CEF), and (iii) a climate credit fund. The DF is a wholly concessional capital pool funded by donor contributions, which aims for capital preservation and mobilizes private capital into the CEF. The DF offers up to 50 percent of the planning and development costs of the projects along with technical assistance. Equity financing of up to 75 percent 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 such as 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 for successful fundraising.

In other words, the additional value generated by investing in resilience in comparison to 'business as usual' (Bridgett-Jones, 2017).

Monetizing the resilience dividend can be seen through the dual lenses of tangible vs. intangible benefits and internal vs. external benefits. Tangible benefits relate to potential streams of cash flows that can be quantified relatively easily, such as reduced maintenance costs, avoided asset losses, improved infrastructure services and other benefits including biodiversity preservation that can be quantified (and monetized) through a voluntary carbon market mechanism. Intangible benefits are more diffuse and benefit broader society. Quantification is less obvious, meaning they are more difficult to monetize. They may only be measurable nationally (e.g., health, environmental, or other societal benefits).

Internal benefits are those that accrue at the asset level to the users, managers, or owners of the asset. Their allocation is generally governed by the regulations and legal framework under which the asset operates. For example, a public highway with no toll fees is an infrastructure asset where the internal tangible benefits are allocated entirely to its users. In contrast, if the same highway is operated by a concessionaire with the right to charge tolls, the benefits are normally allocated between the concessionaire, the users, and the authority that granted the concession. External benefits are typically not attributes of the infrastructure asset *per se*. While the asset owner may benefit directly or indirectly, these benefits are normally not quantified (e.g., economic growth from new or improved infrastructure or the increased resilience of a national economy to economic-, financial-, and hazard-related shocks).

Tangible, internal benefits are the easiest to monetize (for example, through the identification and quantification of costs and benefits of different resilience strategies). In contrast, intangible and external benefits are the most difficult to monetize, as demonstrated through decades of negotiations on the costs of climate change. Benefits that are tangible and external can be monetized by mechanisms such as fiscal incentives provided that the beneficiaries, and their propensity to be taxed, can be clearly identified, with proceeds redistributed to asset owners.

On the other hand, internal and intangible benefits can be monetized through existing mechanisms, such as payment for ecosystem services and other conservation 'banking' tools developed

to support NbIS, distinguishing between benefits that communities and local businesses should pay and the benefits that governments should pay. Box 4.6 highlights a case where investors can monetize part of the resilience benefits accrued from an NbIS programme.

For the monetization of the resilience dividend to become a quotidian practice, 'Voluntary Resilience Benefit Certificates', modelled along the lines of the Voluntary Carbon Market, could be introduced (Chavarot, 2023). The certificates could identify and monetize the resilience dividend based on predefined standards. Finance ministries could then issue the certificates and implement or regulate a trading scheme. They could also be potentially structured as a pre-payment of future resilience dividends and used for finance investments in resilience through national resilience funds. MDBs could be asked to co-fund such pre-payments through investment in national resilience funds.

It could also be possible to develop and structure a parametric insurance product that links pay-outs with a reduction in losses as a result of embedded resilience features in an asset. This could then be replicated at a portfolio or even national level with insurance-linked resilience securities issued in capital markets.

4.5.8. Innovative Financing Instruments for Infrastructure Resilience

New financial instruments and mechanisms are required to mobilize capital for infrastructure resilience, thus unlocking new economic opportunities.

First, there is a need for financial structures that adequately blend public and private sources of capital through de-risking mechanisms (Box 4.7).

↓ **BOX 4.8**

Financial Instruments to Mobilize Untapped Financial Resources: Philippines Energy Development Corporation (EDC)

Source: ICSI (2022)

Following the major earthquake in Leyte in July 2017 and a series of severe weather events throughout the year, the renewable energy company Philippines Energy Development Corporation (EDC) and its partners developed an approach to prioritize the implementation of risk reduction measures to protect key assets. In June 2018, the International Finance Corporation (IFC) issued the first AAA peso-denominated green bond for approximately $90 million with a 15-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 the risk to EDC Philippines's assets, allowing EDC to expand its generation capacity and offerings to other clients.

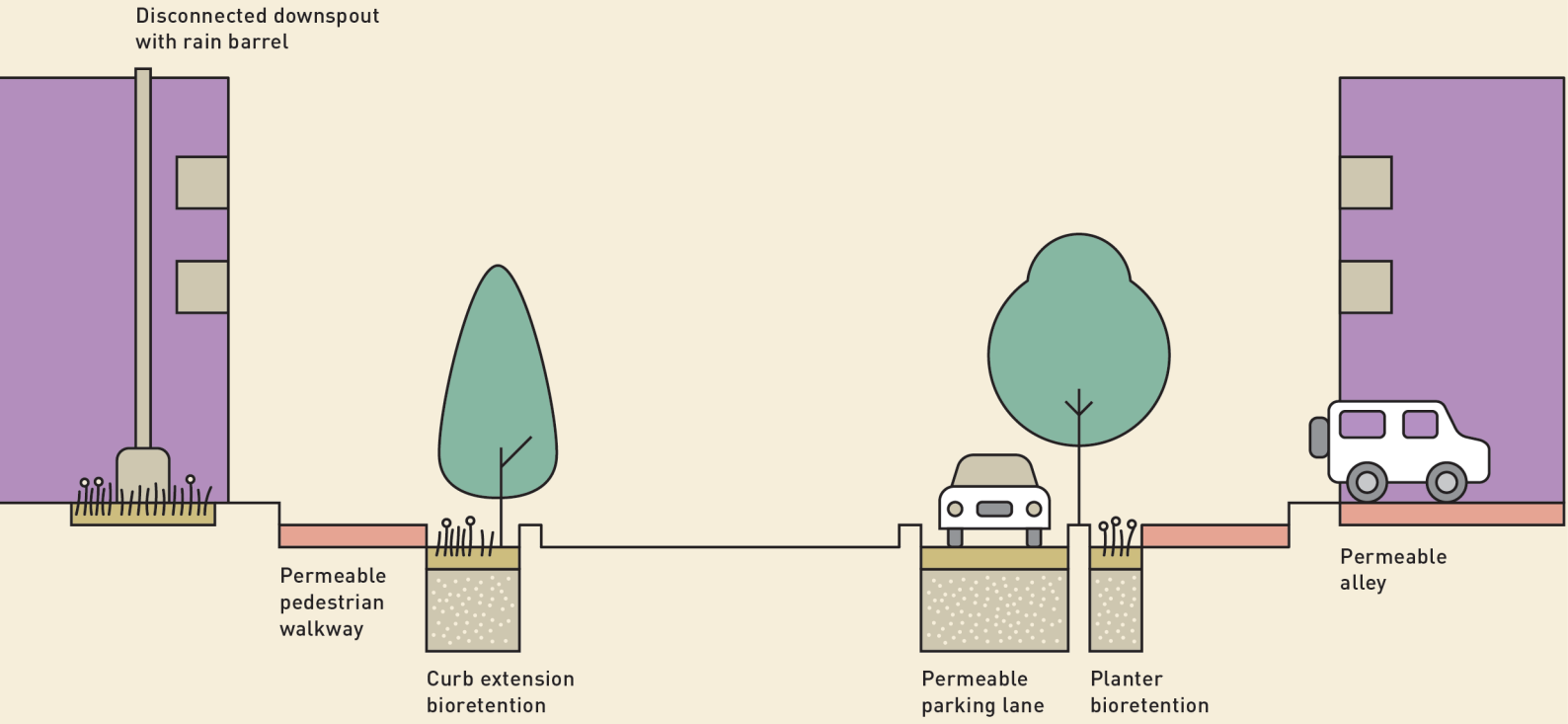
In addition to increasing resilience to physical assets, IFC's green bond paved the way for EDC Philippines to issue its own green bonds. IFC and other investors anticipated that the first green bond issued for the Philippines could create a market for local green bond investments in the country. EDC Philippines established a similar procedural model for green bond issuance as the IFC, with clearly defined guidelines for projects and a second reviewer. It issued its first bonds in 2021 for several small projects across its portfolio, benefitting from a regulatory environment that was amenable to green finance and resilience projects. Pre-established governance structures related to risk and capacity in disaster risk reduction allowed EDC Philippines to engage with different departments and incorporate new assessment tools.

→ BOX 4.9

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)

Source: ICSI (2022)

The combined stormwater/sewer system in the District of Columbia (DC) could no longer handle capacity, especially during flooding events, thus increasing sewage levels in the District's rivers and exceeding existing water quality standards. DC Water and its partners financed an integrated green-grey 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 (Figure 4.12).



↑ FIGURE 4.11

Interventions to Reduce Stormwater Runoff

Source: Adapted from USFS (2023)

Traditional financial products could not adequately incorporate project uncertainty or capture the longer-term benefits of DC Water's green-grey solution. The EIB adapted performance mechanisms from a social impact bond to meet these needs. The bond used performance-based metrics to hedge project performance uncertainties for DC Water and 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.

With the help of such mechanisms, public funds can provide the basis for and stimulate private investment in resilient infrastructure while simultaneously accelerating development goals.

The creation of national resilience funds, to fund project pipelines, could provide a vehicle that blends public capital, private investment, and, where appropriate, climate finance in a way that de-risks projects for investors, maximizes rate-of-return, and appropriately distributes the resulting resilience dividend amongst the range of stakeholders. 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.

Second, new financial instruments can allow the mobilization of untapped financial resources. As Box 4.8 illustrates, the issue of *green bonds* has helped strengthening resilience in the Philippines.

Third, as Box 4.9 shows, green financial instruments can also promote the integration of NbIS (ICSI, 2022).Debt relief programmes or new debt swap mechanisms are another mechanism that can significantly increase the fiscal space of heavily indebted LMICs, generating new resources for resilience building and energy transition (Box 4.10) (Elston, 2021).

Figure 4.12 summarizes some of the sources and innovative instruments that LMICs may use to mobilize resilience financing (South Pole Carbon, 2022). Sources of financing range from local to international and public to private and include instruments that can be used for resilient infrastructure development and those linked to post-disaster risk financing.

↓ **BOX 4.10**

Debt for Climate Swaps as New Ways to Align Increased Fiscal Spaces with Globally Shared Climate and Development Goals

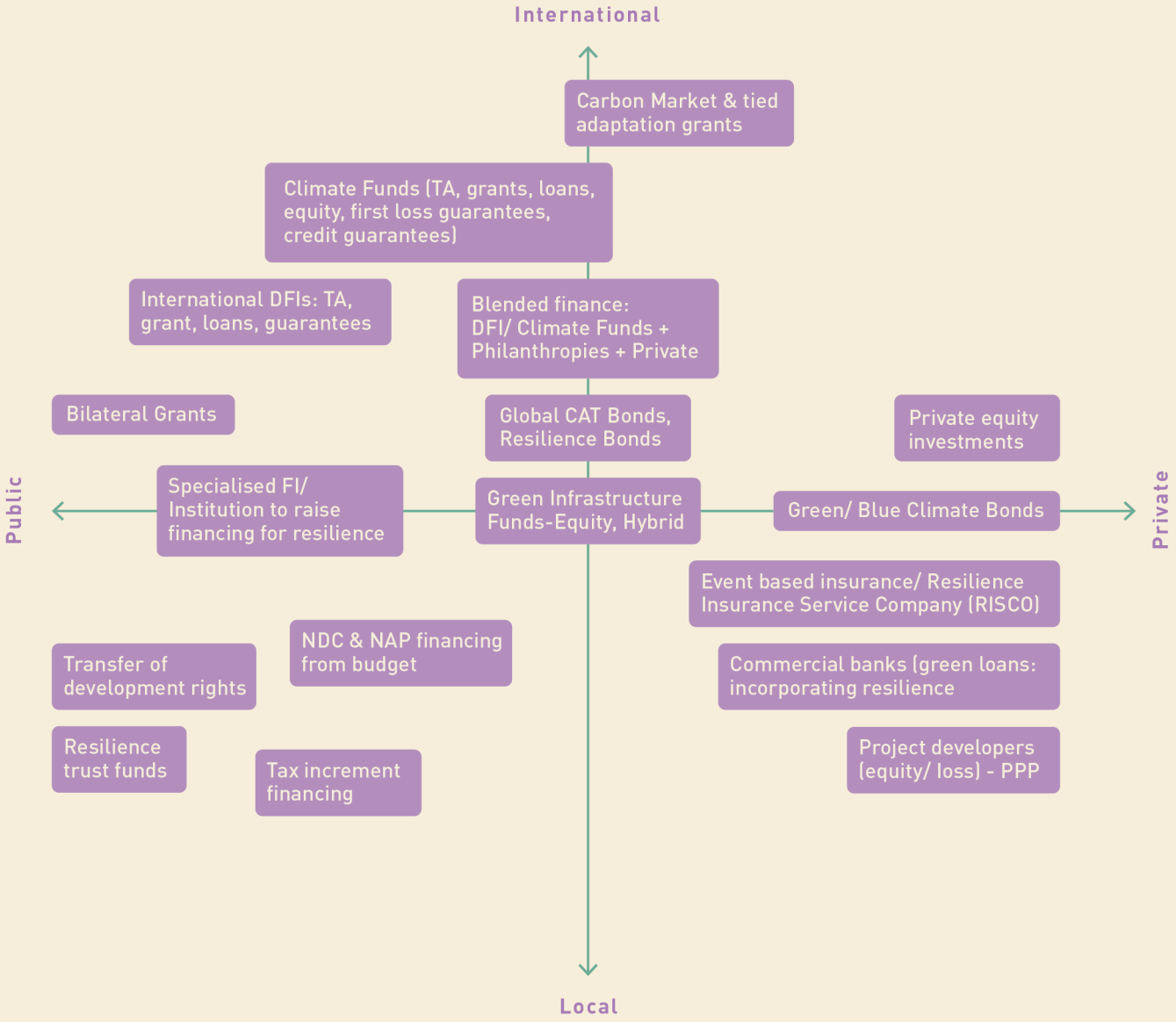
Source: Arlington (2022); IMF (2022)

Debt for climate swaps and debt for nature swaps are new mechanisms that can free up fiscal resources currently bound up in servicing unsustainable debts to improve resilience without triggering financial crises or sacrificing spending on existing development priorities. The principle is relatively simple: creditors provide debt relief conditional on a country's commitment to invest in resilient infrastructure, protect forests or marine ecosystems, or decarbonize the economy.

While such debt swaps cannot provide a universal solution to countries struggling with debt, they can be developed in a manner that complements existing instruments and helps strengthen resilience building in countries already affected by climate change or biodiversity loss. Despite having existed in various forms for decades, debt swaps are still a niche product and can now be scaled up by structuring deals around broad environmental and adaptation goals and linking swaps to clear and measurable metrics.

One country that has developed an innovative debt swap tool is Barbados, supported by The Nature Conservancy (TNC) and the Inter-American Development Bank. The financial deal will enable the Government of Barbados to redirect a portion of its sovereign debt service into marine conservation funding. Under this debt swap agreement, Barbados has committed to conserve 30 percent of its ocean and develop a sustainable marine economy. Barbados' high debt burden severely limited its efforts to invest in climate change adaptation and conservation. Under the new initiative, it completed a $150 million debt conversion that is expected to free up approximately $50 million to be invested in environmental and sustainable development over the next 15 years, building the resilience of the country and the livelihoods of its people.

Barbados is a good example of where climate action at this scale could not have been taken without a swap. In the mid to long term, debt reduction that translates into resilience investment in this manner can not only just give a country fiscal relief through budget savings but also result in the upgrade of a country's credit rating, making future government borrowing cheaper.



NDC: Nationally Detemined Contributions; **NAP**: National Adaptation Plans; **FI**: Financial Institutions; **DFI**: Development Finance Intitutions; **TA**: Technical Assistance; **ITMI**: Internationally Traded Mitigation Outcomes; **PPP**: Public Private Partnership

↑ FIGURE 4.12

Innovative Sources to Finance/ Fund Resilient Infrastructure

Source: South Pole Carbon (2022)